

An inquiry of **conditions** and **criteria** associated with Green Building project **success**

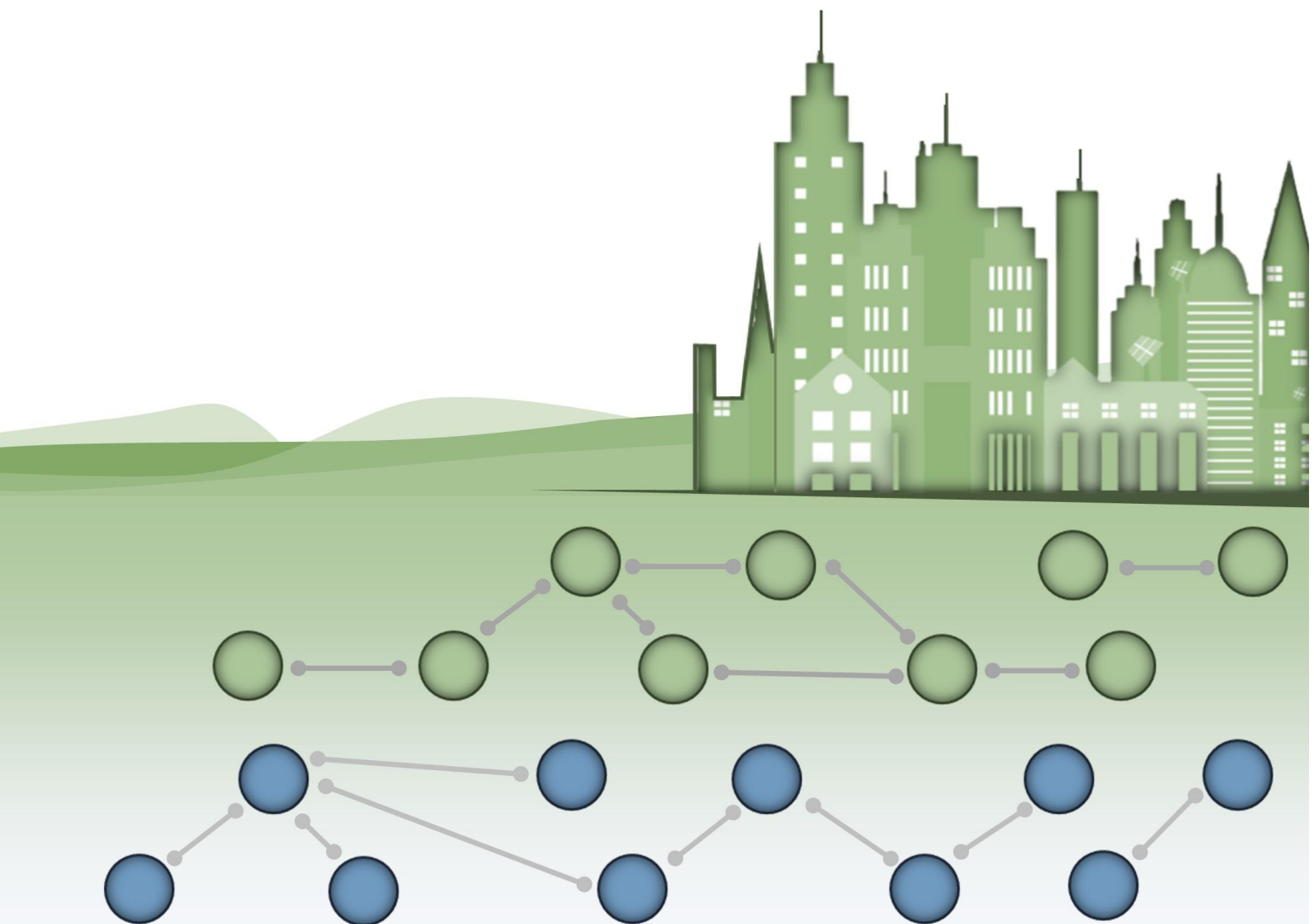
Tayyab Ahmad

PhD Thesis

Melbourne School of Design

Faculty of Architecture, Building and Planning

University of Melbourne



Весь космос только бесконечный и сложный механизм. Сложность его так велика, что граничит с произволом, неожиданностью и случайностью, она дает иллюзию свободной воли сознательных существ.

The Universe is nothing but an infinite and complex mechanism. Its complexity is so great that it borders on wilfulness, suddenness, and randomness; it gives the illusion of free will possessed by conscious beings.

Konstantin Tsiolkovsky

An inquiry of conditions and criteria associated with Green Building project success

Tayyab Ahmad

ORCID iD: <https://orcid.org/0000-0002-9024-3369>

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Abstract

Buildings are an extremely important part of the built environment as they fulfil the requirements of human life on a daily basis in terms of living and working. However, services from buildings come at a cost as the building and construction sector tends to consume large amounts of resources and therefore negatively impacts the environment. With an increased understanding of environmental degradation, society is starting to show more acceptance towards Green Buildings. These buildings tend to be much more environment-friendly, socially habitable and economically affordable in the long term. To sustain increased development of such projects, attention should be given to the Success conditions which enable aspired project outcomes and Success criteria against which the project performance is evaluated.

Most existing studies have not focused on identifying Success conditions and criteria specific to Green Building projects. There is also a dearth of research focused towards interrelationships within Success conditions and Success criteria. This limits the use of previous research on Green Building development practices.

Focusing on office buildings, this thesis investigates how Green Building development can be managed to achieve successful project outcomes. This research takes into account the special requirements of Green Buildings as well as the Success criteria and Success conditions of Green Buildings. This research used the theoretical lens of Project Success, Sustainability, Complexity perspective and the Transformation-Flow-Value-generation theory. An exploratory and explanatory mixed-methods research design is used. This research design relies on a multi-regional survey of 104 Green Building professionals and 75 semi-structured interviews in Australia, Hong Kong, Pakistan, Singapore, the United Arab Emirates, and the United Kingdom. To interpret the data and test the reliability of findings, qualitative and quantitative analysis are conducted on interview and survey findings.

Results show that Green Buildings are significantly different from traditional buildings primarily because of their complexity, design methodology, and team collaboration. Project management performance (that is, *Schedule, Cost, and Quality*) in Green Buildings is interrelated with sustainability performance. Good project management tends to associate with high sustainability performance in Green Buildings. Results also confirm the fact that successful Green Buildings are mainly those which meet the end-users needs and client's requirements and at the same time have reduced environmental effects. Results also demonstrate that success in Green Buildings is generally associated with socio-technical conditions. To achieve success in Green Building development it is necessary to have proficient project teams and clients, high collaboration among the team, highly committed project team and client, rigorous project planning, timely execution of activities, and rigorous process of defining goals. These conditions help realise success in Green Buildings by resulting in value for the project client and reducing the non-value adding activities during project development.

For practice related to Green Buildings, the findings of this research will allow project decision-makers to have a more holistic range of criteria to judge the project performance and make decisions related to project development. Clients and project teams can consider the wide range of identified conditions to optimise project performance and achieve successful project outcomes. The Success conditions and criteria can also be considered by Green Building certification systems in their credit lists to ensure a higher correlation between certification and success. Theoretically, the findings can inform future research focused on Green Building project development. This will ultimately result in the more efficient development of Green Building projects that help reduce the effects of climate change as well as resource depletion.

Declaration

This is to certify that

- The thesis comprises only my original work towards the PhD except where indicated in the Preface,
- Due acknowledgement has been made in the text to all other material used,
- The thesis is fewer than 100,000 words in length, exclusive of tables, bibliographies and appendices.

Tayyab Ahmad

May 2020

List of Research Publications

Publications directly relevant to this thesis

The researcher authored the following journal and conference papers directly relevant to the research inquiry in this thesis

Refereed Journal Papers

- Ahmad, T. and A.A. Aibinu, *Project delivery attributes influencing green building project outcomes: A review and future research directions*. Built Environment Project and Asset Management, 2017. 7(5): p. 471-489.
- Ahmad, T., A.A. Aibinu, and A. Stephan, *Managing green building development – A review of current state of research and future directions*. Building and Environment, 2019. 155: p. 83-104.
- Ahmad, T., A.A. Aibinu, A. Stephan, and A.P.C. Chan, *Investigating associations among performance criteria in Green Building projects*. Journal of Cleaner Production, 2019.

Refereed Conference Papers

- Ahmad, T., A. Aibinu, and A. Stephan, *Green Building Projects: Process Innovation Leading to Project Innovation*, in *33rd Annual ARCOM Conference*. 2017: Cambridge, UK.

Other publications

During his PhD candidature, the researcher also authored conference papers and a layman article related to Green Building projects, however not directly relevant to the research inquiry in this thesis.

Refereed Conference Papers

- Ahmad, T., A. Aibinu, and M.J. Thaheem. *BIM-based iterative tool for sustainable building design: A conceptual framework*. in *International High-Performance Built Environment Conference – A Sustainable Built Environment Conference 2016 Series (SBE16)*, iHBE 2016. 2017. Sydney.
- Ahmad, T., A. Aibinu, and M.J. Thaheem. *The effects of high-rise residential construction on sustainability of housing systems*. in *International High-Performance Built Environment Conference – A Sustainable Built Environment Conference 2016 Series (SBE16)*, iHBE 2016. 2017. Sydney.
- Ahmad, T., A.A. Aibinu, and A. Stephan, *Green buildings in Australia: explaining the difference of drivers in commercial and residential sector*, in *6th CIB International conference on Smart and Sustainable Built Environments - SASBE2018 Conference*. 2018: Sydney, Australia.

Non-refereed article

- Aibinu, A.A. and T. Ahmad, *High-rise housing and. Sustainable development: are we doing it right?*, in *Atrium 33*. 2017. p. 14-15.

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List of abbreviations

Abbreviation	Definition
AEC	Architecture, Engineering and Construction
BEEC	Building Energy-efficiency Certificate
BOT	Build-Operate-Transfer
BREEAM	Building Research Establishment Environmental Assessment Method
CMR	Construction Management at Risk
CSAQ	Computerised self-administered questionnaires
CSF	Critical Success Factor
D&C	Design and Construct
DB	Design-Build
DBB	Design-Bid-Build
DBMC	DB mechanical contractors
DEC	Display Energy Certificates
ESD	Ecologically Sustainable Development
GB	Green Building
GBCA	Green Building Council of Australia
GBSC	Green Building Success Conditions
GDP	Gross Domestic Product
GRESB	Global Real Estate Sustainability Benchmark
GHG	Green House Gas
IPD	Integrated-Project-Delivery
ITR	Interviewee Transcript Review
LCC	Life-cycle Cost
LEED	Leadership in Energy and Environmental Design
M&E	Mechanical and Electrical
MCON	US Navy Military Construction
MEP	Mechanical, Electrical, and Plumbing
NABERS	National Australian Built Environment Rating System
nZEB	nearly Zero-Energy Building
PDA	Project Delivery Attribute
PDM	Project Delivery Method
Penren	Pentagon Renovation Projects
PM	Project Manager
PPC	Perception-based Performance Criteria
PPP	Public-Private Partnering
RPC	Reference-based Performance Criteria
SPFs	Sustainable Performance enabling Factors
TPES	Total Primary Energy Supply
USGBC	U.S. Green Building Council
VE	Value Engineering

1. Introduction

1.1. Background

Building projects are associated with negative environmental effects and Green Buildings (GBs) can help reduce these. Buildings are an extremely important part of the built environment as they fulfil the requirements of human life on a daily basis in terms of living and working. However, services from buildings come at a cost as the building and construction sector tend to consume large amounts of resources. For instance, the buildings and construction sector in 2018 accounted for 39% of energy and process-related carbon dioxide (CO₂) emissions and 36% of final energy use (IEA, 2019). To mitigate these environmental effects, Green Buildings have been proposed. These buildings tend to be much more environment-friendly, socially habitable and economically affordable in the long term. Some prominent environmental reasons for developing GB projects include the reduction of energy and water use, the protection of natural resources, reducing Greenhouse Gas (GHG) emissions, and improving indoor air quality. Some key social reasons for developing GB projects include encouraging sustainable building practices, creating a sense of community, increasing worker productivity, supporting the domestic economy, and the creation of an aesthetically pleasing environment. Compared to traditional buildings, GBs have considerations towards socio-economic and environmental aspects, and this increases their market demand (Petrullo, Jones, Morton, & Lorenz, 2018).

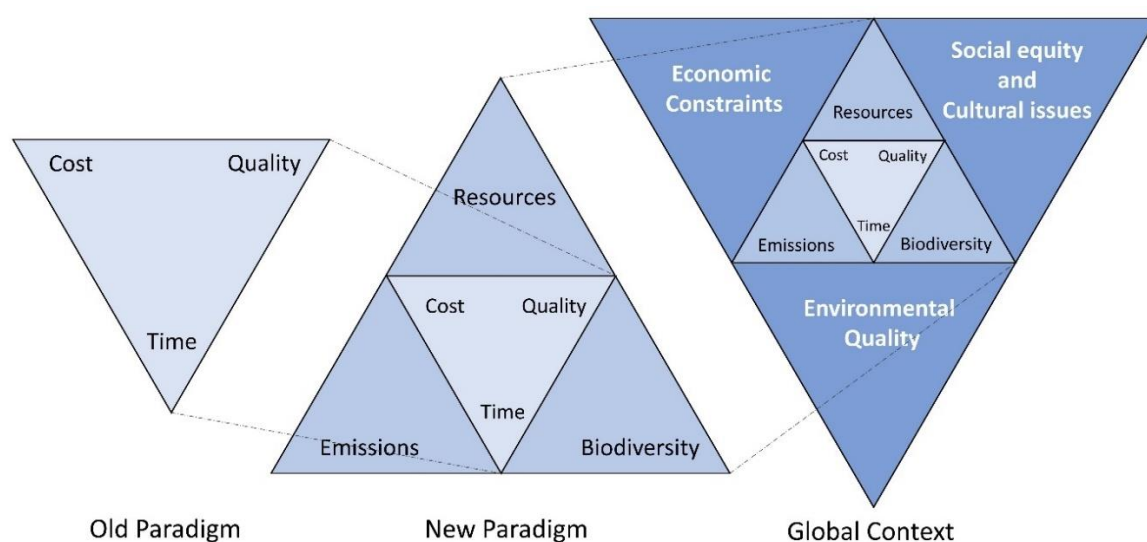


Figure 1-1: Paradigm shift in the construction industry (originally developed by Vanegas, DuBose, and Pearce (1995), expanded by Bourdeau (1999))

In addition to *cost*, *time*, and *quality* parameters which determine the project management success (Baccarini, 1999; Ika, 2009), sustainable design and construction adopt additional criteria which prioritise minimal resource consumption and environmental procedures to achieve a healthy built environment (Kibert, 1994, 2008). Vanegas et al. (1995) pointed to a paradigm shift in the construction industry with its emerging focus on environmental aspects (such as resources, emissions, and biodiversity) in addition to *cost*, *schedule*, and *quality* performance (Figure 1-1). In a global context, this paradigm shift in the construction industry has profound implications for sustainable development as it can help address environmental quality, economic constraints, and sociocultural issues (Bourdeau, 1999). GB projects can be seen as an important application of the new paradigm in construction industry shown in Figure 1-1. GB projects are part of the new paradigm in the construction industry as

alongside *schedule*, *cost*, and *quality* parameters, their performance is also determined by *social*, *economic*, and *environmental* aspects. This subsequently contributes to sustainability in a global context.

With an increased understanding of environmental degradation, society is starting to show an increased acceptance towards GB projects. The market for such buildings is growing (Petrullo et al., 2018). Even though in 2006, GB projects represented only 4% of the building market (Construction, 2007), since then their number has exponentially increased. In a global market survey conducted in 2015, GB projects were found to represent as much as 25% of the overall share of building activity (Petrullo et al., 2018). In the case of the Green Star certification system by Green Building Council of Australia (GBCA), the number of Green Star certified projects has rapidly increased during the last few years. With one Green Star certified project in 2004 and 8 such projects in 2005, the total number of certified projects by 2019 has increased to 2574 (GBCA, 2019). Many countries are making significant shifts towards more sustainable construction, for instance, Singapore intends to certify 80% of its buildings as GBs by 2030 (Bon-Gang Hwang & Tan, 2012). The construction industry is rapidly approaching a stage where the ability to plan and execute a sustainable project would be a core competency for any top builder. Developers need to be aware that a building without a third-party green certification is unlikely to be a Class-A building and there is an increasing demand for such buildings from corporate tenants (Deane, 2008; S. Kim, Lim, & Kim, 2016). GB projects are becoming increasingly popular in society and this signifies the need for effective development practices regarding these projects.

Increased attention towards the development practices of GBs is required to boost their increasing rate of construction. The design of project processes is critical to their success or failure (V. E. Sanvido & Konchar, 1998), as the research is increasingly showing that the way project teams are composed, the relationships that are formed, the organisation of the project, and the contracts used, significantly affect how projects are undertaken and the success of a project (AbulHassan, 2001; Mir & Pinnington, 2014). As a niche segment of the construction industry, GB sector is still in the early stages of its evolution. It is therefore important to focus on the project development practices of GBs. The Architecture, Engineering and Construction (AEC) industry is beginning to realise that GB projects have additional requirements in their overall development process. These requirements include the use of integrated project delivery, the use of simulation tools, the early involvement of key project parties along with the commitment of a project owner towards sustainability (Beheiry, Chong, & Haas, 2006; Horman et al., 2006; S. Korkmaz, Riley, & Horman, 2011; A. R. Lapinski, 2005; D Riley & Horman, 2005; D. R. Riley, Magent, & Horman, 2004). The influence of planners, users/operators and community services on sustainable projects is much higher than on traditional projects. Furthermore, team collaboration and integration are usually more important for achieving sustainability goals than for traditional goals (S Korkmaz, Horman, Molenaar, & Gransberg, 2010; Rafindadi, Mikić, Kovačić, & Cekić, 2014; Swarup, Korkmaz, & Riley, 2011). Hence, GB projects provide socio-economic and environmental benefits, but they also have special requirements in their development.

1.2. Problem Statement

The special requirements in the development of GBs need to be managed to achieve the aspired outcomes in these projects. In the face of increasing challenges and complexities, the construction industry is continuously optimising the ways of developing projects, and many times these adjustments are demanded by the unique types of projects being developed. An exemplary case is of GB projects which are significantly different from non-GB projects, yet are developed mostly by the use of traditional project development approaches. The limited understanding of owners and project teams regarding the additional processes involved in GB projects can significantly hinder the process of sustainable project development (A. R. Lapinski, Horman, & Riley, 2006).

If success enabling conditions are ignored during the development process of GB projects, a multitude of problems can result, and project performance may be detrimentally affected. As the requirement for high-performance in GB projects escalates, increased optimisation becomes indispensable (S Korkmaz et al., 2010). Different levels of sustainability performance require varying levels/states of delivery attributes. For instance, in the case of Gold or Platinum-certified LEED¹ (Leadership in Energy and Environmental Design) projects, a very high owner's commitment is usually required (S Korkmaz et al., 2010). The effects of seemingly common issues in complex projects become detrimental if not addressed properly. Alongside the organisational and procedural issues, GB project development faces many challenges in the integration of complex building systems, alignment of multi-party interests, use of team experience and knowledge in project development, and the like. There is a need for project development research on the GB market that can guide owners and project teams in their practices to maximise project performance such as cost, schedule, and especially sustainability performance (Sinem Korkmaz, Horman, & Riley, 2009).

Besides the fact that buildings as industrial products are improving with new technologies, techniques, and materials, the delivery process of these buildings is still lagging (Gultekin, Korkmaz, Riley, & Leicht, 2013). For instance, in the case of GB projects, the eminent barriers are not the lack of technologies and assessment methods, but are instead the organisational and procedural difficulties involved in the adoption of new methods. New technologies for GB projects face resistance as they require process changes involving risks and unforeseen costs (Häkkinen & Belloni, 2011). For a successful implementation of GB projects, the nontechnical aspects are equally important and often management factors determine the success or failure of a project (Y. Y. Li, Chen, Chew, Teo, & Ding, 2011). Government Research and development circles and the industry are aware that if a process is not well-understood then the benefits of newly developed technology might be minimised owing to fragmented and consequently uncooperative processes (Reed & Gordon, 2000). With an increasing number of developers (public and private) opting for sustainable development under the pressure of public scrutiny or government regulations, the conventional project management can become obsolete in managing green construction projects (Bon-Gang Hwang & Tan, 2012). The majority of construction projects is still being carried out according to the traditional methods, with short-term solutions preferred in place of long-term solutions, and with the incorporation of managerial solutions, technical approaches and material selection which can hardly be regarded as innovative green practices (Demaïd & Quintas, 2006; Gluch, Gustafsson, & Thuvander, 2009; Bon-Gang Hwang & Tan, 2012). This implies that to ensure the increase in number of GB projects and to ease the achievement of sustainability aspirations, more attention is required on the aspects of their development and delivery.

A fundamental challenge for sustainable building practices is to find a balance among many and often conflicting building performance aspects and achieving trade-offs among multiple decision criteria (Pan, Dainty, & Gibb, 2012). As a GB project is being developed, the higher performance in one criterion may come at the cost of another criterion. For instance, when affordability and environmental performance are considered together, the increase in the potential for carbon reductions results in relatively higher initial cost, and this is a concern for the clients and end-users, as well as builders and developers (Stephan & Stephan, 2016; S. Zhang, Pan, & Kumaraswamy, 2014). To optimise project performance across multiple criteria, it is important to understand the interrelationships across performance criteria

¹ Leadership in Energy and Environmental Design is a green building certification program. Buildings can qualify for four types of certifications with this program, that is Certified, Silver, Gold, and Platinum

such as cost, schedule, quality, and sustainability performance. These interrelationships are not clear as previous research has not paid attention in this regard.

Currently, the research on GB project success is limited either in terms of the specificity or in terms of the number of investigated factors, that is studied content. Research in sustainable construction lacks a critical mass of Success conditions (Sfakianaki, 2019). The research on construction project success associate, to some extent, the effect of project conditions on cost, schedule and quality performance, however, ignore the effects of these conditions on the sustainable performance which is an important criterion to determine the performance of GB projects (A. Darko & Chan, 2016). On one hand, the application of existing knowledge of construction project success may not result in meeting project aspirations because of the lack of regard towards sustainable performance criterion. On the other hand, recent research focused on GB project success is limited in terms of Success conditions and criteria investigated. Moreover, previous research on GB project success is majorly limited in the theoretical interpretation of findings; hence, constraining the development of theory related to GB project success.

While *Schedule, Cost, and Quality* are important criteria to evaluate the performance of a project during its development, GB projects may also involve many other Success criteria. Previous research has not involved a dedicated inquiry to identify Success criteria for GB projects. Previous studies are limited to identifying Success conditions and have not paid attention to the interrelationships among conditions (Ahmad & Aibinu, 2017; Ahmad, Aibinu, & Stephan, 2019). The development of GB projects is a complex problem of systemic nature. In a system, the whole has properties which cannot be realised from analysing the constituting elements in isolation. Similarly, in GB project development different dependent variables (that is sustainability performance) and independent variables (such as Success conditions) are interrelated in a complex manner. In short, the previous studies on GB project development have limited implications for project development practices, since the interrelationships between Success conditions and criteria are not realistically modelled.

The research on GB project development needs to depart from previous studies by considering the interrelationships among Success conditions and Success criteria realistically without oversimplifying the interrelationships. Research conducted in this way can also uncover a number of Success conditions and criteria previously undiscovered. Inquiry on GB project success also needs to provide a detailed account of the difference of GB projects from non-GB projects so that the research outcomes are aligned with the special requirements of GBs.

1.3. Research aim and questions

Considering the need for research on successful GB project development, the aim of this study is 'to promote the development of better Green Building projects'. To address the research aim, it is important to know how GB projects are different from non-GB projects; how the sustainability performance in a GB project affects the project management performance and *vice versa*; which criteria define success in GB projects; and which conditions enable GB project success. Considering GB projects as complex projects where the various aspects of development are interrelated, the interrelationships among the factors involved (for example, Success conditions and criteria) are also important to answer the research question. Based on these aspects, there are three main questions which this study will address:

Question 1: How do sustainability requirements set Green Buildings apart from non-Green Buildings?

Question 2: What are the associations between sustainability performance criteria and project management performance criteria in Green Building projects and which conditions control these associations?

Question 3: What are Success conditions and Success criteria in Green Building project development; and how are the Success criteria interrelated as well as the Success conditions?

The third question is addressed by two sub-questions:

Sub-question 3.A: What are Success criteria in Green Building projects and how do they interrelate?

Sub-question 3.B: What are Success conditions in Green Building projects and how do they interrelate?

1.4. Scope

The scope of this study is defined in the following areas.

Project lifecycle stages: The scope is primarily limited to the examination of the development process of GB projects, spanning from the project inception to the project hand over. The study will consider a wide variety of Success conditions with the potential to influence the performance of GBs not only during the project development stage but also the use stage. Yet, the operation stage, per se, as well as the end-of-life, are not included.

Field of study: The data collection focuses on GB professionals from multiple regions. The sample set of interview participants is limited to Australia, Hong Kong, Pakistan, Singapore, the United Arab Emirates (UAE), and the United Kingdom (UK) owing to limited time and funding resources available to the researcher. A large variety of stakeholders are considered, including the project clients, design consultants, sustainability consultants, Facility Management (FM) professionals, and commissioning consultants.

Building type selection: This study focusses on Green office projects and the basic reasons for this selection are listed below.

- **Controlling data variability:** To control data variability, the target population needs to be limited to a certain building type.
- **Data availability:** Owners are mostly motivated to use green features in office buildings, as these usually reduce life-cycle costs and improve the productivity of occupants (Sinem Korkmaz, 2007). Most of the certified GBs in Australia, Singapore, Hong Kong, the UK, and the UAE are commercial office projects. This also means that within the population of GB professionals, many people have the experience of working on green office projects. This suggests that the sampling of GB professionals with experience of green office projects is easier to achieve as compared to other building types. This contributes to the ease of data availability.
- **Comparable findings:** Since many previous studies on GB project development are related to office building projects (Gultekin et al., 2013; Sinem Korkmaz, 2007; S Korkmaz et al., 2010; Sinem Korkmaz, Riley, & Horman, 2010; S. Korkmaz et al., 2011; Sinem Korkmaz, Swarup, & Riley, 2011; Swarup et al., 2011), the focus of this study on office buildings will make its findings comparable with previous research. This may also enable this study to contribute towards longitudinal research.

Pressing needs: Within the commercial sector, along with warehouses and retail premises, offices are a significant contributor to energy use and GHG emissions (Pérez-Lombard, Ortiz, & Pout, 2008; Seifhashemi, Capra, Milller, & Bell, 2018; Wade, Pett, Ramsay, & House, 2003). Within these three sub-sectors, for achieving significant savings, offices offer the greatest potential for action (Wade et al., 2003). Moreover, the total built area of office buildings has substantially increased (Michaels, 2015) and expected to continue to increase with many new business developments in cities (Pérez-Lombard et al., 2008; Wade et al., 2003). For instance, Singapore boasts an increasingly large number of office spaces as 641,000 square metres of the nett floor area of office space was added from 2013 to 2018 (*Yearbook of statistics Singapore 2019*, 2019). The increase in the number of office building projects drives the negative environmental effects associated with these projects. The development of green office buildings with reduced environmental effects is therefore needed. This research will help facilitate that.

1.5. Definitions

Green Buildings: The study will use the term ‘Green building’ to refer to the buildings which are developed on the principles of sustainability. These buildings can have the lowest level of sustainability performance as permitted by local regulations in a region and these buildings can also achieve the maximum potential of sustainability performance as technologically possible. These building may and may not be certified by third-party certification systems such as LEED.

Project development: Project development in this study is considered as the Green Building project stage which spans the whole duration during which the project is conceived and materialised. The way the project is developed plays different direct and indirect roles in defining project outcomes and in achieving those outcomes.

Success conditions: In this study, the factors enabling the achievement of aspired outcomes in GB projects are referred to as Success conditions. These conditions are the circumstances, decisions or events contributing towards project outcomes, but do not form the basis of success judgment (Ahmad & Aibinu, 2017; Ika, 2009). For instance, project team collaboration contributes towards the achievement of project outcomes and therefore qualifies as a Success condition.

Success criteria: The set of principles or standards by which project performance can be evaluated are referred to as Success criteria in this study (Ika, 2009; Lim & Mohamed, 1999). In simple terms, the relationship between ‘Success factors’ and ‘Success criteria’ is a relationship of cause-factors (for example, the owner’s sustainability commitment) with effect-factors (such as sustainability performance).

Performance criteria: In this study Performance criteria refer to project management performance (that is *schedule*, *cost*, and *quality* performance) and sustainability performance. Performance criteria are part of the overarching set of Success criteria.

Underlying conditions: Performance criteria are interrelated and the conditions affecting these interrelationships are termed as Underlying conditions in this study. For instance, considering project cost performance and sustainability performance as GB Success criteria, the ‘rigour of project planning’ is one of the Underlying conditions affecting the interrelationships between two criteria. On one hand, a more rigorous project planning can result in a positive association between sustainability and cost criteria and on the other hand poorly conducted project planning can lead to negative associations between the two criteria. From this example, it may appear that the Underlying conditions are also Success conditions. However, instead of making this assumption, a separate investigation of the underlying and Success conditions is conducted in this study and only in Chapter 9 *Discussion and Implications of findings*, the overlap of success and Underlying conditions is established.

Differentiating conditions: The special characteristics of GB project which differentiate them from their traditional non-green counterparts are referred to as Differentiating conditions in this study. Alongside the identification of success and Underlying conditions, this study also involves the identification of Differentiating conditions. Since Differentiating conditions are the special characteristics of GB projects, it is probable that many of these conditions are also Success conditions. However, instead of making this assumption, the study conducts a separate investigation of Differentiating conditions.

Project client: The term ‘project client’ is used to refer to the party for whom the project procurement takes place and services of the project team are availed. A project client can be the owner of a GB, a developer, an investor, and in some cases also the end-user.

Credits of Green Building certification systems: A credit of a GB certification system (such as LEED) addresses a measure to improve the sustainability performance of a project. A credit defines a clear

outcome that the project meets. For instance, 'Water metering' as a credit in LEED intends to identify opportunities for water-saving. During LEED certification if a project considers water metering credit it is awarded one point which contributes towards the overall rating of the project.

1.6. Rationale for the study

1.6.1. Lack of research on performance criteria interrelationships

As a GB project is being developed, the higher performance in one criterion (such as schedule performance) may come at the cost of another criterion (for example, sustainability performance). To optimise project performance across multiple criteria, it is important to understand the interrelationships across performance criteria. There is a dearth of studies addressing the interrelationships among performance criteria.

Some studies have been conducted on multi-objective optimisation aimed at balancing performance across multiple criteria (El-Rayes & Kandil, 2005; Jiang & Zhu, 2010; Khang & Myint, 1999; Marzouk, Madany, Abou-Zied, & El-said, 2008; Moselhi, 1993; Ozcan-Deniz, Zhu, & Ceron, 2011; Rahimi & Iranmanesh, 2008; W. Wang & Feng, 2008; Zhu, Inyim, & Rivera, 2012). These studies are mainly focused on optimising *schedule*, *cost* and *quality*. Only Marzouk et al. (2008) and Zhu et al. (2012) have considered some aspects of sustainability performance such as pollution, and GHG emissions. The key limitation of these studies is that they are not focused on GB projects. Further, these studies have not considered the project development processes, and have only used construction activities and construction materials as the unit of analysis and optimisation.

On the contrary, the studies on GB project success have mainly focused on sustainability performance in GBs in addition to other criteria such as *schedule*, *cost*, and *quality* (El Asmar, Hanna, & Loh, 2013; Enache-Pommer & Horman, 2009; Gultekin et al., 2013; Hanks, 2015; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Sinem Korkmaz et al., 2011; Swarup et al., 2011). However, these studies are aimed at Success conditions instead of identifying interrelationships among performance criteria.

1.6.2. Lack of research on Success criteria of Green Building projects

For evaluation of what leads to project success, it is necessary to establish the criteria of project success (Turner, 1999). By ascertaining Success criteria applicable to a certain project type, it is possible to conduct intermediate or post-completion audits to identify the reasons for project success or failure.

Studies have been previously conducted to investigate the effect of different factors on the performance of GB projects (Bilec, 2008; Carpenter, 2005; El Asmar et al., 2013; Enache-Pommer & Horman, 2009; Gultekin et al., 2013; Hanks, 2015; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Sinem Korkmaz et al., 2011; Molenaar et al., 2009; Olanipekun, Xia, Hon, & Darko, 2018; Sang et al., 2018; Swarup et al., 2011; Venkataraman & Cheng, 2018; Yu, Shi, Zuo, & Chen, 2018). The performance criteria used in these studies include project management-related performance (that is, *schedule*, *cost*, and *quality* performance); performance in GB certifications; safety performance; technical performance; organisational performance; and public perception of a project. In the majority of cases, a rigorous methodology is not used for selecting Success criteria in previous studies. This is because these studies regarding GB project success had a focus on investigating the Success conditions instead of exploring Success criteria in GBs. Hence, there is a lack of studies dedicated to investigating Success criteria in GB projects.

1.6.3. Lack of exploratory research on Success conditions of Green Building projects

Other than a few examples such as the study by Z. W. Tang, Ng, and Skitmore (2019) using system dynamics, the research on GB project success has generally ignored the complexity and systems nature of GB project development. Instead of seeing project development holistically, with a vast number of enabling factors and interrelationships among those factors, the previous studies have typically used reductionist approaches in data collection, analysis, and interpretation.

Previous studies lack an emphasis towards exploratory research design and are excessively reliant on explanatory research design. As a result, these studies lack the attention towards identifying previously unknown Success conditions specifically related to GB projects. Further, they do not explain the interrelationships among the Success conditions and the cumulative effects of these conditions on project success.

1.6.4. Lack of theory-based interpretation of research on Green Building project success

The previous studies on GB project success are limited in explaining the Success conditions in terms of the theories related to construction or sustainable development. While explaining the effect of Success conditions on some performance criteria in GB projects, the studies usually do not provide a theoretical interpretation of findings. This lack of interpretation has constrained the development of theory as well as research on GB project success.

1.7. Deliverables

The results and deliverables of this research which will contribute to the GB development literature and act as foundations for future research on GB project development are:

- A list of Success conditions and Success criteria for GB projects;
- The explanation of associations among Success conditions and the significance of conditions for GB project success; and
- A detailed account of interrelationships among sustainability and project management performance criteria and the list of Underlying conditions affecting those interrelationships.

1.8. Organisation of the Thesis

Chapter 1: *Introduction*, provides the research background, research problem, the rationale as well as the research aim and questions. It also provides the definitions of key terms and presents the scope and deliverables of the study.

Chapter 2: *Literature Review*, provides a review of previous studies related to GB project success. Research on GB development has been reviewed by classifying the studies into Project Delivery Attribute (PDA) and Critical Success Factor (CSF) paradigms. Some of the key outcomes of this chapter include the contribution of previous studies; factors considered in previous studies; limitations of previous studies; and the research gaps of previous studies.

Chapter 3: *Theoretical Framework*, provides an overview of the theoretical lenses used in this study. While considering GB projects within the context of the construction industry and sustainable development, the four theoretical lenses used are Transformation-Flow-Value-generation (TFV) theory of production, Triple Bottom Line, project success, and complexity perspective.

Chapter 4: *Research design*, explains the research paradigm employed for this study, the methodology used as well as the approaches used for data collection and analyses. The sample sets for online surveys and semi-structured interviews are discussed. Moreover, the reliability and credibility of the research are explained.

Chapter 5: *Differences between Green and non-Green Building projects*, explains the Differentiating conditions of GB projects based on interview findings. The key outcomes of this chapter include the identification of Differentiating conditions and the associations among Differentiating conditions.

Chapter 6: *Associations among sustainability and project management performance criteria*, provides a detailed account of associations among six performance criteria which are *schedule*, *cost*, *quality*, *economic sustainability*, *environmental sustainability*, and *social sustainability*. Moreover, this chapter provides a detailed account of the Underlying conditions influencing performance criteria associations.

Chapter 7: *Green Building Success criteria* identifies the Success criteria for GB projects, using semi-structured interviews. Some key outcomes of this chapter include the identification of Success criteria for GB projects; identification of associations among Success criteria; investigation of Success criteria priorities; and a discussion of Success criteria in terms of the theory and practice of GB development.

Chapter 8: *Green Building Success conditions*, explains the study findings regarding Success conditions. The key outcomes of this chapter include: identification of Success conditions and their interrelationships; identification of stakeholders responsible for and affected by Success conditions; discussion regarding the reasons for the importance of individual conditions; interpretation of Success conditions in terms of the TFV theory of production; analysis of the Success conditions when occurring in a network; and a discussion of Success conditions in terms of the theory and practice of GB development.

Chapter 9: While presenting the analysis of research findings, Chapter 5, 6, 7, and 8 also provide the detailed discussion regarding the individual findings of study results particularly in terms of the theoretical interpretations and implications. However, the holistic account of study implications and limitations is provided in Chapter 9 *Discussion and Implications of findings*. The key outcomes of this chapter include: the overview of study findings; the overlap of Success conditions, Underlying conditions, and Differentiating conditions; theoretical interpretations and implications of research findings; practical implications of research findings; and a detailed discussion on the study limitations and suggestions for future research.

Chapter 10: *Summary and Conclusion*, provides a brief summary of the overall study, draws conclusions, and proposes directions for future research. To ensure the successful development of GB projects, it also provides a brief account of suggestions for Clients, End-users, Design consultants, Contractors, Sustainability consultants, Project Management teams, Facility Management teams, and other project stakeholders.

2. Literature Review¹

The previous chapter provided an introduction of research conducted in this study, whereas this chapter provides a detailed literature review of previous studies conducted on GB project success. This chapter aims to identify the knowledge gaps in previous research.

The structure of this chapter is such that first the scope of the literature review is defined (Section 2.1) and then the difference between research paradigms is explained (Section 2.2). Research contributions of reviewed studies are presented in Section 2.3. After this, the factors identified from studies are discussed (Section 2.4). This is followed by a brief overview of the research design and methodological limitations of previous studies (Section 2.5). Finally, the research gaps are highlighted (Section 2.6).

2.1. Scope

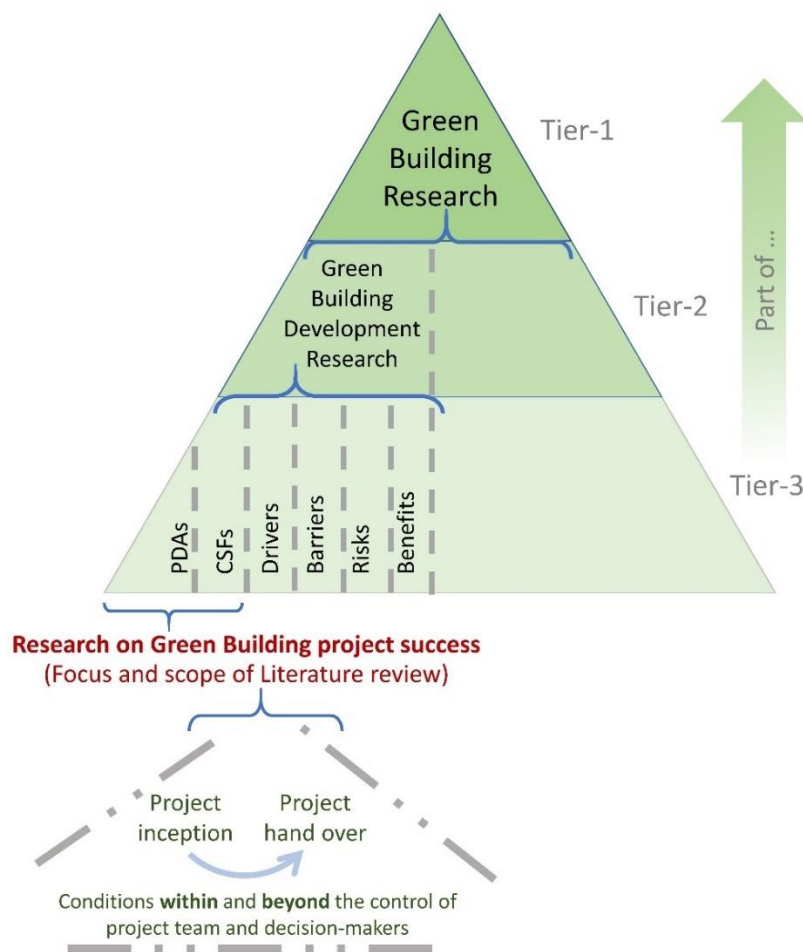


Figure 2-1: Scope of the literature review

¹ This chapter is largely based on:

Ahmad, T. and A.A. Aibinu, Project delivery attributes influencing green building project outcomes: A review and future research directions. *Built Environment Project and Asset Management*, 2017. 7(5): p. 471-489.

Ahmad, T., A.A. Aibinu, and A. Stephan, Managing green building development – A review of current state of research and future directions. *Building and Environment*, 2019. 155: p. 83-104.

For reviewing the literature relevant to this study, it is important to locate research on project success within the knowledgebase of Green Building research as shown in Figure 2-1. Within the GB development research theme, studies are conducted within the paradigms of Project Delivery Attributes (PDAs), Critical Success Factors (CSFs), Barriers, Drivers, Risks, Benefits, and Challenges. While the research within the PDA and CSF paradigms considers the GB project success, research within other paradigms considers the barriers, drivers, risks, and benefits of GB development. For a detailed overview of these six paradigms within GB development research, readers are referred to the review study conducted by the researcher¹.

The focus of this Literature Review is on studies conducted regarding GB project success. Since only PDA and CSF paradigms are directly associated with Green Building project success, only they are included in this Literature Review.

The previous studies in PDA and CSF paradigms considered for detailed review are within the scope of the GB project “development”. In terms of the life-cycle, “development” accounts for all the stages from project inception to hand-over, including planning, design, and construction, however, does not include the project operation stage. Furthermore, the GB development research accounts for both the factors controllable by the project team (for example, team collaboration) and factors beyond the project team and decision-makers’ control (for instance price inflation).

2.2. Difference between CSF and PDA paradigms

The researcher in his review paper¹ has classified studies on GB project success within the CSF and PDA paradigms. The factors investigated within the CSF and PDA studies help understand how to achieve success in GB projects. The two paradigms provide a strategic understanding of what needs to be done for achieving better project outcomes (Ahmad & Aibinu, 2017; Ahmad et al., 2019). For the Literature Review, these two paradigms are considered separately to help understand the research limitations and gap.

Most of the reviewed studies classified within the PDA paradigm have used “project delivery attributes” as the substitute terms for “success enabling conditions”. These factors have been regarded as influential forces that either facilitate or hinder project success (Lim & Mohamed, 1999). PDAs can be the interval, ordinal, or nominal variables. For instance, “team’s prior experience as a unit” is a variable of ordinal nature having two potential values (that is yes or no); “team communication” is an interval variable with a range of values (that is low to high); “Project Delivery Method” is a categorical variable with several distinct values (for example, Design-Build and Design-Bid-Build). Some PDA variable states have a more positive effect on project performance compared to others. As an example, the Project Delivery Method is a PDA with different variable states, such as Design-Build, Design-Bid-Build, and Construction-Management-at-Risk. Among these, Design-Build tends to contribute more towards project success (Gultekin et al., 2013).

The reviewed studies classified within the CSF paradigm have typically used ‘Critical Success Factors’ as the substitute terms for ‘success enabling conditions’. These factors are regarded as absolutely necessary to reach goals (Rockart, 1982). The term CSF was first used by Rockart (1982) in a project management context. CSFs were presented as the “factors predicting success on projects” (V. Sanvido, Grobler, Parfitt, Guvenis, & Coyle, 1992). Fundamentally, CSFs can be considered as the factors identified by management and all project stakeholders as the key areas or issues on a project, requiring

¹ Ahmad, T., A.A. Aibinu, and A. Stephan, Managing green building development – A review of current state of research and future directions. *Building and Environment*, 2019. 155: p. 83-104.

special attention to meet project goals or to achieve success/high performance (A. Darko & Chan, 2016). Unlike PDAs, CSFs are not variables as shown in Figure 2-2. Instead, a CSF is a distinct state of a variable, realised as critically important for the project's performance. For instance, team communication is a variable affecting project performance and it has been studied as a PDA. However, good team communication is a variable state and it can be considered a CSF.

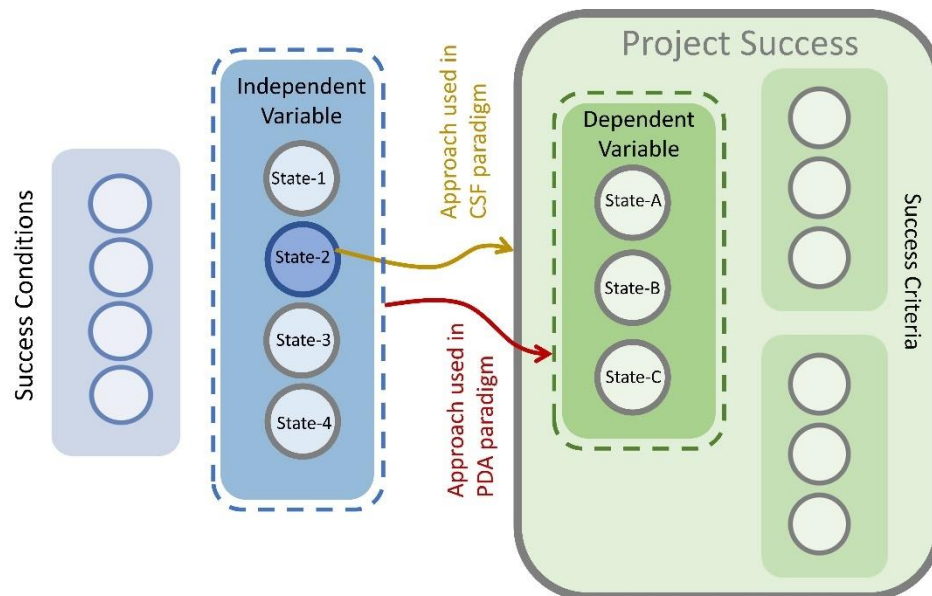


Figure 2-2: Relationships of Success conditions and criteria in studies based on CSF and PDA paradigms

It is important to mention the relation among Success conditions and Success criteria which are important concepts in the PDA and CSF paradigms. Success conditions which are also termed as success factors, critical success factors, and project delivery attributes in GB literature are the conditions, circumstances, or events which contribute towards project outcomes, yet do not form the basis of success judgment (Ahmad & Aibinu, 2017; Ika, 2009). Criteria of project success, on the other hand, are the principles or standards by which project performance can be evaluated (Ika, 2009; Lim & Mohamed, 1999). In simple terms, the relationship between 'Success conditions' and 'Success criteria' is a relationship of cause-factors (for example, owner's sustainability commitment) with effect-factors (for instance, sustainability performance), and project success is the final outcome as shown in Figure 2-2. While in broad terms both the PDA and CSF paradigms use the Success conditions and criteria, some difference in their approach exists as shown in Figure 2-2. Studies within the PDA paradigm explain the association of independent variables (that is Success conditions) with their different states on the dependent variables (that is Success criteria) with their multiple states. For instance, studies within the PDA paradigm have associated different levels (that is variable states) of team communication (that is independent variable) with different levels of sustainability performance (that is dependent variable). However, studies within the CSF paradigm typically associate a state of an independent variable (that is Success condition) with project success but do not specify the Success criteria. Instead of defining Success criteria, studies in the CSF paradigm associate Success conditions with a certain aspect of project success, for instance, project management success, project development success, and organisational success.

2.3. Contributions of research on Green Building project success

This section provides a brief explanation of the contributions of CSF and PDA paradigms in research on GB project success.

2.3.1. Project Delivery Attribute Paradigm

Overall, 28 studies within the PDA paradigm are reviewed. These studies contributed to research on GB project success in a variety of ways. Most of these studies (n=15) are conducted in the US context. For instance: Bilec (2008) and Sinem Korkmaz et al. (2010) conducted inquiries regarding PDAs of GB projects; Gultekin et al. (2013) and Swarup et al. (2011) defined the extent of effects which different PDAs have on GB project outcomes; S Korkmaz et al. (2010) and Sinem Korkmaz et al. (2011) aimed to understand the extent of the effect of Project Delivery Method (PDMs) on the level of integration achieved in projects and further their effects on project outcomes with a focus on sustainability goals; Enache-Pommer and Horman (2009) provided an understanding of the key processes most critical for the delivery of green healthcare facilities; S. Korkmaz et al. (2011) identified key criteria for GB project delivery; and Xia, Skitmore, Wu, and Chen (2014) undertook an investigation to highlight the prevailing practices of public sector owners, for defining sustainability requirements of projects developed on Design-Build approach.

A number of studies based in the US context primarily focused on the investigation of PDMs for sustainable construction projects (Dahl, Horman, Pohlman, & Pulaski, 2005; El Asmar et al., 2013; Hanks, 2015; Molenaar et al., 2009; David Riley, Sanvido, Horman, McLaughlin, & Kerr, 2005). For instance: Dahl et al. (2005) investigated the use of Design-Build-Operate-Maintain approach for sustainable projects; David Riley et al. (2005) inquired the use of Design-Build approach in sub-contracting for GB projects; Hanks (2015) investigated the effects of Project Delivery Methods on LEED targets of GB projects; El Asmar et al. (2013) quantified the performance of Integrated-Project-Delivery method as compared to traditional delivery systems; and Z. W. Tang et al. (2019) adopted a system dynamics model to analyse the influence of five delivery methods on the performance of sustainable buildings.

Some of the PDA studies are based specifically in the UK context. For instance: Lei (2005) investigated the use of Private-Finance-Initiative for sustainable construction; Zhou and Smith (2013) investigated the use of Private-Finance-Initiative procurement approach for sustainable development of hospital projects; Murtagh, Roberts, and Hind (2016) analysed the relationship between motivations of architectural designers and the design outcomes of sustainable projects; and N. Wang, Wei, and Sun (2013) identified the unique features of whole life project management and their relationship to building sustainability.

Other than the PDA studies based in the context of the UK and the US, some studies are also based in the context of Singapore, Malaysia, Hong Kong, and Australia. For instance: in a Singapore-based study, Bon Gang Hwang, Zhu, and Ming (2016) investigated the factors affecting the productivity of GB construction; in another Singapore-based study, Bon Gang Hwang, Zhao, and Tan (2015) investigated the factors affecting schedule performance of GB projects; in a Malaysia-based study, Elforгани, Alnawawi, and Rahmat (2014) inquired the association between client's qualities and design team attributes; in a Hong Kong-based study, Lam, Chan, Poon, Chau, and Chun (2010) investigated the factors affecting the implementation of green specifications in construction; and in an Australia-based study, Olanipekun et al. (2018) inquired the effect of motivation and owner's commitment on the delivery performance of GB Projects.

Some PDA studies are not based on a particular regional context. For instance: Doskočil and Lacko (2018) conducted a detailed inquiry regarding the two important aspects of sustainable projects, that is, advanced risk management and project knowledge; Kantola and Saari (2016) investigated the role of Project Delivery Methods for GB projects; and Gard (2004) inquired the use of the Design-Build approach for GB projects.

2.3.2. Critical Success Factor Paradigm

Overall, 20 CSF-related studies are reviewed. While the majority of these studies (n=13) clearly state that they inquire the Critical Success Factors, the other studies (n=7) use the same methodology and have similar research aims but do not use the term 'CSF'. Even though the CSF research typically has a focus on *cost*, *quality*, and *schedule* performance (A. Darko & Chan, 2016), the reviewed studies have specifically focused on GB projects and have considered sustainability performance criterion.

Some studies are specifically conducted with a focus on project management success factors for GBs. For instance: Bakar, Hassan, Abd Razak, Abdullah, and Awang (2009) identified factors required for the successful implementation of GB projects in Malaysia and established the best practices for project management; Kiani Mavi and Standing (2018), in an Australia-based study, determined the CSFs of sustainable project management in construction; Banihashemi, Hosseini, Golizadeh, and Sankaran (2017) investigated the CSFs affecting the integration of sustainability into project management practices of construction projects in developing countries; Venkataraman and Cheng (2018) identified the success and failure factors related to the management of GB projects; and Y. Y. Li et al. (2011) conducted a study to determine the controllable Critical-Project-Management-Success-Factors of AEC firms for delivering GBs in Singapore; and Best practices framework for delivering public housing estate units in Nigeria was developed by Ihuah, Kakulu, and Eaton (2014), based on a theoretical exploration of Critical-Project-Management-Success-Factors.

Some studies within the CSF paradigm have exclusively focused on team skills and capabilities for GB project success. For instance, Y. Y. Li, Chen, Chew, and Teo (2014) identified the necessary resources and capabilities of design firms for better development of GBs in Singapore; and Bon Gang Hwang and Ng (2013) identified critical knowledge areas and skills essential for responding to green construction challenges.

Some CSF studies are also focused on the development aspects of GB projects. For instance: L. Zhang, Li, and Zhou (2017) determined the CSFs of low-carbon building development in China's urban area; Shen et al. (2017) established the CSFs in Thailand's GB sector; B. Aktas and Ozorhon (2015) investigated the CSFs for GB certification process of existing buildings in Turkey; in an Australia-based study, Bond (2010) investigated the best practices of sustainable building development; Wai, Yusof, Ismail, and Tey (2012) investigated the CSFs for sustainable building development in Malaysia; for the context of Singapore B. G. Hwang, Zhu, and Tan (2017) determined the CSFs for Green Business Parks and Pheng Low, Gao, and Lin Tay (2014) investigated CSFs for greening existing buildings. Some studies are also conducted to investigate the CSFs for the sustainable housing sector. For instance: C. B. Aktas, Ryan, Sweriduk, and Bilec (2012) identified the CSFs regarding the constructability issues of net-zero energy homes; and Oyebanji, Liyanage, and Akintoye (2017) conducted a study to determine the CSFs for achieving sustainable social housing.

Some CSF studies have also put emphasis on learning lessons from the case studies of GB projects. For instance, Bilec et al. (2009) analysed the lessons learnt from the design of green children hospitals in the USA and Rasekh and McCarthy (2016) conducted a study to learn from the difficulties of delivering sustainable buildings.

2.4. Factors considered in previous research on Green Building project success

This section provides an overview of the factors considered in previous research on GB project success. First, the Success criteria identified from reviewed studies are discussed and then the Success conditions are discussed.

2.4.1. Success criteria considered in previous research

The Success criteria used in previous studies on GB project success are shown in Table 2-1. These criteria are mainly about project management performance (that is, *schedule*, *cost*, and *quality* performance) and sustainability performance (*Environmental*, *Economic*, and *Social sustainability*). The studies on GB project success are highly focused on project management criteria, for instance, schedule (number of studies=8), cost (n=7), and quality performance (n=6). In terms of the sustainability criteria, some studies considered the performance of GB projects at the level of individual sustainability dimensions, that is, economic sustainability (n=2) and environmental sustainability (n=4). However, some other studies considered sustainability performance in more depth, for example, indoor environmental quality (n=1) and occupant turnover rate (n=1). Many studies (n=7) also used GB certifications as the measure of sustainability performance. GB certification as a measure of sustainability performance was used in many studies where it was preferred to assess project sustainability by considering the certification levels and scores instead of only relying on the client's and end-users' perception of sustainability performance. Using GB certifications as a criterion of sustainability performance also has limitations since GB certifications may not always result in the achievement of sustainable outcomes in a project (Navarro, 2009). Hence, GB certifications partially define the success of GB projects at best.

In the majority of cases, the selection of sustainability performance criteria by previous research is not based on a rigorous methodology mostly because the studies had the focus on Success conditions and not the Success criteria (Bilec, 2008; Carpenter, 2005; El Asmar et al., 2013; Enache-Pommer & Horman, 2009; Gultekin et al., 2013; Hanks, 2015; Bon Gang Hwang et al., 2015; Bon Gang Hwang et al., 2016; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Sinem Korkmaz et al., 2011; Lam et al., 2010; Molenaar et al., 2009; Olanipekun et al., 2018; Sang et al., 2018; Swarup et al., 2011; Venkataraman & Cheng, 2018; N. Wang et al., 2013; Yu et al., 2018).

Previous studies on GB project success have used the terms 'performance criteria', 'performance metrics', 'performance indicators' and 'dependent variables', instead of using the term 'Success criteria'. This may be because these studies did not focus on GB project success in its entirety and only considered some of its facets such as project management-related success and sustainability-related success. This may also be because project success is an abstract concept subject to interpretation. Therefore, the use of the term 'Success criteria' could potentially expose a study to criticism, unless the study specifically develops a framework to define project success.

While the previous studies have been focused on identifying correlations of Success conditions with performance criteria, they have not specifically investigated the interrelationships among Success criteria. To optimise performance among multiple criteria and to predict performance across different criteria, it is necessary to understand how success/performance criteria interrelate.

Table 2-1: Performance criteria used in previous research on Green Building success

Performance criteria		(Yu et al., 2018)	(Venkataraman & Cheng, 2018)	(Bilec, 2008)	(El Asmar et al., 2013)	(S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Sinem Korkmaz et al., 2011; Swarup et al., 2011)	(Carpenter, 2005)	(Molenaar et al., 2009)	(Enache-Pommer & Horman, 2009)	(Hanks, 2015)	(Gultekin et al., 2013)	(Olanipekun et al., 2018)	(Sang et al., 2018)	(Bon Gang Hwang et al., 2016)	(Bon Gang Hwang et al., 2015)	(Lam et al., 2010)	(N. Wang et al., 2013)	Sum
Project Management performance	Schedule Performance		x		x	x			x	x	x	x			x			8
	Cost Performance		x		x	x			x	x	x	x						7
	Quality Performance				x	x			x	x		x					x	6
	Construction productivity				x									x				2
Sustainability performance	Green specification implementation															x		1
	Environmental sustainability	x	x	x													x	4
	Water use					x							x					2
	Energy use					x						x	x				x	4
	Consumption of Resources and materials												x					1
	Economic sustainability/ Whole life costing	x															x	2
	Business Performance				x													1
	Community engagement																x	1
	Indoor Environmental Quality					x												1
	Occupant turnover rate					x												1
	Absenteeism					x												1
	Owner's and end-users' satisfaction		x			x												2
	Acoustic quality					x						x						2
	Ventilation					x						x						2
	Controllability					x												1
	Lighting					x						x						2
	Thermal comfort					x						x						2
	Certification as a measure of sustainability					x	x		x			x						4
	Achieved certification or achieved points					x												1
	Achieved certification points compared to total points					x		x		x								3
	Intended vs. achieved certification or score					x		x		x								3
Health and Safety Performance					x	x											x	3
Organisational relationships			x															1
Public recognition			x															1

Note: Publications (S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Sinem Korkmaz et al., 2011; Swarup et al., 2011) are part of a single study and are therefore collectively considered.

2.4.2. Success conditions considered in previous research

A synthesis is provided in Table 2-2 and Table 2-3 to account for the project development aspects and project stakeholder-related attributes which are considered as success conditions by previous studies. The number of studies considering a factor can imply its importance as a success condition for GB projects. Success conditions specifically related to project stakeholders are provided in Table 2-2 and all the other conditions are provided in Table 2-3. In terms of project stakeholders, most conditions are related to the project team, design team, and project client (Table 2-2). This means that project success is significantly affected by the attributes of the project team and client. In terms of the project development aspects, a large number of success conditions as shown in Table 2-3, are related to team formation, procurement and contractual aspects; project planning; project design; and project monitoring, risk management and quality assurance. Some of the highly studied conditions (shown in Table 2-2 and Table 2-3) include: client's commitment (S-1), project team integration (S-14), team expertise and experience (S-17), team communication (S-18), competence of design consultant (S-22), competence of project manager (S-37), support from senior management (S-40), adequate funding of project (S-44), defining project goals (S-68), design integration (S-76), performance monitoring and control (S-77), risk management (S-80), completion level of construction documents (S-83), involvement of sustainability consultant (S-107), stakeholder engagement (S-122), Project Delivery Method (S-125), contractual terms (S-126 and S-129), and team procurement process (S-133). Some highly studied Success conditions are related to the timeliness of project activities. For instance, the timing of contractors' involvement (S-103), the timing of key participants' involvement (S-105), and early adoption of environmental considerations (S-114). While the literature review findings reported in Table 2-2 and Table 2-3 provide a holistic account of previously studied success conditions, they also act as a benchmark for comparison with the findings of this study (see Section 8.7.1).

Table 2-2: Stakeholder-related Success conditions occurring in studies on Green Building project success

Stakeholder	ID	Success condition	PDA Source	CSF Source
Client/ Developer	S-1	Client's commitment/ involvement	(Bilec, 2008; Enache-Pommer & Horman, 2009; Gultekin et al., 2013; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Molenaar et al., 2009; Olanipekun et al., 2018; Swarup et al., 2011)	(Bakar et al., 2009; Pheng Low et al., 2014)
	S-2	Commitment of the client's organisation to provide finances for GBs	(Elforgani et al., 2014)	
	S-3	The party proposing 'green' in the project	(Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Swarup et al., 2011)	
	S-4	The primary reason for pursuing 'green'	(Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Swarup et al., 2011)	
	S-5	Client type	(Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Swarup et al., 2011)	
	S-6	Client's ability to define the scope and make decisions	(Gultekin et al., 2013; S. Korkmaz et al., 2011; Molenaar et al., 2009)	(C. B. Aktas et al., 2012)
	S-7	Client's capability	(Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Swarup et al., 2011)	
	S-8	Client's ability for team procurement	(Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Swarup et al., 2011)	

Stakeholder	ID	Success condition	PDA Source	CSF Source
Project team	S-9	Client aware of potential savings from GB project; Clients' knowledge of GBs	(Elforgani et al., 2014)	(Ahn & Pearce, 2007)
	S-10	Educating the client about the features and requirements of a GB project		(Rasekh & McCarthy, 2016)
	S-11	The relation between client and project team	(Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Swarup et al., 2011)	
	S-12	Team commitment to sustainable development	(Enache-Pommer & Horman, 2009)	(Y. Y. Li et al., 2011; Venkataraman & Cheng, 2018)
	S-13	Alignment of team goals with project goals		(Bilec et al., 2009; Bon Gang Hwang et al., 2015)
	S-14	PROJECT TEAM INTEGRATION: composition and cohesiveness, team chemistry, team's prior experience as a unit, good working relationships among team members, trust among stakeholders, a well-integrated project team	(Enache-Pommer & Horman, 2009; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Sinem Korkmaz et al., 2011; Swarup et al., 2011)	(C. B. Aktas et al., 2012; Banihashemi et al., 2017; Bond, 2010; Ihuah et al., 2014; Kiani Mavi & Standing, 2018)
	S-15	Project team motivation		(Y. Y. Li et al., 2011; Shen et al., 2017)
	S-16	Project ownership		(Bakar et al., 2009; Ihuah et al., 2014)
	S-17	Team expertise and experience in GB development	(Bilec, 2008; Enache-Pommer & Horman, 2009; Gultekin et al., 2013; Hanks, 2015; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Sinem Korkmaz et al., 2011; Molenaar et al., 2009; Swarup et al., 2011)	(C. B. Aktas et al., 2012; Bakar et al., 2009; Ihuah et al., 2014; Shen et al., 2017)
	S-18	Team communication	(Bilec, 2008; Gultekin et al., 2013; Hanks, 2015; S Korkmaz et al., 2010; David Riley et al., 2005)	(C. B. Aktas et al., 2012; Shen et al., 2017; Venkataraman & Cheng, 2018)
	S-19	Cooperation between architects and engineers		(Y. Y. Li et al., 2011)
	S-20	Project team composition and cohesiveness		(C. B. Aktas et al., 2012; Ihuah et al., 2014)
	S-21	Adequate enterprise capability		(L. Zhang et al., 2017)
Design team	S-22	COMPETENCE OF DESIGN CONSULTANT: mix-experienced design team, design team's experience in the construction industry, design team's experience in similar type and size of project, design team's decision-making effectiveness, design team's effectiveness in controlling and monitoring of economic design, design team's communication effectiveness, design team's effectiveness of managing conflicts, design team's knowledge relevant to green design, design team's knowledge of green design assessment tools, design team's skills of using design programs, design team's ability to interpret client's needs into efficient green design, design team's speed in producing green design drawings, design team's ability in overcoming green design difficulties	(Elforgani et al., 2014)	(B. Aktas & Ozorhon, 2015; Bond, 2010; B. G. Hwang et al., 2017; Y. Y. Li et al., 2011; Shen et al., 2017; N. Wang et al., 2013)
	S-23	Design team's leadership effectiveness	(Elforgani et al., 2014)	
	S-24	Design consultant's experience and knowledge in GB projects		(Y. Y. Li et al., 2011)
	S-25	Motivations of design consultants; Commitment level of the architect to produce green design	(Elforgani et al., 2014)	(Murtagh et al., 2016)

Stakeholder	ID	Success condition	PDA Source	CSF Source
	S-26	The commitment of Mechanical and Electrical engineers to implement green energy	(Elforgani et al., 2014)	
Occupants/ End-users	S-27	End-users' involvement or interest in GBs; Tenants' cooperativeness		(Bond, 2010; Ihuah et al., 2014; Pheng Low et al., 2014)
	S-28	Occupant type	(Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Swarup et al., 2011)	
	S-29	The familiarity of end-users with energy-efficiency		(B. Aktas & Ozorhon, 2015)
	S-30	Having a user guide for building and educating tenants/end-users about optimally using the building; Advising tenants on the efficient use of energy		(Bond, 2010; Rasekh & McCarthy, 2016; N. Wang et al., 2013)
Facility Management team	S-31	COMPETENCE OF FACILITY MANAGEMENT TEAM: Skilled Facility Management (FM) team, knowledge of maintenance staff to operate facilities fully and efficiently, the ability of FM team to satisfy end-users' requirements		(Bond, 2010; B. G. Hwang et al., 2017; Pheng Low et al., 2014)
Contractor	S-32	Subcontractor's 'green' education	(Gultekin et al., 2013; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Swarup et al., 2011)	
	S-33	Providing sustainable education to on-site construction personnel	(Bon Gang Hwang et al., 2015)	(Robichaud & Anantatmula, 2010)
	S-34	Training workers to ensure that they operate equipment fully and efficiently	(Bon Gang Hwang et al., 2015)	(Robichaud & Anantatmula, 2010)
	S-35	Competence of contractor		(Shen et al., 2017)
Sustainability consultant	S-36	Competence of GB consultant; Experience and awareness of sustainability consultant regarding GB development; Effectiveness of consultant in terms of documentation		(B. Aktas & Ozorhon, 2015; Robichaud & Anantatmula, 2010; Shen et al., 2017)
Project manager	S-37	Competence and skilfulness of the Project Manager; Experience and awareness of Project Manager regarding GB development	(Bon Gang Hwang et al., 2016)	(Banihashemi et al., 2017; Bond, 2010; B. G. Hwang et al., 2017; Kiani Mavi & Standing, 2018; Y. Y. Li et al., 2011; Pheng Low et al., 2014; Robichaud & Anantatmula, 2010; Shen et al., 2017)
	S-38	Authority of the Project Manager/Leader		(Bakar et al., 2009; Ihuah et al., 2014)
	S-39	Efforts of the Project Manager to achieve project outcomes		(Robichaud & Anantatmula, 2010)
Decision-makers	S-40	Support from senior management and decision-makers		(B. Aktas & Ozorhon, 2015; Bakar et al., 2009; Bond, 2010; B. G. Hwang et al., 2017; Ihuah et al., 2014; Kiani Mavi & Standing, 2018; Y. Y. Li et al., 2011; Pheng Low et al., 2014; Shen et al., 2017; Venkataraman & Cheng, 2018)
Local market	S-41	Supportive market environment; Market demand for GB projects and high market recognition		(Venkataraman & Cheng, 2018; L. Zhang et al., 2017)
Public and neighbouring community	S-42	Public awareness and acceptance for GB; Supportive public cognition		(L. Zhang et al., 2017)

The scope of this review is limited to GB development and does not include studies which are exclusively related to the operational life of such projects. This explains a relatively small 'sustainable maintenance and operations' theme in Table 2-3. This theme is included to cater for the findings of studies which covered both the development and operational life of GB projects.

Table 2-3: Success conditions occurring in studies on Green Building project success

Theme	ID	Success condition	PDA Source	CSF Source
Budgetary and Financial issues	S-43	Cost premium of GB projects; Cost of sustainable materials, products and technology		(Iluah et al., 2014; Venkataraman & Cheng, 2018)
	S-44	Strong financial capability of client; Adequate funding and resources for project development	(Bilec, 2008)	(Bakar et al., 2009; Bond, 2010; B. G. Hwang et al., 2017; Iluah et al., 2014; Kiani Mavi & Standing, 2018; Y. Y. Li et al., 2011; Oyebanji et al., 2017; Pheng Low et al., 2014; Venkataraman & Cheng, 2018)
	S-45	Innovative financing methods		(Y. Y. Li et al., 2011)
	S-46	Adequate return on investment		(L. Zhang et al., 2017)
	S-47	Innovative management approaches		(Y. Y. Li et al., 2011)
Innovation and diffusion	S-48	Use of innovative technological approaches		(Y. Y. Li et al., 2011; Shen et al., 2017)
	S-49	Advanced machinery and equipment		(Y. Y. Li et al., 2011; Shen et al., 2017)
	S-50	Use of technology	(Hanks, 2015)	
	S-51	Adopting tried and tested technologies; Using appropriate construction technology	(Bon Gang Hwang et al., 2016)	(Oyebanji et al., 2017)
	S-52	Use of advanced technology and automation for construction work by the contractor		(B. G. Hwang et al., 2017; Lam et al., 2010; Y. Y. Li et al., 2011; Venkataraman & Cheng, 2018)
	S-53	Effective and efficient software development and application		(Y. Y. Li et al., 2011)
	S-54	Understanding of project and project objectives		(Bakar et al., 2009; Iluah et al., 2014; Wai et al., 2012)
Knowledge, awareness and perceptions	S-55	Knowledge management; Reliability and quality of the specification, guide and benchmarking systems		(Bond, 2010; Doskočil & Lacko, 2018; Lam et al., 2010)
	S-56	Adequate policy system		(L. Zhang et al., 2017)
Policy	S-57	Effective environmental compliance and auditing programs		(Y. Y. Li et al., 2011)
	S-58	Adequate policy execution		(L. Zhang et al., 2017)
	S-59	Project site condition		(Iluah et al., 2014)
Project constraints	S-60	Project type		(Shen et al., 2017)
	S-61	Project size; Scope of work	(Bilec, 2008)	(Shen et al., 2017)
	S-62	Land issues		(Iluah et al., 2014)
	S-63	Geography and climatic conditions		(Iluah et al., 2014)
	S-64	Economic environment		(Shen et al., 2017)
	S-65	Socio-political environment		(Shen et al., 2017)
	S-66	Availability of sustainable building materials	(Bon Gang Hwang et al., 2016)	(Kiani Mavi & Standing, 2018)
	S-67	Good accessibility and provision of adequate alternative transport modes		(Oyebanji et al., 2017)
	S-68	DEFINING PROJECT GOALS: the selection of green features that naturally align with the other project goals; aligning sustainability with the business case and corporate strategy		(Bakar et al., 2009; Bilec et al., 2009; Bon Gang Hwang et al., 2015; Iluah et al., 2014; Kiani Mavi & Standing, 2018; Robichaud & Anantatmula, 2010)
Project focus, goals and ambitions	S-69	Clear and realistic goals and objectives; Clear priorities of stakeholders		(Banihashemi et al., 2017; Bond, 2010; Kiani Mavi & Standing, 2018; Pheng Low et al., 2014)
	S-70	Ensuring that the preliminary budget is aligned with project goals		(Robichaud & Anantatmula, 2010)
	S-71	Importance of 'green' for the project	(Gultekin et al., 2013; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Swarup et al., 2011)	
	S-72	Ensuring cost-effectiveness of work; Finalising economic and ecological goals based on cost/benefit analysis		(Kiani Mavi & Standing, 2018; Robichaud & Anantatmula, 2010)

Theme	ID	Success condition	PDA Source	CSF Source
Integration	S-73	Timing of introducing 'green'	(Enache-Pommer & Horman, 2009; Gultekin et al., 2013; S Korkmaz et al., 2010; Swarup et al., 2011)	
	S-74	Transparent delivery process	(Enache-Pommer & Horman, 2009)	
	S-75	Adequate information/communication channels		(Bakar et al., 2009; Ihuah et al., 2014; Y. Y. Li et al., 2011)
	S-76	Level of design integration; Integrated design approaches	(Bilec, 2008; Enache-Pommer & Horman, 2009; Gultekin et al., 2013; Hanks, 2015; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Sinem Korkmaz et al., 2011; Molenaar et al., 2009; Swarup et al., 2011)	(Bond, 2010)
Project monitoring, risk management and quality assurance	S-77	Performance monitoring, feedback and control		(C. B. Aktas et al., 2012; Bakar et al., 2009; Ihuah et al., 2014; Y. Y. Li et al., 2011; Wai et al., 2012)
	S-78	Schedule control	(Gultekin et al., 2013)	
	S-79	Regular health and safety reports during construction and operational stages		(N. Wang et al., 2013)
	S-80	Incorporating effective risk management		(Bakar et al., 2009; Bond, 2010; Doskočil & Lacko, 2018; B. G. Hwang et al., 2017; Ihuah et al., 2014; Kiani Mavi & Standing, 2018; Lam et al., 2010)
	S-81	Implementing troubleshooting		(Bakar et al., 2009; Ihuah et al., 2014; Y. Y. Li et al., 2011; Wai et al., 2012)
	S-82	Strong/detailed plan effort in design and construction		(Y. Y. Li et al., 2011)
	S-83	The completion level of construction documents	(Gultekin et al., 2013; Bon Gang Hwang et al., 2016; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Swarup et al., 2011)	
	S-84	Use of commissioning process	(Enache-Pommer & Horman, 2009; Kantola & Saari, 2016)	(Robichaud & Anantatmula, 2010)
	S-85	Use of envelope mock-ups	(Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Swarup et al., 2011)	
	S-86	Quality of workmanship	(Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Swarup et al., 2011)	
	S-87	Quality control inspections	(Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Swarup et al., 2011)	
Project Design	S-88	Client maintaining active participation in the green design process	(Elforgani et al., 2014; Lam et al., 2010; N. Wang et al., 2013)	
	S-89	Use of Quantitative metrics	(Gultekin et al., 2013; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Swarup et al., 2011)	
	S-90	Use of energy and lighting simulations	(Enache-Pommer & Horman, 2009; Gultekin et al., 2013; S. Korkmaz et al., 2011)	
	S-91	Strong/detailed effort in design		(Y. Y. Li et al., 2011; Oyeibanji et al., 2017)
	S-92	Regular inspection of design specification and building code to prevent discrepancy		(Y. Y. Li et al., 2011; Oyeibanji et al., 2017)
	S-93	Economic design and efficient use of resources		(Y. Y. Li et al., 2011; Oyeibanji et al., 2017)
	S-94	Appropriate land use and development plan;		(Y. Y. Li et al., 2011; Oyeibanji et al., 2017)

Theme	ID	Success condition	PDA Source	CSF Source
	S-95	Check for errors and discrepancies in design documents before submitting for approval to avoid deviations or corrections		(Y. Y. Li et al., 2011; Oyebanji et al., 2017)
	S-96	Performing sufficient studies and analysis on project requirements and complexity before the work starts on the project		(Y. Y. Li et al., 2011; Oyebanji et al., 2017)
	S-97	Adding flexibility in design to allow future expansion		(B. G. Hwang et al., 2017)
	S-98	Simplicity/low level of complexity in building design		(B. G. Hwang et al., 2017; Kiani Mavi & Standing, 2018)
	S-99	Design of building to fulfil constructability		(B. G. Hwang et al., 2017)
	S-100	Design focus on energy-efficiency		(N. Wang et al., 2013)
	S-101	Ensuring that the interior fit-out matches the base building		(Bond, 2010)
	S-102	Design team's attention to green design and construction details	(Elforgani et al., 2014)	
	S-103	Timing of contractor's involvement; Contractor's involvement in design stages	(Gultekin et al., 2013; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; Sinem Korkmaz et al., 2011; Swarup et al., 2011)	(Y. Y. Li et al., 2011)
	S-104	Designer's involvement in construction stages		(Y. Y. Li et al., 2011)
Expert engagement	S-105	Timing of key participants' involvement; Early involvement of key project participants	(Enache-Pommer & Horman, 2009; Hanks, 2015; S. Korkmaz et al., 2011)	(Shen et al., 2017; Venkataraman & Cheng, 2018)
	S-106	Involvement of the Facility Management team in the design stage		(Rasekh & McCarthy, 2016)
	S-107	Involvement of a green consultant; Involvement of a green professional throughout the project development; Dedicated department for sustainability	(Enache-Pommer & Horman, 2009; Gultekin et al., 2013; Sinem Korkmaz et al., 2010)	(Bond, 2010; B. G. Hwang et al., 2017; Venkataraman & Cheng, 2018; N. Wang et al., 2013)
	S-108	Involvement of commissioning professional from the project onset		(Robichaud & Anantatmula, 2010)
Project planning	S-109	Selection of prime location for the project		(B. G. Hwang et al., 2017)
	S-110	Site selection based on community input		(Bond, 2010; Robichaud & Anantatmula, 2010)
	S-111	Designing building as per standards; Following LEED checklist and documenting system at the feasibility stage		(B. G. Hwang et al., 2017; Robichaud & Anantatmula, 2010)
	S-112	Efficient compilation and submission of documentation for certification		(Robichaud & Anantatmula, 2010)
	S-113	Avoiding setback in review and approval of documents	(Bon Gang Hwang et al., 2015)	
	S-114	Early evaluation and adoption of environmental considerations	(Enache-Pommer & Horman, 2009; Gultekin et al., 2013; S Korkmaz et al., 2010; Swarup et al., 2011)	(Bilec et al., 2009; Bon Gang Hwang et al., 2015)
	S-115	Minimal scope changes; Minimising change orders during construction; Avoiding design changes	(Bon Gang Hwang et al., 2015; Bon Gang Hwang et al., 2016)	(B. G. Hwang et al., 2017; Kiani Mavi & Standing, 2018)
	S-116	Effective change management		(Pheng Low et al., 2014)
	S-117	Realistic schedule Estimate		(Bakar et al., 2009; Ihuah et al., 2014; Wai et al., 2012)
	S-118	Realistic cost estimate		(Bakar et al., 2009; Ihuah et al., 2014)
	S-119	Adequate planning		(C. B. Aktas et al., 2012; Bakar et al., 2009; Ihuah et al., 2014)
	S-120	Using whole life costing approach; Whole life project management		(Kiani Mavi & Standing, 2018; Lam et al., 2010; Robichaud & Anantatmula, 2010; N. Wang et al., 2013)

Theme	ID	Success condition	PDA Source	CSF Source
Team formation, procurement and contractual aspects	S-121	Well allocation of resources		(Wai et al., 2012)
	S-122	Community engagement; Active stakeholder involvement; Consulting meetings with tenants/end-users		(Bond, 2010; Oyeibanji et al., 2017; Rasekh & McCarthy, 2016; Venkataraman & Cheng, 2018; N. Wang et al., 2013)
	S-123	Clearly written lines of responsibilities; Creating accountabilities, expectations, roles and responsibilities		(Banihashemi et al., 2017; Pheng Low et al., 2014)
	S-124	Design team's effectiveness in controlling and monitoring design development	(Elforgani et al., 2014)	
	S-125	Project Delivery Method	(Bilec, 2008; Carpenter, 2005; Dahl et al., 2005; El Asmar et al., 2013; Gard, 2004; Gultekin et al., 2013; Hanks, 2015; Kantola & Saari, 2016; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Sinem Korkmaz et al., 2011; Lei, 2005; Molenaar et al., 2009; David Riley et al., 2005; Swarup et al., 2011; N. Wang et al., 2013; Zhou & Smith, 2013)	(Bond, 2010)
	S-126	Contractual terms used	(Gultekin et al., 2013; Hanks, 2015; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Molenaar et al., 2009; Swarup et al., 2011)	
	S-127	Contracts having incentives for implementing sustainable practices and exceeding sustainability goals; Contract incentives/penalties	(Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Swarup et al., 2011)	(Robichaud & Anantatmula, 2010)
	S-128	Completeness and adequacy of project design and specifications		(B. G. Hwang et al., 2017)
	S-129	'Green' requirements in the contract	(S Korkmaz et al., 2010; S. Korkmaz et al., 2011; Molenaar et al., 2009; Swarup et al., 2011)	(Pheng Low et al., 2014)
	S-130	Contractual relations for consultants	(Gultekin et al., 2013; S Korkmaz et al., 2010; Swarup et al., 2011)	
	S-131	Contractual relations for core team members	(Gultekin et al., 2013; S. Korkmaz et al., 2011; Swarup et al., 2011)	
	S-132	Procurement method costs	(Gultekin et al., 2013)	
	S-133	The primary process for team selection/procurement	(Gultekin et al., 2013; Kantola & Saari, 2016; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Molenaar et al., 2009; Swarup et al., 2011)	
	S-134	Selection of companies relative to the size of the project		(Bond, 2010; Venkataraman & Cheng, 2018)
	S-135	Importance of criteria in the request for proposal	(Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Swarup et al., 2011)	
	S-136	CONTRACTOR'S PROCUREMENT: Emphasis on high-quality workmanship; Comprehensive contractors' portfolio investigation in terms of their level of awareness of the sustainability concept and their previous records of sustainable project implementation; Checking contractors' resources and capabilities before awarding the contract; Using the open-book subcontracting process which allows the Client to have access to the estimates and pricing submitted by subcontractors	(Bon Gang Hwang et al., 2015)	(Banihashemi et al., 2017; B. G. Hwang et al., 2017; Robichaud & Anantatmula, 2010)

Theme	ID	Success condition	PDA Source	CSF Source
Sustainable maintenance and operations	S-137	Using sophisticated Building Monitoring Systems for monitoring the building to achieve peak performance		(Bond, 2010; N. Wang et al., 2013)
	S-138	Regular operational monitoring		(Bond, 2010; N. Wang et al., 2013)
	S-139	Conducting regular surveys for tenants' feedback		(Bond, 2010; N. Wang et al., 2013)

2.5. Research methodologies of previous studies on Green Building project success

The research methodologies of previous studies on GB project development are reviewed in detail. A breakdown of research methodologies in terms of research design, data collection methods, and contextual specificity of the reviewed studies, is provided in Figure 2-3 and Table 2-4.

Regional specificity: Up to 90% of the publications reviewed in this study (n=43) investigated GB project success in particular regional contexts. While most of the CSF studies are related to Singapore (n=5) and Australia (n=3), most of the PDA studies are related to the US (n=15) and the UK (n=4).

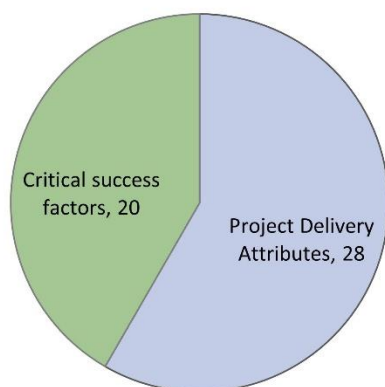
Research design: In terms of the research design, the fieldwork-based approach (40%; n=19) and case study-based approach (48%; n=23) are commonly used. While fieldwork is the preferred approach in the CSF studies, case studies are preferred in the PDA studies.

Research Method: A similar number of studies have used quantitative (46%; n=22) and qualitative (44%; n=21) approach. Few studies (10%; n=5) have used the mixed-methods research design. In terms of the analysis of research findings, the quantitative analyses mainly included: factor analysis, univariate regression analysis, and multivariate regression analysis. Qualitative analyses mainly included: content analysis, inductive reasoning, pattern matching, and process mapping.

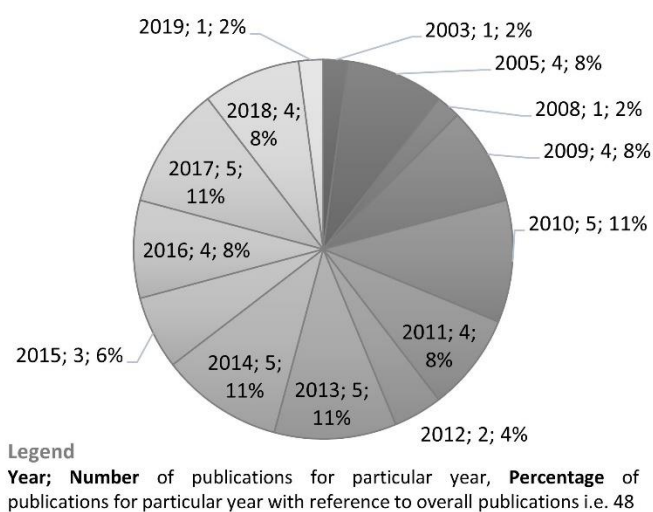
Data Collection Method: In terms of the data collection methods questionnaire surveys, interviews, critical literature reviews, expert panels, workshops, and documentaries were used by studies. From among the prevalent data collection methods, most of the studies (40%; n=19) used questionnaire surveys. A significant number of studies also used interviews (31%; n=15). Factors investigated in many studies (33%; n=16) were not identified in those studies and were instead acquired by previous literature on the subject matter.

Year of Publication: In terms of the year of publication, none of the reviewed studies is dated before the year 2003. Up to 79% (n=38) of the reviewed studies are published before the year 2017.

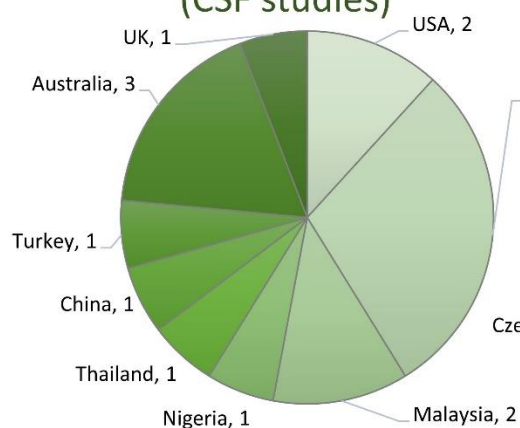
Research Paradigm of studies



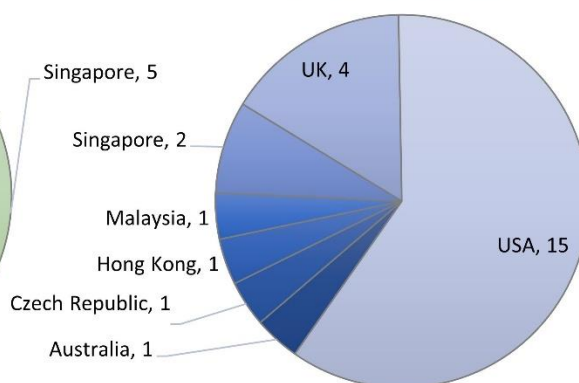
Publications by year



Specificity of Regional Context (CSF studies)



Specificity of Regional Context (PDA studies)



Research methodologies of studies

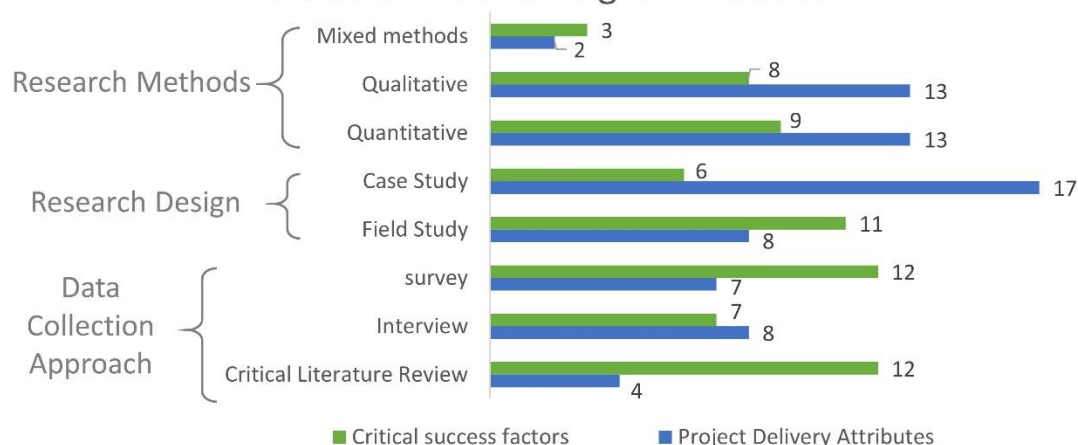


Figure 2-3: Methodological attributes and regional specificity of studies on Green Building project success

Table 2-4: Methodological attributes and regional specificity of individual studies on Green Building project success

Paradigm	Source	Qualitative	Quantitative	Mixed-methods	Case Study	Field Study	Survey	Interview	Critical Literature Review	Context specificity
	Aggregate	21	22	5	23	19	19	15	16	
Project Delivery Attributes	Lei (2005)		x			x	x			UK
	Xia et al. (2014)			x						USA
	Olanipekun et al. (2018)		x			x	x			Australia
	Zhou and Smith (2013)	x			x			x		UK
	Dahl et al. (2005)	x			x					USA
	David Riley et al. (2005)	x			x					USA
	Kantola and Saari (2016)	x								
	Gard (2004)			x						
	Hanks (2015)	x			x					USA
	Enache-Pommer and Horman (2009)	x			x					USA
	El Asmar et al. (2013)		x		x					USA
	Carpenter (2005)		x		x					USA
	Bilec (2008)	x			x					USA
	Sinem Korkmaz et al. (2011)	x			x					USA
	Swarup et al. (2011)	x			x					USA
	S Korkmaz et al. (2010)	x			x					USA
	Molenaar et al. (2009)		x		x		x	x		USA
	S. Korkmaz et al. (2011)		x		x					USA
	Sinem Korkmaz et al. (2010)		x		x					USA
	Gultekin et al. (2013)		x		x					USA
	Z. W. Tang et al. (2019)		x			x		x	x	
	Bon Gang Hwang et al. (2016)		x			x	x	x	x	Singapore
	Bon Gang Hwang et al. (2015)		x			x	x	x	x	Singapore
	Elforgani et al. (2014)		x			x	x			Malaysia
	Lam et al. (2010)		x			x	x		x	Hong Kong
	Murtagh et al. (2016)	x				x		x		UK
	N. Wang et al. (2013)	x			x			x		UK
	Doskočil and Lacko (2018)	x			x			x		Czech Republic
	Venkataraman and Cheng (2018)		x			x	x		x	
	C. B. Aktas et al. (2012)	x			x				x	USA
	Y. Y. Li et al. (2011)		x			x	x		x	Singapore
	Wai et al. (2012)		x			x	x			Malaysia
	Bakar et al. (2009)	x							x	Malaysia
	Ihuah et al. (2014)	x							x	Nigeria
	Shen et al. (2017)		x			x	x			Thailand
	Bon Gang Hwang and Ng (2013)		x			x	x	x		Singapore
	L. Zhang et al. (2017)		x			x	x			China
	Y. Y. Li et al. (2014)			x	x		x			Singapore
	B. Aktas and Ozorhon (2015)	x			x			x		Turkey
	Bilec et al. (2009)	x			x			x		USA
	Bond (2010)	x			x			x		Australia
Critical Success Factors	Kiani Mavi and Standing (2018)		x			x	x		x	Australia
	B. G. Hwang et al. (2017)		x			x	x		x	Singapore
	Pheng Low et al. (2014)			x		x	x	x	x	Singapore
	Banihashemi et al. (2017)			x		x	x	x	x	Developing countries
	Oyebanji et al. (2017)		x			x	x		x	UK
	Rasekh and McCarthy (2016)	x			x			x	x	Australia
	Robichaud and Anantamula (2010)	x							x	

2.5.1. Methodological limitations of Project Delivery Attribute research

The PDA studies have a variety of limitations in terms of the research design, data collection techniques used, and the reporting of findings. Within the studies using a case study approach, the comparison of Project Delivery Methods is entirely based on inductive reasoning (Bilec, 2008; Dahl et al., 2005; Kantola & Saari, 2016; David Riley et al., 2005) which constrains the generalisability of the findings. Some new

Project Delivery Methods (for example, Integrated-Project-Delivery) have not yet found much use in GBs and this also affects the evidence-based studies that quantify the usefulness of those Project Delivery Methods for GBs. For these reasons, very few GB studies have involved Public-Private-Partnership/Private-Finance-Initiative and Integrated-Project-Delivery methods. Another source of uncertainty is the difference in the GB accreditation/certification systems (for example, LEED) for case studies that are compared on the same basis. Such differences can invalidate the effectiveness of control variables (for instance LEED certification) in quantitative studies. In addition, the ownership of projects by private owners can threaten the external validity of research findings, as found in some studies (S Korkmaz et al., 2010; Sinem Korkmaz et al., 2011; Swarup et al., 2011).

In statistics, multicollinearity is a state of high inter-associations in independent variables. This reduces the reliability in statistical inferences. In simple terms, the change in the behaviour of performance criteria (that is dependent variable) resulting from a PDA (that is independent variable) cannot be reliably modelled. Within the multivariate regression models created in certain PDA-related quantitative studies, multicollinearity is not addressed (Gultekin et al., 2013; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011). Many of these studies are limited to office buildings with a focus on LEED-certified new construction (Gultekin et al., 2013; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Sinem Korkmaz et al., 2011; Swarup et al., 2011). Furthermore, in the PDA-related quantitative studies, the relationship between PDAs and project performance is merely indicative of correlation, not causation. For a complex process such as building development, it is extremely difficult for regression-based models to substantially explain the influence of a combination of independent variables on dependent variables while also explaining the relationships among independent variables.

Most of the PDA-related studies provide evidence for more collaborative delivery systems as being superior to less collaborative ones. The statistical significance of results varies depending on construction type and study scope. Most of the studies suffer from limited types of case studies (El Asmar et al., 2013; Enache-Pommer & Horman, 2009) and also the limited number of case studies (Bilec, 2008; Carpenter, 2005; Dahl et al., 2005; El Asmar et al., 2013; Enache-Pommer & Horman, 2009; Gultekin et al., 2013; Hanks, 2015; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Sinem Korkmaz et al., 2011; David Riley et al., 2005; Swarup et al., 2011; Zhou & Smith, 2013). They also explore the PDA issues within the LEED-certified buildings excluding other GB accreditation systems. Furthermore, the majority of case studies are within the US context and in most studies, the case studies are hand-picked, that is not based on random selection (Gultekin et al., 2013; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011). An important limitation observed in the methodology of PDA-related studies is an overemphasis on the use of certified GBs as a subject of investigation. While such an approach facilitates the research activity because of the verification of sustainability by a GB's certification status/score, the approach may also result in undesirable effects on research outcomes. This is because the study findings for certified-GBs may be different as compared to research findings for non-certified GBs.

Although the PDA studies have also considered Success conditions other than Project Delivery Methods, the primary focus of mainstream research is the usefulness of different delivery methods for GB development. The PDA-based studies are not only limited in terms of the methodology of testing factor relationships and significance, but also in terms of the content tested. The factors considered in most studies (S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Sinem Korkmaz et al., 2011; Swarup et al., 2011) were mainly identified from non-GB-related foundational studies (El Wardani, Messner, & Horman, 2006; Gransberg & Buitrago, 2002; Konchar & Sanvido, 1998), and to

some extent from GB-related field study research. Since the foundational studies were not GB specific, the PDA studies for GBs are partially based on the knowledgebase of non-GB projects.

2.5.2. Methodological limitations of Critical Success Factor research

The predominant approach used by studies in the CSF paradigm is to conduct a critical literature review of Success conditions previously studied and then to subsequently verify the criticality of those conditions within a certain context using questionnaire surveys. CSF as a paradigm is not driven by qualitative methods and the use of interviews in data collection. This can have detrimental effects for research as the opportunity of unveiling new factors is often missed if the database of factors is only being developed from existing literature. Both the CSF and the PDA factors have evolved from non-GB projects which is an important limitation for these studies.

Although in theory, the CSF and PDA studies are closely related and most of their Success conditions overlap, the methodology employed by these paradigms is markedly different. CSFs have been investigated mainly using the survey-based approach and without consideration towards GB case studies. Along with the project management factors, the major focus of these studies is towards organisational factors empowering enterprises to develop GBs.

2.6. Research gaps

The review of previously published literature on GB project success shows that the focus of research studies is mainly towards the investigation of success factors and not towards the inquiry of Success criteria. For the research inquiry to fulfil the aim of promoting good project outcomes in GBs, not only the Success conditions but also the Success criteria are important for investigation.

Both the CSF and PDA studies investigating GB project success have mainly relied on reductionist approaches in data collection, analysis, and interpretation. This is primarily because of the sheer large number of Success conditions. Other than a few examples, such as the study by Z. W. Tang et al. (2019) using system dynamics, the research on GB project success has generally ignored the complexity and systems nature of GB project development. Instead of seeing project development holistically (that is with a vast number of enabling factors and interrelationships among those factors), the previous studies whether occurring in the PDA or the CSF paradigm have typically used reductionist approaches. The reductionist approaches (for example, factor analysis) limit the theoretical and practical application of research findings. For instance, Project Delivery Methods (PDMs) are a key focus of many reviewed studies. Even though some studies have established the comparative effectiveness of some PDMs for successful GB development, the implications of these findings are limited. This is because a PDM is a complex variable made up of many other variables such as contractual relationships between client and project team, payment mechanism, and contractual clauses. In practice, it may be more desirable to introduce changes in these constituent variables than to introduce a new PDM. Also, in theory, it may be more desirable to investigate the role of constituent variables for project success than to know about the role of a particular PDM in project success. While knowing about the constituent variables can help understand the importance of overarching variables (for example, PDM), it is not *vice versa*. This means that at the current stage when there are still many unknown Success conditions and the interrelationships among conditions have scarcely been discovered, it is not desirable to use reductionist approaches.

Even though a significant number of studies have used qualitative methodologies, there is still a lack of emphasis towards exploratory research design. Previous studies on GB project success have been excessively reliant on explanatory research design instead of exploratory design. As a result, the factors (that is, Success conditions and criteria) and factor interrelationships have not been significantly explored. For a research area like GB project success, in the early stages of its development, it is

important to use the exploratory research design as the critical mass of factors still need to be discovered. It is important as often exploratory research is followed by explanatory research and not the *vice versa*.

Previous studies have not explained the interrelationships among sustainability and traditional project management criteria (*Schedule, Cost, and Quality performance*). As a GB project is developed, it has to perform well in meeting its long-term objectives (for example, sustainability) and the short-term objectives (for instance, project management success). In current GB project development, where the industry is beginning to accept sustainability as a project requirement, it is important to address 'how' sustainability and project management-related performance interrelate, as this understanding can facilitate decision-making in projects and can lead to better performance prediction models. Although previous studies have considered the effect of different factors on performance criteria of GBs, they have not exclusively addressed how performance criteria are interrelated in the case of GBs.

By adopting epistemic relativism, this study acknowledges that our knowledge about reality is always historically situated. By seeing the previous research on GB project success with this viewpoint it can be stated that many findings of previous studies are outdated since as many as 79% of studies were published before the year 2017. The GB sector in the construction industry is rapidly changing with time. The ever-increasing requirement of energy-efficiency in these projects is one of the reasons that a continuous innovation process is going on to develop better-performing building systems. Many GB projects are developed for certification purposes, and many certification systems are recently developed and are in a state of continuous evolution. Under the influence of continuous evolution in the industry, the knowledge which industry professionals have regarding the successful development of these projects is continuously evolving. This indicates that for research conducted in this area, some findings may become outdated in few years' time, as by interviewing or surveying the same industry experts as engaged earlier, different opinions regarding the same old constructs/questions might emerge.

Although the previous research on GB project success has considered a significant number of Success conditions, still more Success conditions for GB projects need to be identified. Moreover, the previous research shows no serious effort regarding the interrelationships among Success conditions. Dedicated studies to inquire Success criteria for GB projects have also been missing. These gaps in knowledge have also been observed by some recent review studies on the subject matter. For instance,

- Within the two systematic review studies conducted by the researcher¹, it is identified that the interactions among Success conditions and their cumulative effect on Success criteria have not been studied in previous research on GB project success. Moreover, it is also identified that the previous studies are constrained by a limited number of Success conditions and criteria.
- Upon conducting a systematic review of published studies, Sfakianaki (2019) realised that sustainable construction is an emerging research area and in terms of content lacks a critical mass of Success conditions.
- In a review of GB research trends, A. Darko and Chan (2016) recognised a lack of studies focused on GB project success. It was also acknowledged that previous studies have mainly focused on project-related and project management-related factors, instead of human-related (such as project

¹ Ahmad, T. and A.A. Aibinu, Project delivery attributes influencing green building project outcomes: A review and future research directions. *Built Environment Project and Asset Management*, 2017. 7(5): p. 471-489.

Ahmad, T., A.A. Aibinu, and A. Stephan, Managing green building development – A review of current state of research and future directions. *Building and Environment*, 2019. 155: p. 83-104.

team-related) and external environment-related factors. Moreover, A. Darko and Chan (2016) indicated that previous studies on GB project success are still excessively reliant on traditional performance criteria (*cost, schedule, and quality*) and need to use sustainability criteria for benchmarking GB project performance.

- In a review of GB project success research, Y. Li, Song, Sang, Chen, and Liu (2019) identified some knowledge gaps from which it was suggested that studies on GB project success need to consider relationships between Success conditions. Moreover, different project objectives (for example, Success criteria) need to be considered in this research.

The overall literature review of research on GB project success has resulted in the following key suggestions for future research development in this area.

- **Non-reductionism:** Non-reductionist research approaches are to be emphasised while considering GBs as complex systems and GB development as a complex problem. Non-reductionist approaches are to be used in data collection, analysis, and interpretation.
- **Exploratory research design:** the more exploratory focus is required in research design. The interrelationships among Success conditions need to be inquired to understand how these conditions cumulatively contribute to project success. The interrelationships among Success criteria and particularly among sustainability and traditional project management criteria (*Schedule, Cost, and Quality performance*) need to be inquired to understand how project success can be optimised by controlling performance in certain criteria.
- **Accounting for context:** The identification of factors (that is, Success conditions and criteria) needs to be strongly based in the context of GB projects instead of importing Success conditions from non-GB projects.

2.7. Chapter Summary

This chapter provided a detailed literature review of previous studies conducted on GB project success. Previous studies conducted on GB project success are mainly context-specific and are based on two paradigms (that is, CSF and PDA). Studies within the PDA paradigm are mostly conducted in the US and the UK and have focused on identifying suitable Project Delivery Methods for GB projects. These studies have mainly used the case study approach. Studies within the CSF paradigm are mostly conducted in the Asian region and have mainly relied on field study approach. Both the CSF and PDA paradigms have mostly used reductionist approaches and explanatory research design. Moreover, these studies lack a focus on identifying conditions and criteria specific to GB projects and identifying interrelationships within the conditions and criteria.

This chapter has reviewed previous studies conducted on GB project success. The theoretical framework used in this study to address research questions is explained in Chapter 3.

3. Theoretical Framework

To address the research questions in this study, four theoretical lenses are used which are Triple Bottom Line, Transformation-Flow-Value-generation (TFV) theory, Complex systems perspective, and project success. This chapter provides a detailed explanation regarding these theoretical lenses. Section 3.1 is about the requirements of this study which lead to the selection of four theoretical lenses. Section 3.2 is about the use of the Triple Bottom Line in explaining the GB projects within the sustainable development context. This is followed by Section 3.3 which characterises project success into Success conditions and Success criteria. The use of TFV for explaining GB projects in the construction industry is discussed in Section 3.4. Finally, the application of complex systems in explaining GB project success is provided in Section 3.5.

3.1. Theoretical lenses

This study aims to promote the development of better Green Building projects. These projects have origins in the construction industry and are developed using sustainability principles. Therefore, the theoretical framework of this study needs to contextualise GB projects within these two fields of knowledge. The framework also needs to conceptualise GB project success and needs to adopt an appropriate lens to understand the complex nature of such projects. While responding to the requirements of this study four lenses are used to develop the theoretical framework as shown in Figure 3-1. These lenses are Triple Bottom Line, Transformation-Flow-Value-generation (TFV) theory, Complex systems perspective, and project success.

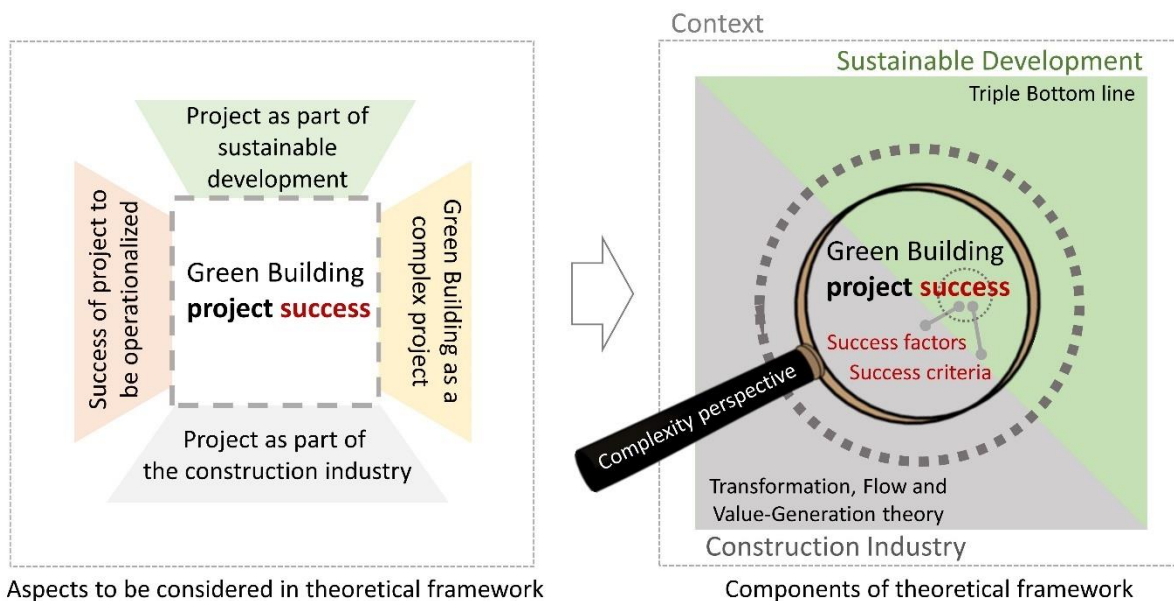


Figure 3-1: Contextual aspects of Green Building project success defining the theoretical framework of this study

The significance of the four lenses for the inquiry of GB project success is as follows:

Triple Bottom Line to contextualise GBs in terms of sustainable development: GBs are fundamentally different from their traditional counterparts because of their sustainability considerations. GBs are an application of sustainable construction which is itself a subset of sustainable development based on *social, economic, and environmental* principles. A GB as a system in itself and as a subset of the built environment system has to adhere to the Triple Bottom Line, in other words, the principles of *social,*

economic, and *environmental sustainability*. Hence, within the context of sustainable development, GBs are defined by the Triple Bottom Line.

Conceptualising Green Building project success using Success conditions and criteria: While contextualising GBs in the sustainable built environment and construction industry, the theoretical framework also needs to characterise GB project success into criteria used to determine success and conditions which enable success.

TFV theory of production to contextualise GBs in the construction industry: As construction projects, the development of GBs within the context of the construction industry can be explained by the Transformation-Flow-Value-generation (TFV) theory. Based on this theory, the development process of a GB can be defined in terms of Transformation (that is the transformation of inputs into outputs), Flow (that is the flow of materials involving transformation, inspection, moving and waiting), and Value-generation (that is value creation for the customer).

Complexity perspective to conceptualise the intricate nature of GB project development: Acknowledging the intricate nature of GB project development, the complexity perspective is a relevant lens to view the subject of GB project success. GBs have multiple layers of complexity in their development and operation and therefore need to be analysed using non-reductionist approaches. Two key aspects of GBs result in their complexity. First, GBs are a product of the construction industry which is known for its complexity. Second, GBs are an application of sustainable development and therefore have the added requirement of sustainability resulting in complexity.

3.2. Triple Bottom Line: Contextualising Green Buildings in sustainable development

Building on the foundations of Meadows, Meadows, Randers, and Behrens (1972) and Bruntland (1987), and the like, Elkington, in the mid-1990s, coined the term “Triple Bottom Line” to represent the three component areas of sustainability: *social*, *environmental*, and *economic* (or “people, planet, profit”) (Elkington & Rowlands, 1999). Elkington proposed these three values for use in strategic decision-making. In practical terms, the Triple Bottom Line expands the income statement, the traditional company reporting framework, to consider environmental and social performance in addition to financial performance (Bae & Kim, 2008; Slaper & Hall, 2011). The Triple Bottom Line evolved as a basis for sustainable development and this concept has been subsequently adopted by numerous organisations and agencies (Slaper & Hall, 2011; Wilson, 2015).

Sustainable construction is a subset of sustainable development and it explains the contribution of the built environment towards an overarching sustainability vision (Kibert, 2008). Sustainable construction addresses the Triple Bottom Line as according to Kibert (1994) it is “the creation and responsible management of a healthy built environment based on efficient resources and ecological principles.” Kibert’s principles were later divided into social, economic, biophysical and technical pillars by Hill and Bowen (1997) and are explained in detail in Appendix A (Section A.1).

Green buildings are an application of sustainable construction. Kibert (1994) defined GBs as “healthy facilities designed and built in a resource-efficient manner, using ecologically-based principles.” *Environmental*, *social*, and *economic* aspects are prioritised in the design and construction of sustainable and green buildings. While considering short-term performance, these buildings also have a focus on long-term performance. According to EPA (2016), Green Building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation, and deconstruction. This practice expands and complements the classical concerns of building design related to economy, utility, durability, and comfort. In the US, high-performance buildings have become a popular synonym for green buildings (Kibert, 2008). These are considered a special type of GBs with

an emphasis on the indoor environment quality and building energy use (Horman et al., 2006). According to the U.S. Department of Energy (2004), energy, economic, and environmental performance of high-performance buildings is substantially better than standard practice. Their energy-efficiency saves money and natural resources. These buildings are a healthy place to live and work for occupants and have a relatively low impact on the environment.

Green buildings are also known as sustainable or high-performance buildings. Although a distinction can be drawn between sustainable buildings and green buildings, based on the reasoning that the former has more consideration towards socio-economic aspects than the later (Berardi, 2013), this study relies on the Green Building definition by EPA (2016) and does not distinguish between sustainable buildings and green buildings.

Triple Bottom Line is at the very core of a GB project. Since a GB is developed with considerations for people, profit, and planet, it results in socio-economic and environmental benefits. The environmental benefits of GBs include the enhancement and protection of biodiversity and ecosystems, improvement in air and water quality, reduction of waste streams, and conservation and restoration of natural resources. The economic benefits include reduction of operating costs, improvement of occupant productivity, optimisation of life-cycle economic performance, and development of markets for green products and services. In social terms, the benefits are the improvement of overall quality of life, increased aesthetic qualities, reduced strain on local infrastructure, and enhancement of occupant comfort and health (EPA, 2016). It can be concluded that GBs are significantly different from the traditional buildings as their development is based on the Triple Bottom Line, that is, *social, economic, and environmental sustainability*.

3.3. Conceptualising Green Building project success using Success conditions and criteria

To conceptualise project success, it is necessary to answer two key questions: ‘what’ is project success and ‘how’ to achieve project success. Success conditions and Success criteria are the answer to these questions. Success criteria help conceptualise ‘what’ project success is. These are the principles or standards by which project performance can be evaluated. For instance, quality performance is a criterion on which project performance is determined. Success conditions help conceptualise ‘how’ project success is achieved. These are the set of circumstances, facts, or influences that while acting as effective forces either facilitate or impede project success (Lim & Mohamed, 1999). For instance, project team collaboration facilitates project success and is, therefore, a success condition. Success conditions have been addressed as ‘success factors’, ‘Project Delivery Attributes’, and ‘independent variables’ in literature. Project Success criteria have also been addressed by many terms in literature, for instance ‘performance criteria’, ‘performance metrics’, ‘success indicators’, ‘performance indicators’ and ‘dependent variables’ (S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Sinem Korkmaz et al., 2011; Sang et al., 2018; Swarup et al., 2011; Venkataraman & Cheng, 2018; Yu et al., 2018).

The relationships among Success conditions and Success criteria are exemplified in Figure 3-2. To conceptualise GB project success, it is important to consider both the Success conditions and Success criteria. Since a GB project is based on Triple Bottom Line, the Success criteria for a GB project may include *social, economic, and environmental sustainability*.

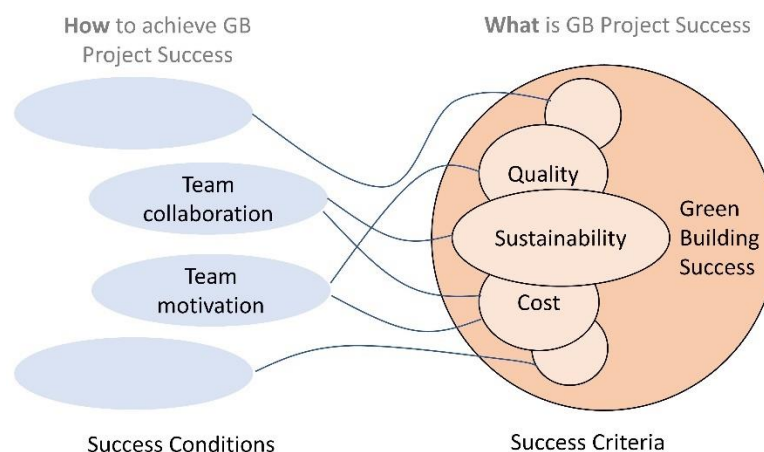


Figure 3-2: Conditions and criteria conceptualising success in Green Building projects

3.4. TFM theory of production: Contextualising Green Buildings in the construction industry

The Triple Bottom Line explains the GB projects within the context of sustainable development. Being construction projects, GBs also need to be explained in the context of the construction industry by a theory related to construction projects. The TFM theory of production in construction proposed by Koskela and implemented by lean construction can explain the development of GB projects. The three views within the TFM theory which are Transformation, Flow, and Value-generation can provide an interpretation of Success conditions and criteria for GB projects. The reason to use TFM theory of production in the theoretical framework is that it helps interpret the GB project development in terms of value created for project client. It also helps see how the success conditions reduce the likelihood of waste or non-value adding activities in project development.

For a research inquiry of project success, the significance of the TFM theory of production is that it explains how the goals of production in a construction project can be achieved. While the goal of getting the intended products produced is realised by task management, the external customer-related goals of production are achieved by value management. The goal of cost minimisation is attributable to both the efficiency of the transformation activities performed in the domain of task management and the amount of non-value-adding activities through which the transformation activities are bound together in the domain of flow management. The Transformation, Flow, and Value-generation views can interpret Success conditions and Success criteria of GB projects. As compared to the existing theories, a much wider framework is provided by the TFM theory of production, since it provides the flexibility to perceive construction projects from three viewpoints instead of only one viewpoint. Some conditions and criteria may associate with all three views, some associate with two views, while the rest associate with one of the three views. Hence, the three views within the TFM theory can ensure that the interpretation of all conditions and criteria is provided. As the Value-generation view can incorporate stakeholders' perception of project success, it can help interpret Success criteria. GB Success conditions may be interpreted using the Flow view as these may result in eliminating or reducing non-value adding activities. Some conditions may also be interpreted using the Transformation view as these may result in realising the efficient development of the project. Conditions resulting in the elimination of value loss can be interpreted using the Value-generation view.

Lauri Koskela (2000) found that the mismatch between the conceptual models and observed reality of construction projects underscored the lack of robustness in the existing theories. While realising the need for a theory of production in construction, Koskela used the ideal production system embodied in

the Toyota Production System to develop an overarching production management paradigm for construction projects. Koskela's understanding of construction was based on the same ideas as that for manufacturing, where the nature of the production was seen from three viewpoints: as a chain of transformations, as a flow of work, and as a generation of value for the customer. Upon identifying these viewpoints, Koskela used them to explain the construction process.

The three concepts of production are not alternative, competing theories of production, but rather partial and complementary. Each of them focuses on certain aspects of the production phenomenon: the transformation concept on the value-adding transformation; the flow concept on the non-value-adding activities; and the Value-generation concept on the control of production from customer's point of view (Lauri Koskela, 2000). The development of a construction project can be conceptualised by collectively considering these three views and their associated principles as an integrated theory of production in Table 3-1. It is not enough to carry out task, flow and value management as separate functions. They have to be balanced and their interactions have to be controlled to avoid anomalies. This theory predicts that a production system where the operational principles of all three domains are implemented at all levels of managerial action (design, control, and improvement) should have a better performance than one where principles are implemented less comprehensively (Lauri Koskela, 2000).

Table 3-1: Integrated TFV view on production (Source: Lauri Koskela (2000))

	Transformation view	Flow view	Value-generation view
Conceptualisation of production	As a transformation of inputs into outputs	As a flow of material, composed of transformation, inspection, moving and waiting	As a process where value for the customer is created through the fulfilment of his/her requirements
Main principles	Getting production achieved efficiently	Elimination of waste (non-value-adding activities)	Elimination of value loss (achieved value in relation to the best possible value)
Practical contribution	Taking care of what has to be done	Taking care that what is unnecessary is done as little as possible	Taking care that customer requirements are met in the best possible manner

In principle, the implementation of TFV in construction can be observed in the form of lean construction. 'Lean' is a way of designing production systems to minimise the waste of materials, time, and effort to generate the maximum possible amount of value. The creation of value in building and construction projects has a particularly strong place in the philosophy that lean construction is based on (Lauri Koskela, Howell, Ballard, & Tommelein, 2002). Lean construction attempts to integrate the construction practices with the Transformation-Flow-Value model, where Value is mainly delivered in the production process on-site, with the goal of improving the quality and environmental impacts of the construction process (Salvatierra-Garrido & Pasquire, 2011). Although studies on GB project success have not been discussed in terms of the TFV theory previously, the synergies between sustainable projects and lean construction are explored in many studies (Banawi & Bilec, 2014; Castro-Lacouture, Ospina-Alvarado, & Roper, 2008; Horman, Riley, Pulaski, & Leyenberger, 2004; Huovila & Koskela, 1998; A. R. Lapinski et al., 2006; Novak, 2012). A detailed account of these studies is provided in Appendix A (Section A.2). Since lean construction is based on the principles of the TFV theory, the synergies and associations among sustainable projects and lean construction can be considered as among the TFV theory and GB project development.

3.4.1. Green Building development from the Transformation view

According to the Transformation view, GB project development can be considered as a transformation of labour, information, equipment and materials into a sustainable building. The Transformation view has its intellectual origins in economics, where it has remained unchallenged to this day (Lauri Koskela et al., 2002). Throughout the twentieth century, the Transformation view of production has been dominant. According to this view, production is a transformation of inputs into outputs (Lauri Koskela,

2000). Production management in this viewpoint equates to decomposing the total transformation into elementary transformations and tasks, acquiring the inputs to these tasks with minimal costs and carrying out the tasks as efficiently as possible (Lauri Koskela, 2000).

The main principle of transformation is to get production achieved efficiently (Lauri Koskela, 2000). Principles of production in transformation suggest decomposing the total transformation hierarchically into smaller transformations, called tasks, and minimising the cost of each task independent of the others. The Transformation view is instrumental in discovering which tasks are needed in a production undertaking and in achieving them (Lauri Koskela et al., 2002). For instance, planning GB project development is an aspect strongly associated with the Transformation view. This is because project planning involves breaking the overall transformation (that is project) into a number of component transformations (that is activities) which are individually optimised for cost, time, and resources.

The Transformation view of production has two main deficiencies: first, it fails to recognise that there are phenomena in production other than transformations, and second, it fails to recognise that it is not the transformation itself that makes the output valuable, but, instead, the value is a result of output conforming to the customer requirements. The issue of avoiding the waste of resources and meeting customer requirements are not addressed well by the Transformation view and these aspects are explained by the Flow and Value-generation view respectively (Lauri Koskela et al., 2002).

3.4.2. Green Building development from the Flow view

In the Flow view, the GB project development is a flow of resources (such as people, material, and information) to result in a sustainable building. The early framework of industrial engineering introduced production in terms of the Flow view. The Flow view of production, first described in scientific terms by Gilbreth and Gilbreth (1922), has provided the basis for Just-In-Time and lean production. According to the Flow view, production is a flow of materials involving transformation, inspection, moving and waiting (Lauri Koskela, 2000). Flow can be defined as "movement that is smooth and uninterrupted, as in the 'flow of work from one crew to the next' or the flow of value at the Pull of the customer." In the Flow view, the basic thrust is to eliminate waste from the flow processes, therefore promoting such principles as lead-time reduction, variability reduction, and simplification (Lauri Koskela et al., 2002). The main principle of the Flow view is the elimination of waste, that is non-value-adding activities. The triumph of Just-In-Time and lean production based on the Flow view has practically proven the power of this concept (Lauri Koskela, 2000).

GB success conditions such as the flow of project information among project team as well as team collaboration and commitment can be well interpreted by the Flow view. This is because these success conditions help reduce non-value-adding activities and strongly influence project development in terms of the flow of materials, resources, and labour. Even though the Flow view explains how to avoid waste, it does not particularly address the issue of meeting customer needs. The Value-generation view considers this aspect to explain project development.

3.4.3. Green Building development from the Value-generation view

In the Value-generation view, the GB project development is a process of producing a sustainable building which meets the client's requirements. The view of production as Value-generation was articulated in the 1930s with the basic goal of achieving the best possible value for the customer (Lauri Koskela et al., 2002). Production management according to the Value-generation view is to translate customer needs accurately into a design solution, and then producing products that conform to the specified design (Lauri Koskela, 2000). Value can be about the usefulness of a product, its functionality, utility and benefit. The intended use of the product by the customer is the final goal of the production process. This makes value for the customer the dominant value perspective in the 'lean' tradition and

the TFV production theory by Koskela. Within this tradition, the definition of value can, therefore, be specified as an output of production wanted by the customer (Bølviken, Rooke, & Koskela, 2014). The main principle of the Value-generation view is to eliminate the value loss, that is reducing the gap between the achieved value and the best possible value (Lauri Koskela, 2000). Value is a relative and subjective term, dependent and ever-changing with the context (Salvatierra-Garrido, Pasquire, & Thorpe, 2010). Appendix A (Section A.3) refers to the studies which have explained the subjective nature of value.

GB success conditions such as those related to defining project goals and project design development can be well interpreted by the Value-generation view. This is because these success conditions are about capturing project requirements, converting these requirements into a workable plan (that is design), and therefore creating value for the project client. Moreover, the Value-generation view is also well-suited to interpret GB Success criteria. This is because most of the GB Success criteria such as achieving green certifications are about meeting the requirements of the project client or creating value for the client.

Some studies have introduced environment as an additional “dimension of value” for sustainable facilities. In these studies, the environmental values include minimal building impact, maximum building system efficiency, efficient energy usage, reduced waste, and a healthy and productive environment for occupants (Bae & Kim, 2008; Horman et al., 2004; A. Lapinski, Herman, & Riley, 2005). While some studies consider the environment as a customer to account for the specific needs of green building delivery (A. Lapinski et al., 2005), Klotz, Horman, and Bodenschatz (2007) considered environmental needs in terms of natural and human resource needs of the building users. For example, reduced GHG emissions resulting from decreased energy use are considered as a natural resource need for the building user rather than a requisite of “the environment.”

In high-performance buildings, the environment is elevated to be a key stakeholder of the building alongside that of the customer (that is building owner or user) (A. Lapinski et al., 2005). Conventional projects set objectives for the building owner and user, but rarely address the needs of the environment explicitly. The disclosure of environmental objectives required in case of high-performance buildings makes those activities critical that were otherwise thought as marginal (that is wasteful), for example, energy modelling and life-cycle cost analysis (Horman et al., 2006). Hence, by acknowledging the environment in the Value-generation view, the TFV theory can explain why the particular steps taken and activities performed in GBs are important for the success of these projects.

The studies which have introduced environment as an additional ‘dimension of value’ for sustainable facilities include the environmental values such as minimal building impact, maximum building system efficiency, efficient energy usage, reduced waste, and a healthy and productive environment for occupants (Bae & Kim, 2008; Horman et al., 2004; A. Lapinski et al., 2005). While some studies consider the environment as a customer to account for the specific needs of green building delivery (A. Lapinski et al., 2005), Klotz et al. (2007) considered environmental needs in terms of natural and human resource needs of the building users. For example, reduced GHG emissions resulting from decreased energy use are considered as a natural resource need for the building user rather than a requisite of ‘the environment’. Therefore, while using the Value-generation view in interpreting Success conditions and criteria in this study, not only the project client/end-user but also the environment will be considered a customer.

3.4.4. Waste defined by the Transformation, Flow, and Value-generation view

According to the TFV theory, in a GB project waste is the loss of materials, time, or value during project development. Instead of being a separate theoretical lens, waste in this study is used as an embedded

part of the TFCV theory to provide an enriched interpretation of the Transformation, Flow, and Value-generation view. Waste (loss of material, time, or value) is an important aspect of this study because of two reasons. First, waste in the project development process reduces the potential of successfully achieving project outcomes, an aspect directly related to project success. Second, waste in the end-product and the production process is in direct contrast with sustainability goals, an aspect related to sustainable development. TFCV framework helps conceptualise waste in the process of project development and the waste related to the end-product (such as building project). All three views of the TFCV theory (that is Transformation, Flow and Value-generation) are important for developing a comprehensive understanding of waste. For this study, waste is not considered as a separate theoretical construct but as a concept strongly embedded in the TFCV construct. Alongside the principles of Transformation, Flow and Value-generation, the waste definitions by the TFCV theory will also be used in interpreting conditions and criteria of GB project success as shown in Figure 3-3.

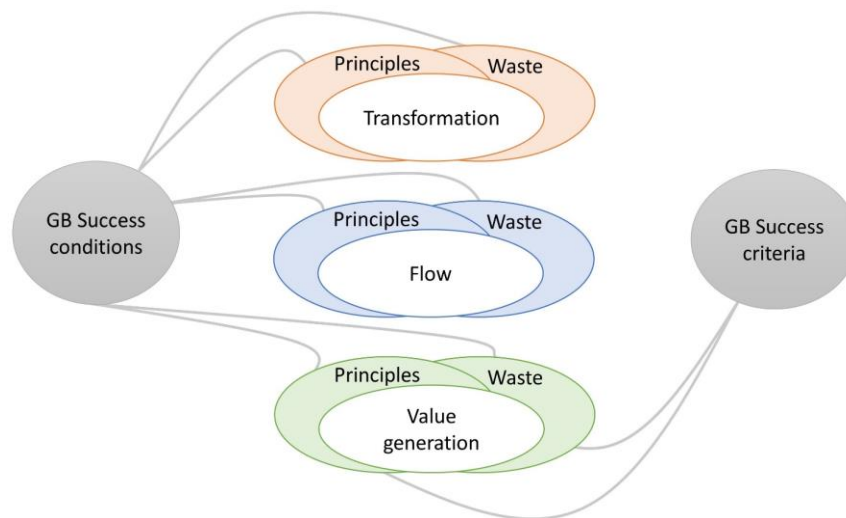


Figure 3-3: Interpretation of Success conditions and criteria by the principles and waste definitions related to the Transformation, Flow, and Value-generation views

In the Value-generation view, waste is value loss, a situation where the product is not used as intended and “part of value (is) not provided even if potentially possible” (Lauri Koskela, 2000). Womack and Jones (1996) suggested viewing the provision of a wrong product or service as Muda, in other words, waste. This phenomenon lies within the domain of Value-generation. The concept of value loss can be adopted to refer to the part of value not provided even if potentially possible. This concept can also be used as a way of measuring value in relative terms (Lauri Koskela, 2000). When analysing value, Rooke, Sapountzis, Koskela, Codinhoto, and Kagioglou (2010) drew a distinction between outputs and outcomes. Based on this distinction it can be said that in the Value-generation view, waste is a situation where the outputs of production are not outcomes (Bølviken et al., 2014). The reason for this can be that the product does not meet the requirements of the client, could have met them in an even better way, or is not used as intended (for whatever reason). These reasons are related to the product coming out of production, however, the unwanted outcomes are not limited to the (main) product, they also include unwanted by-products of the production process. While the wastes related to the main product are lack of quality (including defective product) and lack of intended use, the waste related to by-products can be harmful emissions, injuries, and work-related sickness (Bølviken et al., 2014).

In the Transformation view, production is seen as the transformation of raw materials and parts into products using machinery, energy and labour. In this view, waste is the use of more of these production resources than needed (Bølviken et al., 2014). The Flow view recognises non-value adding activities in

a project as waste (Lauri Koskela, 2000). Waste is the expense of labouring force which does not produce value (LJ Koskela, Sacks, & Rooke, 2012).

Ohno (1988) identified seven sources of waste. Among these, the five sources refer to the flow of material, including (1) the waste of overproduction, (2) the waste of correction, (3) the waste of material movement, (4) the waste of processing, and (5) the waste of inventory. Two waste sources referring to work of men are also identified and these are the waste of waiting, and the waste of motion. Bølviken et al. (2014) realised that the classical list of seven wastes presented by Ohno was context-specific (that is related to mass production) and that there was a need for the creation of a list specific to construction. A taxonomy related to the waste of production in construction was provided based within the TFV framework (Table 3-2).

Table 3-2: Taxonomy of the wastes of production in construction (Source: Bølviken et al. (2014))

	Transformation	Flow	Value
Production resource	Materials, machinery, energy, and labour	Time	
Type of waste	Material loss	Time loss	Value loss
Wastes	• Material waste • Non-optimal use of material • Non-optimal use of machinery, energy, and labour	<i>In the workflow</i> • Unnecessary movement of people • Unnecessary work • Inefficient work • Waiting <i>In the product flow</i> • Space not being used for work • Materials not being processed • Unnecessary material transportation	<i>Main product</i> • Lack of quality • Lack of intended use <i>By-product</i> • Harmful emissions • Injuries and work-related sickness

3.5. Complex systems

GBs are complex projects in terms of their development and operation. While construction projects are by nature complex projects, the special sustainability requirements in GBs further add to their complexity. To achieve their performance benefits, additional requirements are often needed in the delivery processes for sustainable buildings. For example, sustainable building projects require intense interdisciplinary collaboration, highly complex design analysis, and careful material and system selection, particularly early in the project delivery process (D. R. Riley et al., 2004). Additionally, locally manufactured, often untraditional, and higher-priced materials can be required for construction; and if green certification is sought, extensive documentation adds time and cost to the project (Pulaski, Pohlman, Horman, & Riley, 2003). These aspects add to the complexity of GB projects.

Instead of being mechanistic and guided by simple cause and effect, most of the world is made up of complex phenomena. Today, it is more and more recognised that most systems in our surroundings are not linear and ordered but non-linear, complex, and dynamic. The increased complexity of project development with the passage of time is an undeniable fact, as T. Williams (1995) stated, “one aspect of the future is obvious: all new construction projects will be accomplished in an increasingly complex technical, economic, political and social environment”.

The science of complexity looks at these systems in organic and holistic ways (Bertelsen, 2003a). According to Lucas (2000), “complexity studies comprise the connections between things and not the things themselves”. Complexity is not a new science but rather a new way of looking upon systems. By using this approach, it is possible to uncover the characteristics normally ignored or considered noise. Almost any system can be seen as being complex. Thus, complex systems are not a special class of systems but a way of looking upon a system as opposed to the ordered viewpoint, which has dominated the Western science’s reductionistic approach since the Renaissance. In this interpretation,

complexity is to study the system as a whole without simplifications and observing the interaction between the elements as much as the elements themselves (Bertelsen, 2003b).

Baccarini (1996) proposed that complexity can be defined as 'consisting of many varied interrelated parts' and can be operationalised in terms of differentiation and interdependency. This definition can be applied to project dimensions relevant to the project management process, such as organisation, technology, environment, information, decision-making, and systems. Perceiving project nature as ordered and linear is a fundamental mistake, as the dynamics of the surrounding world are not taken into account (Bertelsen, 2003a). Project management must perceive the project as a complex, dynamic phenomenon in a complex and non-linear setting. The complex and often turbulent world of project development should take the project complexity and dynamics from the outset and design and operate its management systems from that perspective (Bertelsen & Koskela, 2005). The analytical lens to be used for interpreting success in GB projects needs to respond to the complex characteristics of these projects.

The philosophy of complexity combines three strands of thought: systems thinking (incorporating cybernetics) related to non-specific systems, organic thinking (including evolution) related to non-static systems, and connectionist thinking (attractor-based) related to non-reductionism (Lucas, 2005). Acknowledging sustainable development projects as complex projects, they require the application of a system approach (Doskočil & Lacko, 2018). This study focused on GB project success incorporates the systems thinking as well as connectionist thinking to explain the interrelationships between Success conditions and Success criteria. Attributes which characterise complex systems are provided in Appendix A (Section A.4).

3.5.1. Relevance of complexity perspective for investigating Green Building project success

Looking upon the system as a whole can help us see new features and behaviours not found through the traditional approaches, and this view contributes greatly to one's understanding of the system in question. Management, in general, has been fruitfully studied and understood in this new perspective. This highlights the importance of looking at and interpreting construction from a complexity perspective as well, when establishing and operating new project management paradigms, as opposed to the ordered and top-down approach traditionally used in organising and operating projects (Bertelsen, 2003b). Companies and public agencies working to commission, design, build, service and maintain the built environment are operating in situations of complexity, both with regard to their environments and their internal operations (Rooke et al., 2008). Several authors have looked at project management as a complex system while employing different perspectives. T. M. Williams (1999) characterised complexity as uncertainty in goals and methods, while Wild (2002) looked at the social system in projects. Gidado (1996) and J. Kim and Wilemon (2003) took an ordered approach to assess complexity in projects. Since the success conditions for GB projects are majorly about managing the complex process of project development, the complexity perspective is well-suited to interpret these success conditions and the interlinks between these conditions.

Most systems in the world are complex and construction is one of them (Bertelsen, 2004; Rooke et al., 2008). Many studies have addressed complexity in construction projects. Bertelsen (2003b) identified the complexity aspect in construction projects from three perspectives, that is, construction as a project-based production process, as an industry providing autonomous agents, and as a social system. While recognising that construction sites reflect prototypical behaviour of complex and chaotic systems, especially in the flow of both material and information on and off-site, Bertelsen (Bertelsen, 2003a, 2003b) suggested that construction should be modelled using chaos and complex systems theory. The complexity understanding of the construction process was introduced in the International

Group for Lean Construction by Bertelsen (2002). It was further developed in Bertelsen's studies (Bertelsen, 2003a, 2003b), and has since then been a useful supplement to Koskela's theory in the understanding of construction management (Abdelhamid, 2004). A connection between lean thinking and complexity was discussed by Jenner (1998) who proposed that the lean organisations are successful because their fundamental structure embodies many characteristics of complex systems, such as self-organisation, and balance between order and chaos. Bertelsen and Emmitt (2005) propose that the client in construction projects also needs to be seen as a complex system. GB projects are construction projects and since the significance of complexity perspective for construction projects is well acknowledged, it can also be used to interpret GB project success.

Complexity has also been considered previously in GB research. For instance, Vakili-Ardebili (2007) addressed the complexity of value creation in sustainable building design. GB research has also used approaches such as systems thinking and system dynamics (Ahmad, Aibinu, & Thaheem, 2017; Z. Tang & Ng, 2014; Z. W. Tang et al., 2019). However, it is important to mention that while the majority of GB-related studies consider GBs as complex projects, the use of the complexity perspective as a theoretical background in these studies is limited.

This study is about the inquiry of successful development practices in GB projects. Since both the project development practices and GBs respond to complex systems, the complexity perspective is an appropriate construct in the theoretical framework of this study. Complexity perspective can have a significant impact on this research as its occurrence in the theoretical framework not only determines the way research findings are interpreted, it also helps develop the research design, specifically data collection and analysis, by prioritising non-reductionist approaches.

3.6. Chapter Summary

The key theoretical lenses incorporated in this research include, Triple Bottom Line, Project Success, the TFV theory of production, and Complexity perspective. These concepts forming the theoretical framework are shown in Figure 3-4.

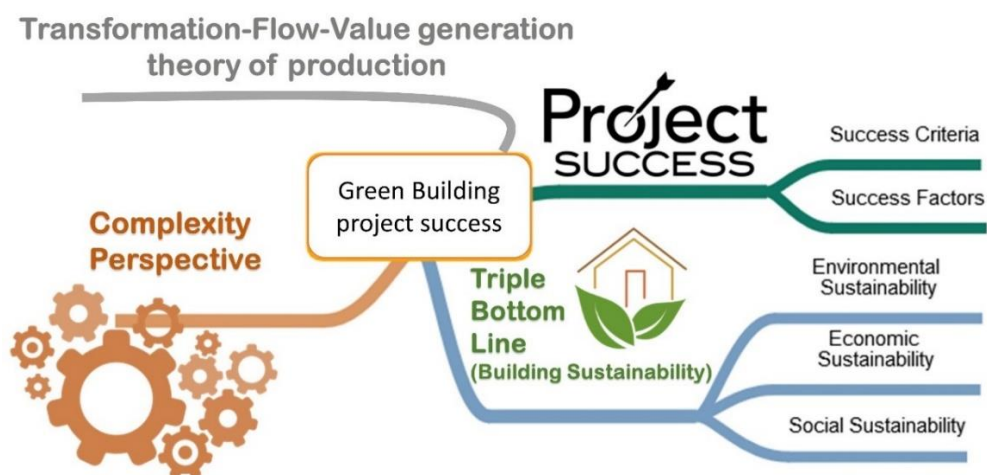


Figure 3-4: Theoretical Framework for research on Green Building project success in this study

Following is a brief elaboration of the four theoretical lenses used in this study:

- **Triple Bottom Line**: Sustainable development according to Triple Bottom Line is comprised of three dominant dimensions representing social, economic, and ecological aspects. With the concept of sustainability narrowed down to built-environment sustainability, the three sustainability

dimensions are still applicable and can inform the project development and decision-making process.

- **Project success:** Project success for GBs can be conceptualised in terms of Success criteria and Success conditions. Success criteria define project success while Success conditions are about enabling project success.
- **TFV theory of production:** The TFV theory of production in construction provides a comprehensive understanding of construction projects. Development of a GB project can be conceptualised in terms of the Transformation-Flow-Value-generation (TFV) theory. Success criteria and success factors in GBs can be explained by understanding their associations with the principles of the Transformation, Flow, and Value-generation views.
- **GBs as complex projects:** GB projects are complex systems and the success of GB projects cannot be explained in case Success conditions and criteria are considered separately in a reductionist approach. The success of GB projects is a combined effect of the multitude of Success conditions and is, therefore, an emergent property related to the system as a whole instead of individual components. In this regard, an underlying construct for the theoretical framework of this research is the complexity perspective.

The theoretical framework developed and explained in this chapter has determined how the literature review is conducted in this study. It has also contributed to formulating research design and in the collection, analysis, interpretation, and discussion of findings. But what paradigm is used in conducting research in this study? Which methodology is used? Which data collection and analyses approaches are used? How reliability and credibility of research are ensured? These questions will be answered in Chapter 4.

4. Research design

This chapter provides a detailed overview of the research design, specifies precisely what is to be studied, and determines the best approach to answer the research questions. The research design determines the amount of control a researcher has over the research environment and guides what to observe and how to analyse the data (INKOOM, 2012; O'Sullivan, Berner, Taliaferro, & Rassel, 2016). In this chapter, the Research Framework is presented first (Section 4.1), followed by the research paradigm, ontology and epistemology (Section 4.2). The overall research design is defined, and its explanatory and exploratory parts are explained in Section 4.3. A detailed discussion of the data collection methods (that is online survey and semi-structured interviews) is provided in Section 4.4. This is followed by an explanation of the analysis and interpretation approaches used for survey and interview data (Section 4.5). Finally, a detailed account of research rigour is provided (Section 4.6).

4.1. Research Framework

The research framework presented in Figure 4-1 shows how the research questions are addressed in this study. The framework is divided into five blocks and has Success criteria (Block A and C), Success conditions (Block D), Underlying conditions (Block B.2), and Differentiating conditions (Block A). These factors together help address the research questions in Chapter 5, 6, 7, and 8.

Block A responding to Chapter 5 represents an exploratory inquiry of Differentiating conditions, based on findings from semi-structured interviews. It helps address the research question, that is '*How do sustainability requirements set Green Buildings apart from non-Green Buildings?*'

Block B.1 in the framework represents the interrelationships among sustainability performance criteria and project management performance criteria. This is the only block where the factors (that is criteria) are identified from the literature. In all other blocks, the factors are identified using semi-structured interviews and online surveys. The key outcomes of Block B.1 are the interrelationships among sustainability performance criteria and project management performance criteria. Block B.1 and B.2 are closely related since Block B.1 provides the interrelationships among performance criteria and Block B.2 provides the Underlying conditions resulting in performance criteria interrelationships. Both these are reported in Chapter 6 and help address the research question, that is '*What are the associations between sustainability performance criteria and project management performance criteria in Green Building projects and which conditions control these associations?*'

Block C responding to Chapter 7 help address a research sub-question, that is '*What are Success criteria in Green Building projects and how do they interrelate?*' While both Block B.1 and C represent Success criteria in GBs, they are different. Block B.1 explains the interrelationships between sustainability and project management criteria and uses quantitative data from the online survey. Block C focusses on the exploration of Success criteria explicitly related to GB projects and uses qualitative data from the semi-structured interviews. Overall, the Success criteria inquiry, conducted in Block B.1 and C, provides an account of the specific Success criteria for GBs and the associations among sustainability and project management criteria in GBs.

Block D (see Chapter 8) represents an exploratory inquiry of Success conditions, based on the findings from semi-structured interviews. It helps address the research sub-question, that is '*What are Success conditions in Green Building projects and how do they interrelate?*'

Figure 4-1 shows that Blocks A, B.2, and D are intersecting to some extent and this highlights an expected outcome of this study: an overlap exists among differentiating, underlying and Success conditions. This overlap is discussed in Chapter 9 (Section 9.1).

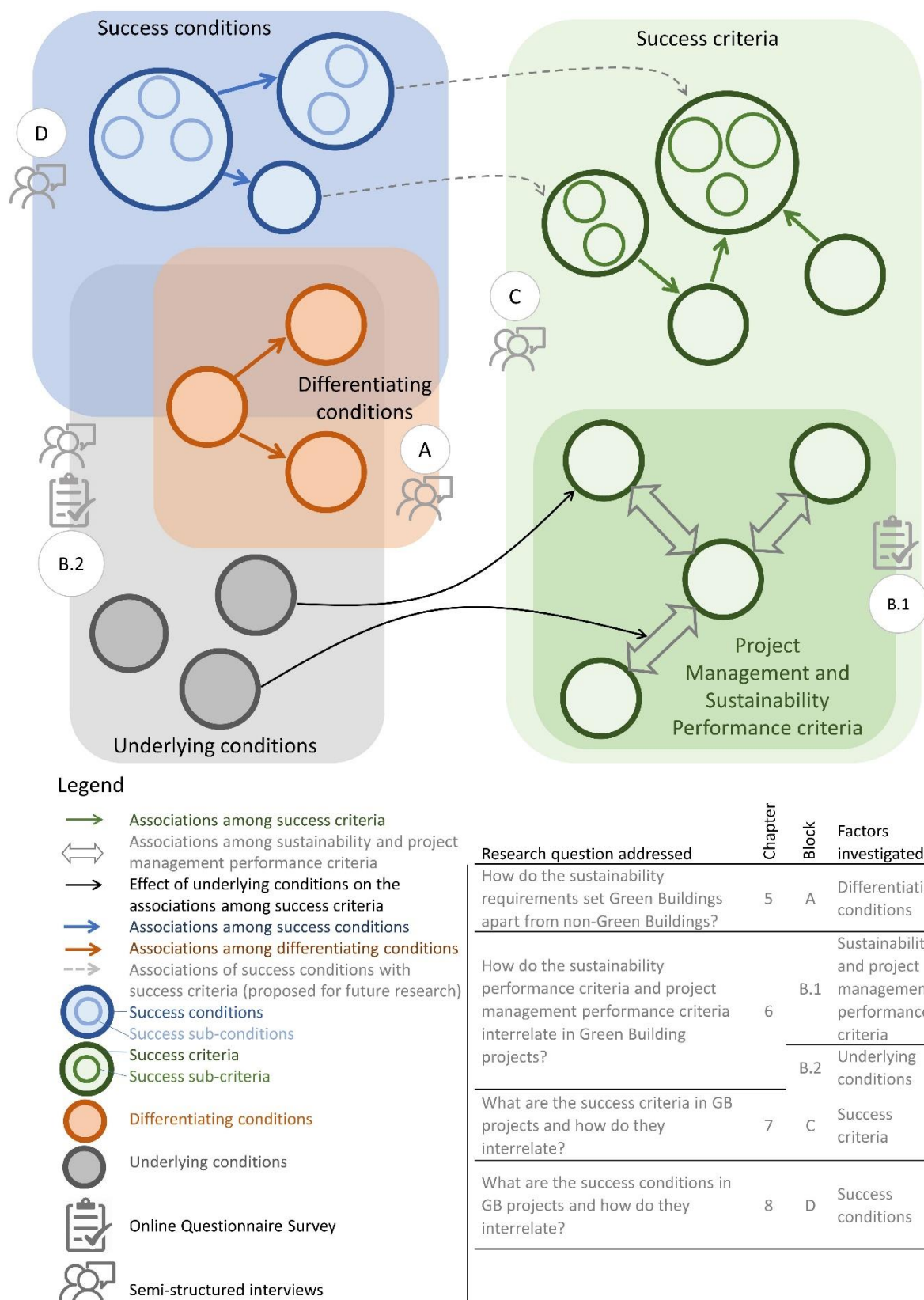


Figure 4-1: Research Framework addressing the research questions

4.2. Research paradigm, ontology and epistemology

Critical realism, a research paradigm based on ontological realism and epistemic relativism is best suited for inquiry on GB project success and is therefore used in this study. While neither the pure positivist nor the interpretive paradigms are suitable for GB project success inquiry, critical realism which sits between positivism and interpretivism can address the research on GB project success. Archer, Decoteau, Gorski, Little, and Porpora (2016) highlighted, "Critical realism situates itself as an alternative paradigm both to scientific forms of positivism concerned with regularities, regression-based variables models, and the quest for law-like forms; and also to the strong interpretive or postmodern turn which denied explanation in favour of interpretation, with a focus on hermeneutics and description at the cost of causation."

This study adopts a critical realism paradigm and accepts that reality exists and operates independent of our awareness or knowledge of it. With this stance, the study considers that GB projects and their development practices exist independent of our knowledge of them, in other words, their existence is not socially constructed. While using realism as ontology, in epistemic terms, relativism is adopted which is based on the belief that knowledge about reality is always socially, culturally, and historically situated. Epistemic relativism is based on the understanding that knowledge is articulated from various standpoints according to various influences and interests and is transformed by human activity. While knowledge is context-dependent, the representations of the world are historical, perspectival, and fallible (Archer et al., 2016). The study accepts that there is no way of knowing the world except under historically transient descriptions. The knowledge of successful GB project development is bound to the limits of the data collection methods used. The study accepts that the factors and their identified interrelationships regarding successful GB development are historically situated. As the GB market will evolve over time, innovative ideas and practices will arise, which project teams will use to improve the project development processes (Sinem Korkmaz et al., 2009). While the research findings proposed in this study may represent current GB projects, they may not completely represent future GB projects. Beside the historical context, the demographics of study participants also influence the study findings as this can affect the perspectives employed in understanding the knowledge.

Using the foundations of epistemic relativism, this study considers project success as context-specific and develops the concept of GB project success based on the qualitative viewpoint of GB professionals.

4.2.1. Contingent and subjectivist: the approaches of project success inquiry

Three approaches to project success research include the 'objectivist', 'contingent', and 'subjectivist' approach (Ika, 2009), and this study adopts the contingent and subjectivist approach for GB project success inquiry as these are consistent with epistemic relativism. The 'objectivist' approach which is a dominant approach in project success research represents success frameworks as universal tools for achieving project objectives. For instance, Project Management Body of Knowledge (PMBOK) which is a flagship publication by the Project Management Institute¹ is presented as a fundamental resource for effective project management in any industry (Rose, 2013). The contingent approach considers success framework as context-specific and the subjectivist approach is focused on defining project success from a subjective perspective resulting from a qualitative viewpoint (Ika, 2009). Considering GB projects as significantly different from traditional construction and acknowledging the experience of building professionals on GBs as a key source of knowledge on GB project success, the contingent and subjectivist approaches have informed the research design of this study.

¹ Project Management Institute is a global non-profit professional organization for project management

Although the concept of project success remains ambiguous and lacks consensus from literature, it has been accepted as context-specific (Ika, 2009), and this is the position taken by the contingent approach. Previous research conducted on project success has demonstrated the impracticality of developing an exhaustive and generalised list of Success conditions and criteria, which are applicable to all types of projects (Ika, 2009). As projects are unique in their complexity and scope (Ika, 2009; Wateridge, 1998), the importance attached to different Success conditions and criteria varies with project type (Müller & Turner, 2007). The contingent approach is based on the contingency theory, an organisational theory which according to Scott [22] assumes that "the best way to organise depends on the nature of the environment to which the organisation must relate". In the case of GB project success, the contingent approach considers success in terms of the particular needs of sustainable development and operation of GBs. Dvir, Lipovetsky, Shenhar, and Tishler (1998) found the contingent approach as more suitable than identifying universal Success criteria and conditions. The importance of using the contingent approach lies in accepting that each project type is unique, so the Success conditions and criteria for one project type may not be the same as for other project types. Hence, there is no "one best way" for defining project success. The contingent approach focuses on operationalising the aspects of a particular project in its actual context (Ika, 2009). In this way, the contingent approach offers a more meticulous and exclusive understanding of project success. Previous studies on GB project success reviewed in Chapter 2 are specifically aimed at GB projects and hence employ the contingent approach. Since GB projects are highly context-specific in their development and operation, the research on GB project success can benefit from the exclusivity offered by the contingent approach and is therefore used in this study.

According to B. N. Baker, Murphy, and Fisher (1997), project success cannot be considered as an absolute concept, and instead occurs as the "perceived success of a project". Different stakeholders may perceive the outcomes of the same project in different ways (Wateridge, 1998). A 'subjectivist' approach incorporates the variety of stakeholder perceptions of project success, providing a more comprehensive rationalisation of project success. An important aspect of this approach is the collection of stakeholder opinions from in-depth interviews, relying on the 'richness' of words instead of just preferences in terms of numbers. While the 'subjectivist' viewpoint is a break from mainstream research practices, it can open new avenues for the less investigated research areas of project success (Ika, 2009), such as GB project success, which is a research area in its early stages of development. For these reasons, this study has used the qualitatively driven subjectivist approach alongside the contingent approach.

By adopting epistemic relativism, this study acknowledges that our knowledge about reality is always socially, culturally and historically situated. The context-specific contingent approach and the subjective perspectives of the subjectivist approach are synergetic with epistemic relativism and critical realism, and are used in this study.

4.3. Exploratory and explanatory mixed-methods research design

Qualitative and quantitative research, together, can provide a thorough insight into a research problem (Zimmerman, 2005) and expand the knowledge base in GB project development research (Sinem Korkmaz et al., 2009). This study employs a mixed-methods approach to exploratory and explanatory research design. This study acknowledges that exploratory research design can capture the use of new and innovative methods. Therefore, this study has used the qualitative method with findings originating from semi-structured interviews to address three out of the four research questions. The remaining research question depends on the explanatory design using the quantitative method with findings originating from an online survey (see Figure 4-2).

The mixed-methods explanatory design approach is used in this study to address the research question in which the interrelationships between the performance criteria of GB projects are explained. Unlike the sequential data collection approach typically used in the explanatory design, where quantitative data collection is followed by qualitative data collection (Creswell & Clark, 2017; Creswell, Plano Clark, Gutmann, & Hanson, 2003), some modifications are introduced in the research design to accommodate both the sequential and concurrent collection of the qualitative data, as shown in Figure 4-2. The quantitative data of the performance criteria interrelationships obtained from the online survey are explained by the qualitative data. These qualitative data are concurrently obtained from an online survey and sequentially obtained from semi-structured interviews. The quantitative and qualitative data are then connected in the intermediate stage to explain the performance criteria interrelationships. The rationale for this approach is that the quantitative data and its subsequent analysis provide a general understanding of the research problem. The qualitative data and its analysis refine and explain those statistical results by exploring participants' views in more depth (Creswell & Clark, 2017; Tashakkori, Teddlie, & Teddlie, 1998).

A mixed-methods exploratory design is required when the variables needed for inquiry are unknown and when the research is about exploring a phenomenon in-depth and measuring its prevalence (Creswell & Clark, 2017; Creswell et al., 2003). The exploratory design approach is adopted with some modifications in this study to address the research questions regarding the in-depth investigation of Success conditions, Success criteria, and Differentiating conditions. Typically, in a two-phase mixed-methods exploratory design, the results of qualitative data collection help develop or inform quantitative data collection with greater emphasis placed on the qualitative data (Creswell & Clark, 2017; Greene, Caracelli, & Graham, 1989). However, because of the data collection constraints in this study, the typical two-phase explanatory design is modified into a single-phase data collection as shown in Figure 4-2, in which instead of separately collecting quantitative data, the qualitative data is transformed into quantitative data. This transformation into quantitative data has played an important role in determining the importance of different factors identified. Finally, the interpretations of research findings are based on both the qualitative and quantitative analysis of the qualitative data. The exploratory research design used in this study is principally qualitative and does not qualify as mixed-methods exploratory design in absolute terms, although it bears some resemblance to it.

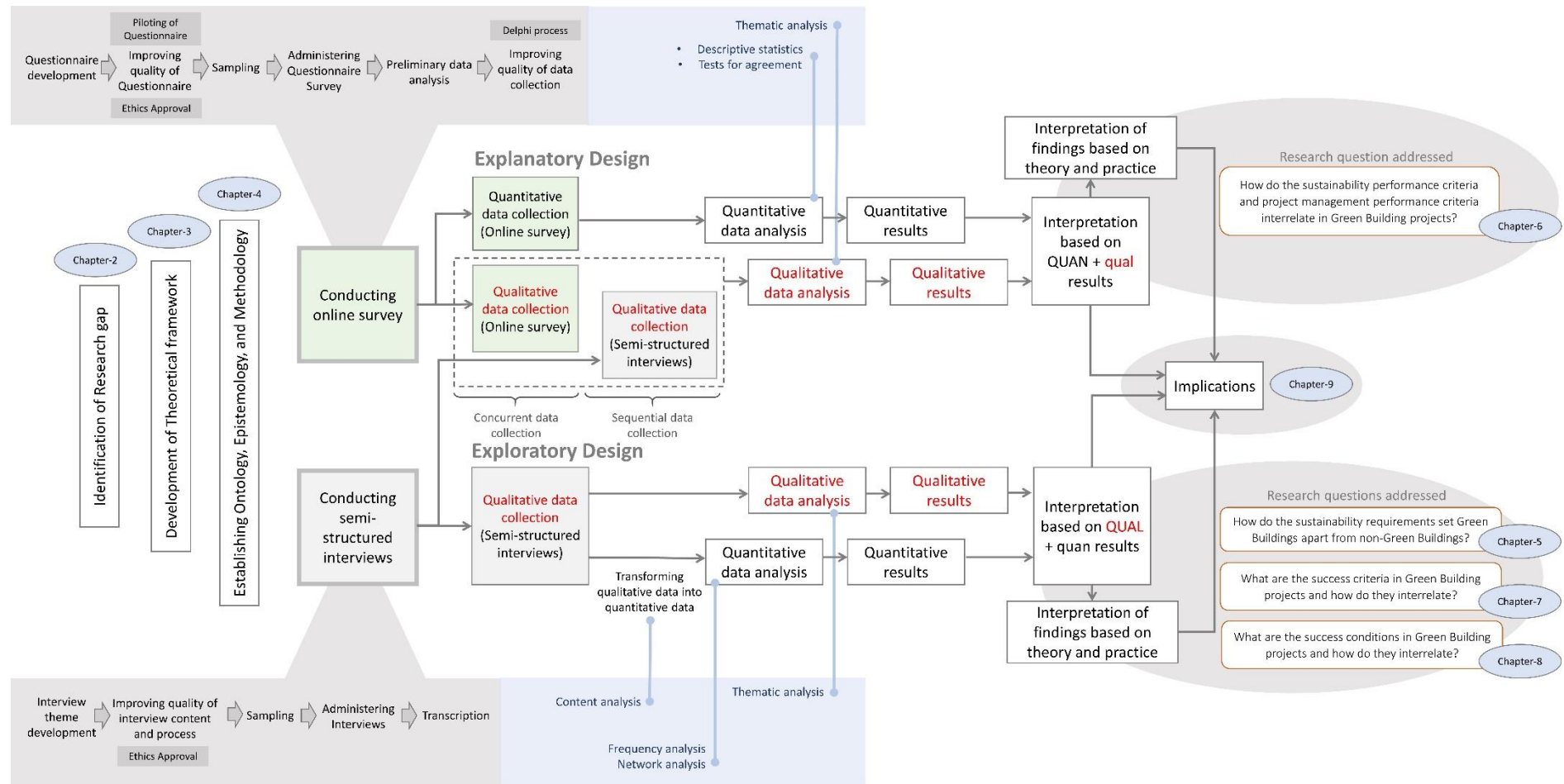


Figure 4-2: Exploratory and explanatory mixed-methods design adopted in this study to address research questions

4.4. Data collection methods

Two data collection methods are used in this study which are online survey and semi-structured interviews. The choice of data collection mode is based on different aspects of the inquiry. Interviews are preferably used when open-ended questions require detailed in-depth discussions regarding Success conditions, Success criteria, and Differentiating conditions. However, for closed-ended questions regarding performance criteria interrelationships, an online survey is used. The data collection methods for different aspects of the research inquiry are collectively shown in Table 4-1.

Both the online survey and semi-structured interviews in this study used the expert sampling approach to concentrate on people with particular characteristics who are more proficient to contribute to this research. Both the data collection methods have involved GB professionals from Australia, Hong Kong, Singapore, and the UAE. Although the population of participants in both these cases is the same, the participants involved in the online survey have not been engaged for semi-structured interviews.

This section provides a demographic overview of the survey and interview participants. However, varying number of participants have responded to different aspects of the research inquiry as shown in Table 4-1 and based on this reason, the section refrains from providing the participants' breakdown for each question. As shown in Table 4-1, the details of interview and survey participants are provided in Chapter 6, 7, and 8 in context of the results to avoid going back and forth through sections and for clarity purposes.

Table 4-1: Questions and themes used in the online survey and semi-structured interviews

Aspect of research	Research question addressed	Theme/Question statement	Question nature	Data collection method	Number of responses	Detailed account of participants' demographic details
Differentiating conditions	How do sustainability requirements set Green Buildings apart from non-Green Buildings?	1. The difference of green building projects from that of traditional buildings	Open-ended	Interviews	25	Chapter 5 Section 5.1
Performance criteria interrelationships	What are the associations between sustainability performance criteria and project management performance criteria in Green Building projects and which conditions control these associations?	2. How do the sustainability performance criteria (<i>Environmental, Economic, and Social sustainability</i>) and project management performance criteria (<i>schedule, Cost, and Quality</i>) in green buildings interrelate?	Closed-ended	Survey	104	Chapter 6 Section 6.1
		3. What are the reasons behind the interrelationships between performance criteria of green building projects?	Open-ended	Interviews	30	
				Survey	83	
Success criteria	What are Success conditions and Success criteria in Green Building project development; and how are the Success criteria interrelated as well as the Success conditions?	4. Criteria of success in green building projects	Open-ended	Interviews	40	Chapter 7 Section 7.1
Success conditions	What are Success conditions in Green Building projects and how do they interrelate?	5. Reasons of success and failure in green building project delivery - Findings from participants' overall experience - Findings from successful/failure projects - Suggestions for clients	Open-ended	Interviews	72	Chapter 8 Section 8.1

4.4.1. Online survey

The survey was administered online as it suits the available research resources and helps collect response from international participants. The questionnaire is designed to minimise bias and a lack of response from participants. Pilot testing of the questionnaire was performed to ensure reliability of the findings (see section 4.4.1.2). Upon conducting the survey, the Delphi process is also conducted to control variance in the data. The following sections provide a detailed overview of different aspects of developing and administering the online survey.

4.4.1.1. Questions in survey

To investigate the interrelationships between sustainability performance criteria and project management performance criteria, the online questionnaire primarily had closed-ended and open-ended questions as shown in Table 4-1. In the closed-ended question, the respondents were asked to provide the interrelationships among performance criteria of green building projects. Respondents could select the effect of good performance in a criterion on other criteria as ‘*Highly Positive*’, ‘*Moderately Positive*’, ‘*Not related*’, ‘*Moderately Negative*’, or ‘*Highly Negative*’. The survey respondents were asked to provide their opinion for the potential associations between 6 performance criteria. Therefore, each respondent had to establish 30 different associations. In the open-ended question, the respondents were asked to highlight the conditions behind the associations between performance criteria of GB projects. Both the closed-ended and open-ended questions helped address the research question ‘*What are the associations between sustainability performance criteria and project management performance criteria in Green Building projects and which conditions control these associations?*’

A project’s performance on project management-related and sustainability criteria can potentially be construed in many ways. To ensure consistency and reliability in responses, facilitate responses from a unified viewpoint, and help reduce the cognitive bias, the good performance of a GB project on different criteria was explained in the online survey questionnaire (shown in Table 4-2).

Table 4-2: Meaning of good performance on different criteria as explained in the survey questionnaire

Good performance in criterion ...	implies
Environmental sustainability	Lower emissions, less resource use, and use of recyclable materials
Social sustainability	Better indoor air quality, healthy and productive spaces
Economic sustainability	Lower life-cycle cost, and lower operation and maintenance costs
Cost performance	Delivering projects on budget or under budget
Schedule performance	Delivering projects within the specified time or before the specified time
Quality performance	Delivering projects within the specifications

4.4.1.2. Piloting of survey questionnaire

The pilot testing of the questionnaire is conducted to examine the measurement properties of the survey questionnaires, examine the viability of survey administration and ensure the quality of data collection. The questionnaire was tested to examine how respondents perceived the questions and to examine the viability of survey administration. Acknowledging the importance of questionnaire pre-testing by colleagues, industry experts and target respondents (Forza, 2002), in this study, the piloting of questionnaire survey was first conducted by two academic scholars (that is colleagues) and afterwards by two GB experts (that is, industry experts and target respondents). The academic scholars helped ensure that the questionnaire was accomplishing the study objectives and the GB experts helped prevent the inclusion of some obvious questions and provided feedback on aspects that could have affected answers of the targeted respondents. For example, the pilot participants suggested that the definitions of performance criteria were required in the survey questionnaire (see Table 4-2) to

avoid misunderstandings as target participants respond to the survey. Minor amendments were suggested by the participants from which the questionnaire was revised and its final version is available online (Ahmad, 2019)¹ and in Appendix B (Section B.3).

4.4.1.3. Sampling of survey participants

For the online survey, the expert sampling approach was used, and this helped engage the GB professionals from diverse professional and regional backgrounds such as India, Singapore, Australia, and the UAE. Expert sampling used in this study is a category of purposive sampling technique and the idea behind purposive sampling is to concentrate on people with particular characteristics who will be more proficient to assist with the relevant research (Etikan, Musa, & Alkassim, 2016). GB experts in Asia and Australia were contacted to participate in the survey. For this study, the professionals who had an understanding of GB projects and who had actually been involved in GB development were considered as 'experts'. The contact details of experts were obtained from different online GB professional databases such as *Building & Construction Authority*², Singapore; *National Australian Built Environment Rating System*³ (NABERS), Australia; and the *USGBC*⁴, US. Overall, 980 survey requests were sent through emails and the responses from 105 GB experts were obtained, resulting in a 10.7% response rate. Owing to incomplete information from one respondent, 104 responses were considered for detailed analysis. The sample size was deemed adequate upon comparing with similar survey-based studies involving GB experts. For instance, while conducting an international survey of experts, Amos Darko, Chan, Owusu-Manu, and Ameyaw (2017) used a sample set of 104 participants to identify major drivers of GB technologies. In a survey-based study of drivers and barriers related to sustainable design and construction, Ahn, Pearce, Wang, and Wang (2013) used a sample size of 100 participants. Some studies based in specific-regional contexts have been limited to smaller sample sizes. For instance, Bon-Gang Hwang and Tan (2012) conducted a survey of 31 experts in Singapore for identifying management-related barriers in green construction projects. Upon conducting expert sampling in this study, the survey was conducted online to engage regionally distributed experts with minimum resource expenditure.

4.4.1.4. Administering online survey

The online survey is used in this study to collect responses from regionally distributed participants. Computerised Self-Administered Questionnaire (CSAQ) is a method of collecting survey data that takes advantage of computer technology to create the instrument (in other words, questionnaire) and this helps the respondents to complete the survey with little or no other human assistance. CSAQ applications include web surveys in which respondents go to a designated website and complete the survey online (Lavrakas, 2008). A mode of using CSAQs in surveys is through the internet or online surveys. Online surveys are those which sample the respondents via the internet, gather data from

¹ <https://doi.org/10.26188/5c49861137284>

² The Building and Construction Authority is a statutory board under the Ministry of National Development of the Singapore Government. The primary role of this statutory board is to develop and regulate Singapore's building and construction industry.

³ The National Australian Built Environment Rating System, is an initiative by the government of Australia to measure and compare the environmental performance of Australian buildings and tenancies.

⁴ The U.S. Green Building Council (USGBC), is a private non-profit organisation that promotes sustainability in building design, construction, and operation. USGBC is best known for its development of a green building rating system known as Leadership in Energy and Environmental Design (LEED).

respondents via the internet, or do both. The online survey approach was deemed suitable for this study owing to its potential to collect responses from regionally distributed experts within relatively short time duration and with minimum resource expenditure. The online survey was conducted using Google Forms, a business product by Google, to facilitate customised market research. The use of online computer-based survey approach played an important role in data collection from regionally distributed GB professionals.

4.4.1.5. Demographics of survey participants

GB experts mainly belonging to four countries and with the experience of working on GBs in different professional roles participated in the online survey. Although all participants (n=104) had an experience of developing GBs in general, up to 5% of participants had no experience of working on commercial office GBs (shown in Figure 4-3). Approximately 81% of participants had at least 5 years' experience related to Green office projects and about 61% of participants had been involved in 6 or more such projects. The respondents' experience of working on GBs indicates the reliability and credibility of survey findings.

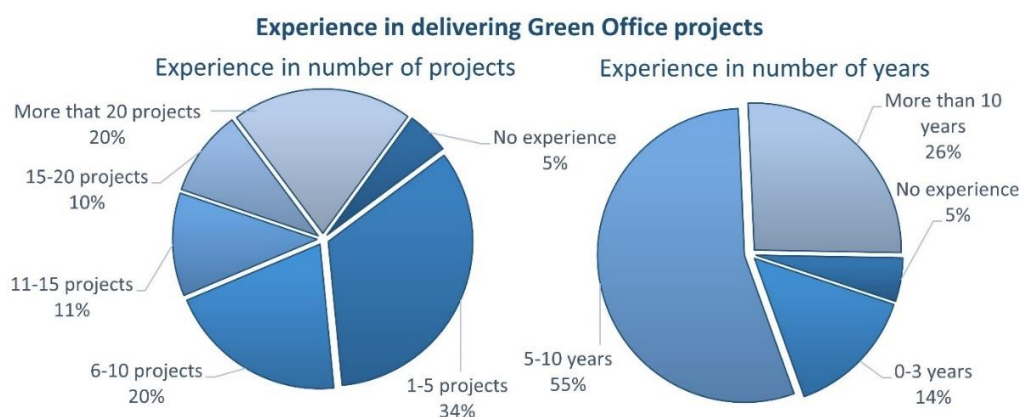


Figure 4-3: Experience of survey participants in Green Building projects

While most respondents (n=78) belonged to design and sustainability consultancy roles (see Figure 4-4), the sample set also had respondents belonging to six other roles in the construction industry. The respondents had their experience of GB projects mainly based in Australia (n=42), Singapore (n=18), India (n=16), and the UAE (n=15).

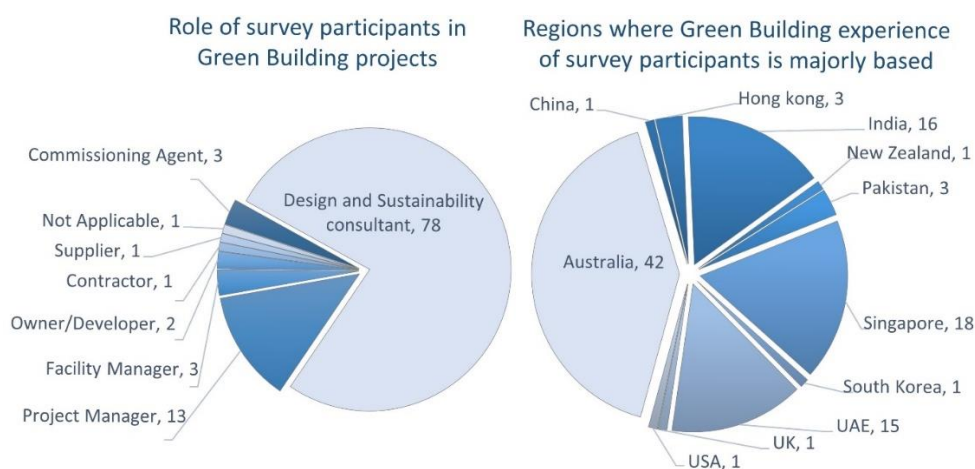


Figure 4-4: Regional belonging and role of survey participants in Green Building projects

4.4.1.6. Use of Delphi technique on survey participants

To control the variance in quantitative data collected in the online survey, the survey participants were engaged in the Delphi process. The questionnaire survey dataset was first analysed and outliers and dispersions in the data were identified. To help converge that data, the Delphi technique was used. The Delphi technique is a structured process of collecting and distilling knowledge from a group of experts using multiple rounds of feedback (Brady, 2015; David Botterill, 2012). The respondents who had a high variance in their responses (n=38) were contacted and 26% of them (n=10) consented to engage in the Delphi process. They were provided with the trends in the data and were asked to reconsider their response. One round of Delphi process was conducted and the revised responses from the survey participants were incorporated in the dataset, which was deemed adequate for analysis.

After conducting the online survey to address the explanatory part of the investigation, semi-structured interviews were conducted to address the exploratory part of research inquiry.

4.4.2. Semi-structured interviews

The face-to-face interview method is used for the exploratory research design in this study, as it reduces nonresponse and maximises the quality of the data collected (Lavrakas, 2008). Semi-structured interviews, mainly consisting of themes, provide the opportunity to probe in detail some particular areas of interest (Lavrakas, 2008). In this study, the researcher engaged with the GB experts (that is interview participants) on detailed discussions regarding the Success conditions and criteria most relevant to their knowledge and experience. A key advantage of face-to-face interviews is the presence of the interviewer to clarify any issue that the respondents might face (Lavrakas, 2008). The researcher used a set of prompts to help respondents struggling to answer questions, particularly while providing distinct accounts of Success conditions and criteria.

Instead of using the questionnaire survey method, the inquiry regarding Success criteria, Success conditions, and Differentiating conditions is conducted using semi-structured interviews. For open-ended in-depth questions, interviews provide more efficient access to information and have more potential to collect valid and reliable data. Although interviews are more time-consuming and expensive to conduct compared to questionnaire surveys, they are superior in terms of the access to comprehensive and detailed expert knowledge and also in terms of the ease of drawing implicit information (Akbarak, 2000). These aspects of interviews were particularly relevant for this study, in identifying Success conditions and criteria, and in understanding the interrelationships among factors. This is due to the fact that a lot of implicit information had to be made explicit. While potential bias exists in both survey questionnaire and interviews due to self-reporting (Akbarak, 2000; Oppenheim, 2000), the bias in interviews was reduced by advanced training of the interviewer regarding the potential issues, careful articulation of questions, and by matching the attributes of the interviewer with the sample to be interviewed. Although higher anonymity and confidentiality is offered by questionnaires as compared to interviews (Akbarak, 2000), these aspects did not become the decision-making criteria, as the discussion in interviews was not of a personal nature. Based on these considerations, the in-depth interview technique was selected as the data collection approach.

Some procedures were adopted to ease the access to information, reduce bias in findings, and ensure the quality of the collected data. These include the use of digital recording, the role of the researcher as both the interviewer and transcriber, accurate transcription of interview discourse, the review of interviewee transcripts, and the use of computer-aided thematic coding for data analysis. The following sections provide a detailed overview of these aspects. Moreover, a detailed account of the themes in the interviews, the sampling approach, the demographics of participants, and the role of the researcher as the research instrument is also provided.

4.4.2.1. Themes in interviews

The themes in semi-structured interviews addressed the research questions posed in this study. The number of participants addressing different themes are shown in Table 4-1. Details regarding the themes used in interviews are as follows:

Differentiating conditions: To address the research question, that is ‘*How do sustainability requirements set Green Buildings apart from non-Green Buildings?*’, the theme of Differentiating conditions was used in interviews. Participants were requested to identify and elaborate on the aspects which set GBs apart from their traditional counterparts. In some cases, the participants reflected on these Differentiating conditions while responding to some other question related to GB development. This theme is in line with the contingent approach (see Section 4.2.1).

Underlying conditions: To address the research question, that is ‘*What are the associations between sustainability performance criteria and project management performance criteria in Green Building projects and which conditions control these associations?*’, the theme of Underlying conditions was used in interviews. Participants were requested to discuss the reasons behind the interrelationships between sustainability and project management performance criteria of green building projects.

Success criteria: To address the research sub-question, that is ‘*What are Success criteria in Green Building projects and how do they interrelate?*’, the theme of Success criteria was used in interviews. This theme is in line with the subjectivist approach (see Section 4.2.1). In some of the initial interviews, the participants indicated success conditions when asked to mention Success criteria of GB projects. During the interviews, the interviewer was able to mitigate this confusion with ease. The question was revised and instead of asking participants to mention Success criteria they were asked to define a successful green building project. While reflecting on their personal conceptualisation of GB project success, the interviewees would typically respond that “a successful Green Building is the one which has ___, which performs well in ___. The building needs to perform well in these criteria/aspects because ___”.

Success conditions: To address the research sub-question, that is ‘*What are Success conditions in Green Building projects and how do they interrelate?*’, the theme of Success conditions was used in interviews. Three viewpoints are used to identify Success conditions (as shown in Table 4-3), since this approach results in rigorous data collection and analysis. The viewpoint of ‘*Findings from participants’ overall experience*’ was intended to highlight Success conditions for GBs, the interview participants had experienced in their overall professional careers of developing such projects. ‘*Suggestions for clients*’ provided Success conditions in control of the client developing the project. ‘*Findings from successful/failed projects*’ highlighted the success and failure conditions of projects occurring in the careers of participants.

Table 4-3: Interview themes regarding Success conditions and resulting viewpoints

No.	Interview theme	Resulting viewpoint
1	The conditions that are associated with success and failure of GB projects. The conditions occurring at the project development stage which can result in success/failure of a GB project during its operational life.	Findings from participants’ overall experience
2	Mention of some successful/failed GB projects in the interview participant’s career. Categorisation of those projects as success/failure. Conditions contributing to the success/failure of those projects. Conditions contributing to challenging circumstances in those projects. Lessons from those projects.	Findings from successful/failed projects
3	Advice to a potential client of a GB project for successfully developing the project within limited resources	Suggestions for clients

While success examples are important to learn about the best practices of project development, the challenging and failed examples are also critical to learn about the conditions which enable success. For instance, Rasekh and McCarthy (2016) conducted a study to learn from the difficulties of delivering sustainable buildings. Considering the importance of both successful and failed projects, the viewpoint of '*Findings from successful/failed projects*' is used in conducting interviews. This viewpoint has an emphasis on learning from real-life projects and was also used by Bon Gang Hwang et al. (2015) who engaged 34 participants in a questionnaire survey to investigate the schedule performance of 98 new and 51 retrofitting green building projects. Another seminal work in this regard is by Bond (2010) who investigated the best practices in GB development in Australia by conducting 23 interviews with GB stakeholders to collect their experiences related to 22 GB projects.

The use of multiple viewpoints for the Success conditions theme helped identify a relatively large number of conditions per participant. By asking interview participants to use multiple viewpoints the availability heuristic and Bandwagon effect were avoided. The Bandwagon effect is the tendency of believing what others believe (Henshel & Johnston, 1987) and the availability heuristic is a mental shortcut relying on immediate examples that come to a person's mind when evaluating a specific topic or concept. Under the availability heuristic, people tend to heavily weigh their judgments toward more recent information, making new opinions biased towards the latest news (Folkes, 1988). Another importance of using multiple viewpoints is that it results in the triangulation of findings and a detailed understanding of Success conditions.

4.4.2.2. Administering interviews

The list of themes covered in semi-structured interviews is provided in Appendix B (Section B.6). Although, the interview questionnaire includes a long list of themes and questions, only the most essential of these themes were repeatedly inquired from each participant and the rest of the questions were asked depending on the particular expertise of the participant as well as the time available for interview. GB Success conditions were the most important aspect of the inquiry, followed by Success criteria, Underlying conditions, and lastly Differentiating conditions. Due to the exploratory nature of the study, the themes used in interviews were slightly modified during the data collection process as interview findings kept on informing/improving the interview themes.

While conducting interviews, the approach used in this study was to inquire the participants about aspects they are most suited to answer and cumulatively using this information to address the research questions. The study acknowledged that regarding a problem, knowledge can be comprised of many disjointed parts of information, possessed by one person or by many people. Normally, people do not realise how much they know about a problem since they are unaware of the information that may have relevance to a problem's solution. A very accurate estimate for a problem can be obtained by identifying relevant information (Alarcon-Cardenas & Ashley, 1992). Use of modularisation approach in conducting interviews can help acquire information from experts regarding independent modules of knowledge. For instance, successful design development and successful construction of a GB are two independent modules of inquiry. The design consultants can inform about conditions for successful design deliverables while the contractors can inform the conditions which lead to successful building construction. Hence, GB experts with diversified roles in GB development can provide knowledge regarding different aspects of GB project success. Modularisation helps to ensure that concerning a subject, the experts' judgment and knowledge are accurate and based on this precise assessments can be made (Alarcon-Cardenas & Ashley, 1992). This study is mainly based on the information of GB project success acquired from the GB professionals. To effectively gather the relevant information from GB professionals in interviews, the modularisation approach has been used to some extent. The interview

participants in this study had a variety of roles in GB projects. While following the modularisation approach, the researcher probed into those aspects of GB projects which were most relevant to an interview participant.

To conduct interviews in an easier manner, the interview agenda was shared with respondents beforehand. This was done to facilitate more thorough answers. When conducting face-to-face interviews, respondents often are not offered the time to provide thorough answers compared to a mail or internet survey. Respondents essentially are expected to give an answer on the spot, which may not be very convenient or very accurate (Lavrakas, 2008). Sending the list of interview themes to participants by email ahead of the meetings enabled respondents to better prepare their responses.

Privacy issues continue to be the main concern in face-to-face interviews. Respondents need to be able to develop trust in the interviewer to disclose sensitive information (Lavrakas, 2008). While realising this as a potential hindrance in effectively conducting interviews, different steps were taken to build rapport with the interview participants during the interview and prior to the interview through email correspondence. A step in this regard was to get the participant's approval on a consent form provided in Appendix B (Section B.5). Another important step in this regard was to send a Plain Language Statement (provided in Appendix B – Section B.4) to participants prior to the interviews, highlighting important details such as the aim of the research, the details of researchers involved, the expected role of interview participants, and steps taken to protect interview data.

Keeping the privacy issues in consideration, during the interview, the participants were not asked to share classified information regarding themselves, their organisation/s, or their projects. There was one question in which the participants were asked to mention success/failure reasons for GB projects they had worked on. Even in this question, the interview participants were not required to share the project name, and confidential details of the project or the organisation.

To ensure the ethical conduct in research and minimise the potential bias, the themes to be used in interviews were scrutinised and submitted for research ethics approval to the academic ethics committee. To match the language of the interviewer with that of the participants, all the interviews were conducted in the English language. Regarding privacy protection, the participants were assured that the interview data would only be used for research purposes and their identities would be kept anonymous.

4.4.2.3. Sampling of interview participants

In this study, expert sampling was used to conduct interviews with industry professionals having experience of developing GB projects in Australia, Hong Kong, Pakistan, Singapore, the UAE, and the UK. Expert sampling which is a category of purposive sampling technique, calls for experts in a field to be the sampling subjects and this sampling is particularly useful when investigating new areas of research (Etikan et al., 2016). Owing to its merits for research on GB project success, the expert sampling approach is used in this study for conducting interviews. Green Building experts in Australia, Hong Kong, Pakistan, Singapore, the UAE, and the UK were contacted to participate in the interviews. Similar to the approach used for the online survey, while sampling for interviews the contact details of experts were obtained from different online expert databases, including *GreenBookLive*¹, *GBCA* database and *USGBC* database. Other than Pakistan, all these regions are on the track of increased development of GBs and these also have a significant number of professionals with extensive

¹ GreenBookLive is a database of Building Research Establishment Environmental Assessment Method (BREEAM), UK

experience of developing GBs. Another reason for selecting different geographic regions was to consider the potential regional variations.

4.4.2.3.1. Using saturation to determine the sample size

When using purposive sampling for qualitative research, as in the case of this study, the sample size is often determined by data saturation. Saturation is a state when the collection of new data does not shed any further light on the issue under investigation (S. E. Baker, Edwards, & Doidge, 2012; Mason, 2010; Morse, 2000). As the analysis begins to take shape, it is important for the researcher to become more disciplined and cut data where necessary. Saturation is, however, a difficult point to identify and an elastic notion as new data will always provide new information, but with diminishing returns, and the cut off between adding to emerging findings and not adding, might be considered inevitably arbitrary (Mason, 2010). Even though, a larger sample may seem like a relatively safe approach, a very large number of respondents can hinder the researcher's ability to provide "in-depth" findings and miss the opportunity of getting an understanding of each respondent (Fink, 2000). Regarding saturation, Guest, Bunce, and Johnson (2006) suggested that 12 interviews are enough for most of the research studies aimed to understand the common perceptions and experiences among a group of relatively homogeneous individuals. However, 12 interviews may not be enough for the studies in which the domain of inquiry is diffuse or vague, participants are relatively heterogeneous, and also in case the research goal is to assess variation between distinct groups or correlation among variables. In this study the interviews provided not only the identification of factors (that is Success conditions, Differentiating conditions, Underlying conditions, and Success criteria) but also the associations among factors. Moreover, the group of selected interview participants was significantly heterogeneous, in other words, belonged to different professional roles and diverse regional backgrounds. As a result, a reasonably large sample size of 75 GB professionals was used in the interviews.

In conducting the data analysis this study has provided a detailed account of the frequency with which different factors (that is, Success conditions, Differentiating conditions, Underlying conditions, and Success criteria) are mentioned in the interviews (see Section 5.1, 6.1, 7.1, and 8.1 in Chapter 5, 6, 7, and 8 respectively). This provides a notion of saturation at the level of individual factors.

4.4.2.3.2. Choice of regions in conducting interviews

As mentioned in Section 4.4.2.3, interviews are conducted with GB professionals having experience of GB projects in Australia, Hong Kong, Singapore, the UAE, the UK, and Pakistan. The choice of regions for conducting interviews was based on the criteria of expert sampling, diversity of socio-economic conditions, and feasibility for the researcher in terms of time and resources. The selected regions had building professionals with expertise in GB development. These regions have a variety of drivers and challenges for GB market and have diverse socio-economic conditions to help develop comprehensive lists of factors (that is Success conditions, Success criteria, Underlying conditions, and Differentiating conditions). Lastly, the selected regions were approachable within the resources and time available to the researcher.

Expert sampling was enabled in case of Australia, Hong Kong, Singapore, the UAE, and the UK as the profiles of GB professionals from these countries are available on the databases of GB certification systems. All these countries have their own GB certification systems, for instance, Building Research Establishment Environmental Assessment Method (BREEAM) by the Building Research Establishment in case of the UK; National Australian Built Environment Rating System (NABERS) by the government of Australia and Green Star by Green Building Council of Australia (GBCA) in case of Australia; Green Mark by Building & Construction Authority in Singapore; Building Environmental Assessment Method (BEAM)

Plus by Hong Kong Green Building Council (HKGBC) in case of Hong Kong; and Emirates Green Building Council in case of the UAE. Pakistan also has a Green Building Council, although it is in its early years of development. Many GB professionals are not only associated with these regional certification systems but also with the Leadership in Energy and Environmental Design (LEED) system from the U.S. Green Building Council (USGBC). Australia, Hong Kong, Singapore, the UAE, and the UK have a significant population of GB professionals enabling expert sampling for this study.

The low number of interview participants ($n=2$) in the case of Pakistan is because the population of GB professionals in this region is low resulting in a very small sample size. A reason for including Pakistan was that it was possible to do so within the available resources of the researcher. However, the key reason for including Pakistan is that it has a developing economy and has its socio-economic conditions in sharp contrast with the other five countries. Hence, interviews in Pakistan could help identify some factors not discussed by participants from more developed economies.

Different socio-economic conditions and the drivers and challenges of the GB market in different regions are also the reason behind the diverse regions covered. Based on data for 2017, Australia had a very high Human Development Index (HDI) value of 0.939. In terms of the HDI value, Australia is followed by Hong Kong (HDI=0.933), Singapore (HDI=0.932), the UK (HDI=0.922), and the UAE (HDI=0.863). While these five regions have very high human development, Pakistan has a medium level of human development (HDI= 0.562) (UNDP, 2018). A report by Petrullo et al. (2018), based on a global survey of more than 2,000 industry participants from 86 countries, analysed the GB market trends for many regions. For different regions, this report provides a detailed account of the triggers, challenges, as well as the social and environmental reasons for GB development. A detailed account of the GB market trends for the six regions (that is Australia, the UAE, the UK, Singapore, Hong Kong, and Pakistan) is provided in Table 4-4.

Table 4-4: Drivers and Barriers of Green Building development in six regions

		UK	UAE	Australia	Hong Kong	Singapore	Pakistan
Top challenges for GB development	Perception that green is for higher-end projects only	x	x	x	x	x	
	Lack of political support/incentives				x		x
	Lack of trained/educated GB professionals		x			x	
	Lack of public awareness		x				x
	Lack of market demand	x					
	Lack of GB codes and regulations						x
Top triggers expected to drive future green activity in the region	Client demands	x		x	x		
	Market demands			x			
	Environmental regulations	x	x	x	x	x	
	Reduce operating costs					x	
Top social reasons for GB development	Improving occupant health and wellbeing	x	x	x	x	x	
	Promoting sustainable business practices	x	x	x	x	x	
	Increase worker productivity	x		x			
	Create a sense of community			x	x		
Top environmental reason for GB development	Reducing energy use	x	x	x	x	x	
	Reduce greenhouse gas emissions	x		x	x		
	Indoor air quality				x		
	Protect natural resources and water conservation		x			x	

Sources: Drivers and Barriers of GB development in the UK, the UAE, Singapore, Hong Kong, and Australia are obtained from the study conducted by Petrullo et al. (2018). Barriers of GB development in Pakistan are obtained from the study conducted by Azeem, Naeem, Waheed, and Thaheem (2017).

Alongside the similarities in triggers, barriers and socio-economic reasons for GB development in the six regions, there are also differences in drivers and barriers indicating differences in GB market trends across these regions. The difference in GB trends across the five regions is a function of the regional context. This highlights that GBs are developed to suit the social, economic, regulatory, and

environmental conditions of a region. Conducting interviews in these regions can help capture diverse GB development practices. As a mainly explorative inquiry, this study thrives on a diverse sample set whether it is in terms of the regional belonging of interview participants or in term of their professional roles in GB projects (such as design consultants, contractors, clients, and end-users)

4.4.2.4. Demographics of interview participants

As compared to recommended guidelines (see Section 4.4.2.3.1), a significantly larger purposive sample of interview participants was used in this study as overall 75 participants participated in semi-structure interviews. In interviews, 25, 30, 40, and 72 participants provided their response for Differentiating conditions, Underlying conditions, Success criteria, and Success conditions, respectively. This relatively large sample size is used because interviews were conducted with slightly heterogeneous participants (that is, GB-related stakeholders having various roles in GB projects and belonging to different regions). Interviews with subject matter experts were conducted in Australia (n=32), Hong Kong (n=8), Pakistan (n=2), Singapore (n=14), the UAE (n=6), and the UK (n=13). The details related to the regional origin, role, and experience of interview participants are provided in Appendix B (Section B.7).

The interview participants are 71% male, are highly experienced in developing GBs, and 76% of them have worked in GBs as sustainability consultants, sustainability managers, or design consultants. The details regarding the experience, organisations, regional belonging, and role of interview participants in GBs are shown in Figure 4-5. As shown, 69 out of the overall 75 participants had an experience of 5 or more years related to GB projects. This supports the reliability and credibility of the interview findings. The participants had different roles in the development of GB projects, with the two most common roles among the participants being 'design consultant' (n=19) and 'sustainability consultant' (n=22). While the majority of interviews were conducted in-person (72%; n=54), 28% (n=21) were conducted over the telephone. Face-to-face interviews are the best choice when participants are geographically accessible to the researcher (Given, 2008), as it allows the researcher to have more control and access to rich information. In terms of telephone interviews, most were conducted with participants belonging to Australia (n=17) as well as Pakistan (n=2) and the UAE (n=2).

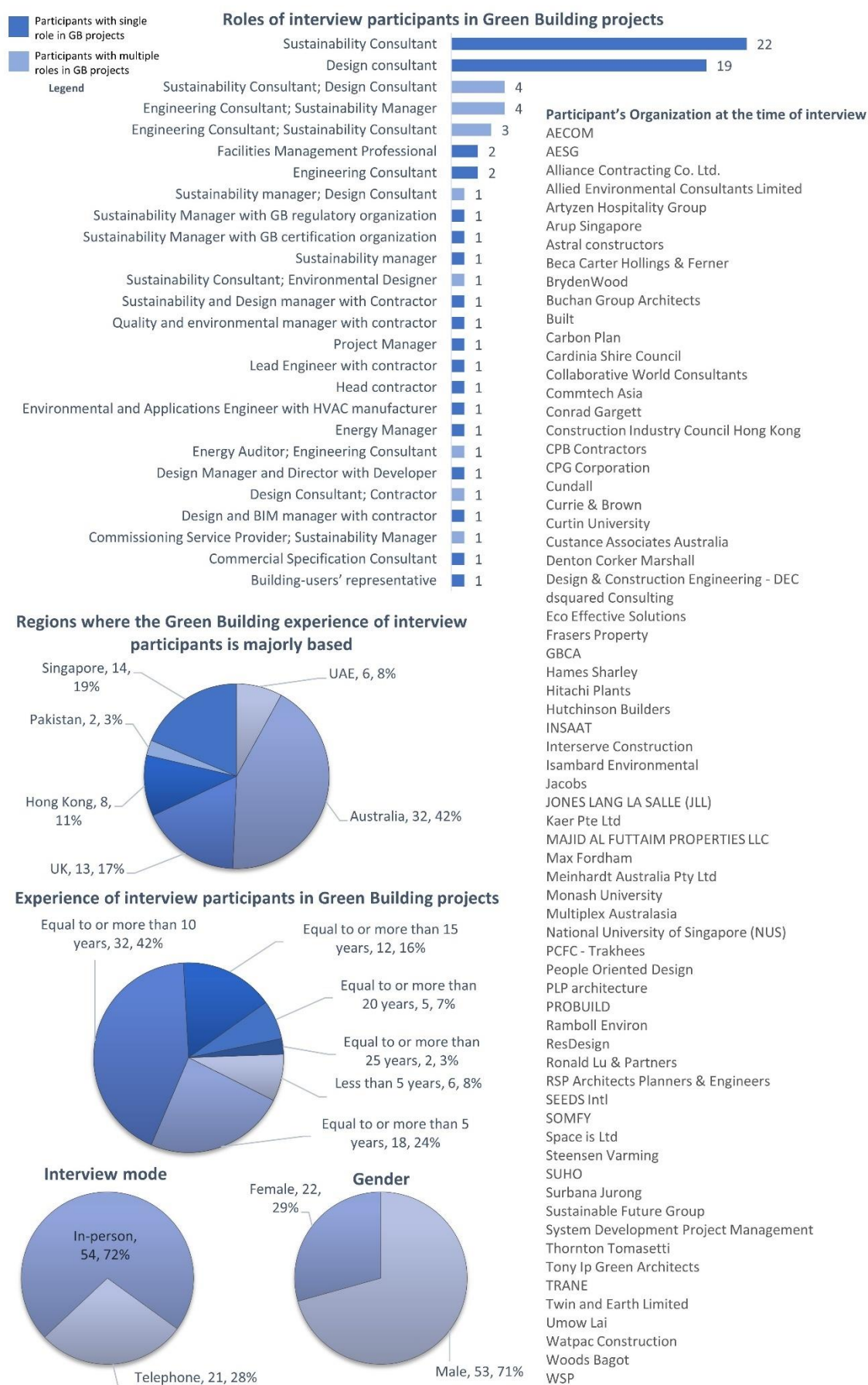


Figure 4-5: Role and experience of interview participants in Green Building projects

4.4.2.5. Transcription of interviews

Researchers belonging to many different disciplines have reported that transcription is an important part of the analysis process. Along with the final transcript product itself, the “process of constructing a transcript by listening and re-listening, viewing and re-viewing” leads to analysis and development of understandings (Lapadat & Lindsay, 1999). Considering transcription as a critical aspect in controlling the quality of data, the researcher acted as interviewer and transcriber. A denaturalised transcription approach was used, and the Interviewee Transcript Review (ITR) process was conducted.

Following both the role of an interviewer and a transcriber resulted in a number of benefits. With a thorough understanding of the background knowledge, as the researcher took the role of interviewer he could unambiguously define and elaborate research topic and interview themes to interview participants. Further, as the researcher also transcribed the interviews, his awareness of the context in terms of the participants’ accent and background noise enabled him to avoid errors in transcription.

To accurately describe the interview discourse, a denaturalised transcription approach was used. In a denaturalised transcription approach, the attention is towards an accurate description of the discourse, and the signs regarding accent and involuntary sounds are eliminated. Since this approach provides accuracy in the essence of the interview (Mero-Jaffe, 2011), it was used for this study. Hence, while transcribing the audio recordings of interviews, different involuntary sounds, as well as grammatical errors, were ignored.

The Interviewee Transcript Review (ITR) was used in this study and can be defined as a process in which interview participants are provided with the transcripts for supporting research ethics and validating the interview discourse (Hagens, Dobrow, & Chafe, 2009; Mero-Jaffe, 2011). While understanding the value of ITR in ensuring the quality of the collected data, the transcript related to each interview was sent to the relevant participant by email. Conducting ITR can be a time-sensitive matter as sending a transcript to an interviewee once a significant time period has elapsed, could mean that the interviewee may not be able to easily recall the different details of discourse and may not feel confident in verifying the transcript. Keeping this in consideration, the transcripts were sent for review, within 1 to 30 days after each interview was conducted.

The objective of this exercise was to have verification from each participant, whether what was written in the transcript was what s/he intended to mention during the interview. Interviewees in the ITR exercise were also requested to make amendments in the transcripts if they deemed necessary. Beside this verification, the other objective of the ITR exercise was to empower the interview participants as ITR could yield a feeling of ownership for the participant in the research product. Of the 75 interviewees, 21 (28%) participants responded to ITR.

4.4.2.6. Researcher as the research instrument

The researcher in this study was self-reflective on an ongoing basis to reduce potential bias. Since the researcher is an important instrument in semi-structured or unstructured qualitative interviews, unique researcher characteristics can potentially influence the collection of research data (Pezalla, Pettigrew, & Miller-Day, 2012). Self-reflexivity is important for a researcher to understand himself/herself as part of the process of understanding others (Ellis & Berger, 2003). The beliefs and values of the researcher can influence qualitative research and regarding this, it is important to provide a reflexive account of the researcher’s attributes which may have influenced the inquiry in this study.

Born in 1990, the researcher is a citizen of Pakistan and has lived there until the year 2016. He has an undergraduate degree in Architectural engineering and a postgraduate (MS) degree in Construction

Engineering and Management. From the undergraduate to the PhD degree, he has conducted research on different aspects of GBs, including design development, life-cycle assessment, use of Building Information Modelling (BIM) in sustainability assessment, and project success. From the year 2015 to 2016, he worked as a project coordinator in an architectural design consultancy in Lahore, Pakistan. In the year 2017, he worked as an internee at the University of Melbourne to help develop sustainable design standards for campus facilities. He has a detailed understanding of the Green Star rating system. During his academic career, a number of factors motivated him to take an interest in sustainable development research. He is primarily motivated by the capability of GB projects to address human-centric development and the need of developing economies to embrace GBs for controlling the socio-economic and environmental burdens of increasing urbanisation.

Self-reflexivity helped the researcher critically observe his own contribution to this research study to control bias and ensure research rigour.

- Since the researcher belongs to a developing economy and most of the interviews (n=73) are conducted with GB experts belonging to developed economies, the researcher had to review the construction practices in the UK, the UAE, Hong Kong, Singapore, and Australia before conducting interviews and before analysing and interpreting the interview data.
- The researcher has the education and professional experience of design development and construction management, and therefore could easily develop a rapport with interview participants from the same or similar professions. However, for participants representing other GB stakeholders (such as clients, commissioning professionals, FM team, and end-users) the researcher reviewed relevant literature to effectively conduct interviews.

4.5. Data analysis and interpretation

Both the quantitative and qualitative data techniques are used to analyse and interpret findings. The interview data is analysed mostly in qualitative terms using thematic analysis and by a theoretical interpretation of findings. To a limited extent, the interview findings are also interpreted through quantitative analysis using Venn diagrams, network diagrams, and network analysis. Survey data is mostly analysed in quantitative terms using descriptive analysis, internal consistency test, and tests of agreement.

4.5.1. Interview data analysis

The interview data is analysed using thematic analysis which was used to classify the findings into groups and categories. Content analysis is used to quantitatively interpret the interview data and before conducting frequency analysis, creating factor networks, and performing network analysis.

4.5.1.1. *Thematic analysis and coding*

The thematic analysis consists of identifying, analysing and reporting themes. The role of a theme is to capture important aspects of the data in relation to the research question, and represent patterned response or meaning within the data set. Considering the ability of thematic analysis to organise and describe the dataset (Braun & Clarke, 2006), it is used for a qualitative analysis of interview data. 'Theoretical' thematic analysis is an approach primarily driven by the researcher's theoretical or analytic interest in the area. Instead of a rich description of the overall data, this approach is more concerned with a detailed analysis of some aspects of the data and is suitable when research starts with a specific question (Braun & Clarke, 2006). Since this study started with specific research questions, theoretical thematic analysis was suitable for this study.

The thematic analysis in this study is conducted at two levels, that is at the level of explicit meanings of data and at the level of underlying ideas in data. In the semantic approach of thematic analysis, the themes are identified within the explicit meanings of the data and the analyst is not looking for anything beyond what a participant has said or what has been written. For instance, when discussing Success conditions some interview participants (n=12) mentioned that the client's understanding of GB requirements is important for GB project success. Using the semantic approach, the researcher considered this as a Success condition. In latent approach, the analysis goes beyond the semantic content of the data and starts to identify or examine the underlying ideas, assumptions, conceptualisations, and ideologies (Braun & Clarke, 2006). For instance, some interview participants mentioned the client's understanding of GB requirements (n=12), and the client's understanding of sustainable building operation (n=2) as a Success condition. Upon analysing these responses for underlying ideas, the researcher realised that the interview participants were mentioning the proficiency of the project client regarding GB development and operation. Based on the analysis of underlying ideas, proficiency of the project client was considered a parent Success condition with multiple sub-conditions. Since both the levels of analysis are important for this study, thematic analysis in case of this study is conducted at the semantic level while identifying factors (that is, Differentiating condition, Success conditions, Underlying conditions, and Success criteria) and also at the latent level while investigating hierarchies of factors.

The six steps of conducting thematic analysis as indicated by Braun and Clarke (2006), have been used in this study. The researcher in this study familiarised himself with the data by reading interview transcripts multiple times, and then the initial codes were generated, and themes were searched. The identified themes were reviewed by their cross-comparison. This was followed by defining and naming themes which finally lead to the development of the report.

In the thematic analysis, codes occur at a primary level and categories or themes occur at a secondary level. Themes are based on the analysis of codes rather than of data (Elliott, 2018). For this study, the interviews were manually transcribed by the researcher and then coded in a computer-based application, NVivo 12, which can systematically code large qualitative datasets (Wiltshier, 2011). NVivo 12 also has the option of automatic coding of the data. Instead of using this technique, the manual coding technique was used throughout since it gives more control to the researcher. From the codes, themes emerged which were further analysed and reported. Both the thematic analysis and coding process informed each other in a cyclic process. The coding for thematic analysis was also used in conducting the content analysis. Details regarding the content analysis are provided in Section 4.5.1.3.

Verbatim descriptions of participants' discourse are provided in this study. Participants are referred by unique IDs which can be used to refer to the information regarding the experience, professional role, and regional belonging of interview participants as shown in Appendix B (Section B.7).

4.5.1.2. *Classifying data into groups and categories*

The construction of typologies and taxonomies, which are categories and groups within categories, is an important element of analyses. While using the data, categories, subgroups and relationships among them should be established. Such categorisation reduces the number of potential variables; hence, making the data more manageable and easing the pattern detection and possible dependencies, or in other words "causalities" (Fellows & Liu, 2015). The classification of GB Success conditions and criteria into groups and categories is necessary for this study and this categorisation not only eased the qualitative analysis but also the interpretation of findings. For instance, the Success criteria in this study represent groups of sub-criteria. Similarly, 20 broad themes represent 73 Success conditions and 25 of these Success conditions further represent 82 sub-conditions.

To reduce the potentially negative outcomes of data classification, it can be useful to provide a clear trail of classification exercise, as practised in this study. Data classification into groups and categories provides the ease of analysis and interpretation. However, this also carries the risk that some important variables are not well-represented in groups and as a result, the analysis and interpretations following the data classification may be flawed. Moreover, in a study involving a large number of factors, the analysis and interpretations may be limited to the level of groups and not the individual factors. This may not only reduce transparency but also the reproducibility of research. Acknowledging that the same factors may be classified differently with different viewpoints, the researcher in this study has provided a clear trail of data classification and has enabled transparency in the analysis. This can help future researchers use data from this study for comparison purpose, to conduct the analysis on the same data with different perspectives, and even to use the findings of this study in longitudinal research.

4.5.1.3. *Theoretical interpretation of interview findings*

The Success conditions and criteria identified from interview data are analysed by the researcher to see if these factors associate with the TFCV theory. Both the core principles and the waste definitions of the Transformation, Flow, and Value-generation views are used while analysing interview findings. The results of these analyses are provided in Chapter 7 and 8. In principle, the associations of Success conditions and criteria with the Transformation, Flow, and Value-generation views is based on the researcher's interpretation of interview findings.

4.5.1.4. *Quantitative analysis of interview data*

It is necessary to provide a visual representation of qualitative data as explained below. According to Grounded theorists, it is essential for the theory-building process to create visual representations of the emerging theories (Charmaz, 2006; Clarke, Friese, & Washburn, 2017; A. Strauss & Corbin, 1998; A. L. Strauss, 1987; Verdinelli & Scagnoli, 2013). This qualitative tradition of inquiry strongly encourages the use of diagrams and figures to synthesise major theoretical concepts and their connections. For qualitative studies, the importance of visual displays lies at all stages of analysis. While adding life to qualitative data, diagrams help the readers see the author's meaning represented in more ways than just textually (Verdinelli & Scagnoli, 2013; Yin, 2015). To suit the different requirements of data visualisation, Venn Diagrams, Circle chord diagrams, and Network diagrams are used in this study. The detailed overview of their use is as follows:

Venn diagrams to show overlaps among sets: To show overlaps among the sets of different factors in this study, a number of Venn diagrams are developed which are common visualisation charts to show all possible logical relations between a finite collection of different sets. Since Venn diagrams show the factors shared and unshared across multiple sets, they effectively visualise similarities among sets under observation (Bardou, Mariette, Escudié, Djemiel, & Klopp, 2014; Venn, 1880).

Network and Circle chord diagrams to show factors and their interrelationships: To visualise the interrelationships among factors, in this study factor networks and circle chord diagrams are developed for Success conditions, Success criteria, Underlying conditions, and Differentiating conditions. These visualisation tools are particularly relevant as the study uses a complexity perspective whereby the interrelationships among factors become highly important for analysis.

Network analysis to determine properties of Success conditions: For Success conditions, network analysis is conducted in addition to the visualisation. This analysis is conducted using Cytoscape, a computer application used for visualising and analysing complex networks (Kohl, Wiese, & Warscheid, 2011). While conducting the analysis, network properties of Success conditions are analysed from

which a measure of their significance is provided. A detailed account of the network properties analysed in this study is provided in Section 8.4 (Chapter 8).

Content analysis is a research technique used in making replicable and valid inferences by interpreting and coding textual material. Content analysis is used in this study to transform qualitative data into quantitative data. By systematically evaluating texts, the content analysis method offers the opportunity to convert qualitative data into numbers or percentages (Vaismoradi, Turunen, & Bondas, 2013; Xenarios & Tziritis, 2007) and enables a quantitative analysis of qualitative data (N. Wang et al., 2013). The method has been applied in various areas of research on management, such as multicriteria decision-making (Xenarios & Tziritis, 2007) and implementation of IS/IT strategy (Gottschalk, 2001). More so, it has also been used for GB project success research (N. Wang et al., 2013). Considering the usefulness of content analysis for this research inquiry, it has been adopted in addition to the thematic analysis. As shown in Figure 4-6, Content analysis has led to the development of adjacency matrices and the lists/sets of factors which have eventually led to network analysis, and also resulted in the development of Venn Diagrams, Circle chord diagrams, and network diagrams.

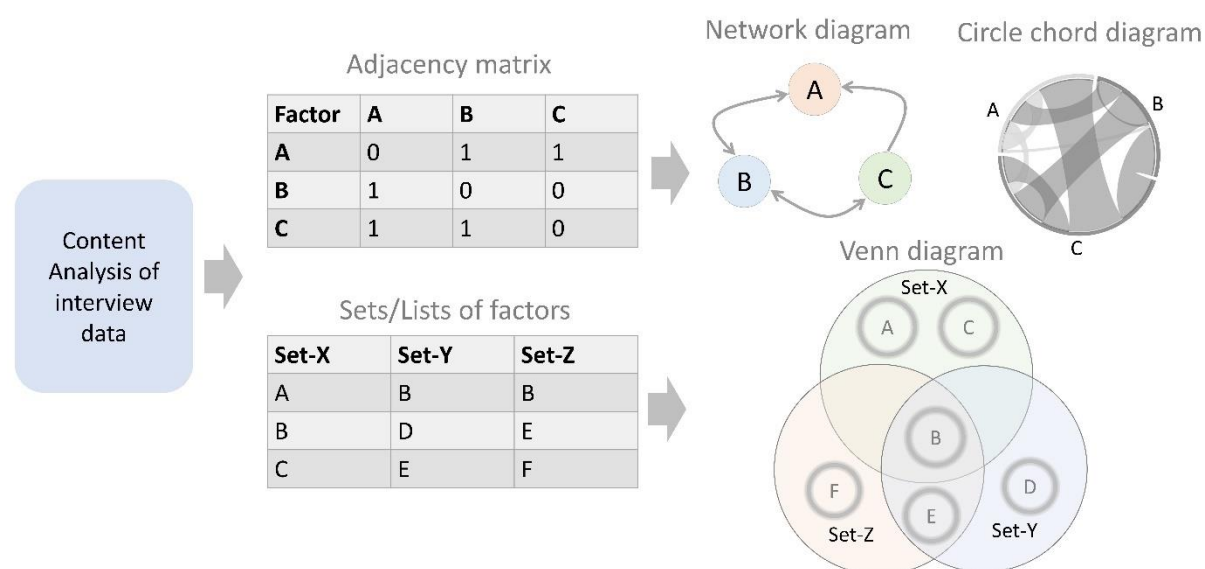


Figure 4-6: Content analysis of interview data leading to the development of visualisation charts

In this study, content analysis has determined the frequency of occurrence of different factors and these frequencies have determined the importance of identified factors. Whether to count codes or not is an important aspect to consider when reporting data. Researchers with pragmatic views consider counting important for a systematic approach to qualitative research. Counting may also serve as a useful indicator for the importance of a given code (Elliott, 2018). For instance, Harding (2018) suggests that a code shared by one-quarter of the participants in a study is worth consideration in the final analysis. Instead of the number of times a code appears in the data, its widespread occurrence in the data might be a more significant parameter to consider. For the quantitative analysis of qualitative research data obtained from interviews, the key parameter used in this study is 'frequency' which is based on the counting of codes. Frequency in this study means the number of participants identifying a factor (that is, Success condition, Success criterion, Underlying condition, or Differentiating condition) or highlighting an interrelationship among two factors. In a qualitative inquiry on GB project success, frequency has been used as a measure by N. Wang et al. (2013) to determine the relative importance of factors. Since the research data in case of this study is mostly qualitative, frequency analysis is used to interpret the relative importance of factors and to develop factor networks.

This study acknowledges that besides the usefulness of counting codes, there also exists the possibility that the frequency of occurrence does not necessarily indicate significance (Saldaña, 2015). Overreliance on counting may also result in a risk of overlooking significant and interesting concepts which have occurred in a dataset once or twice. While a code occurring at one, two or three instances in a dataset may seem unimportant for a research question, it may be the key to unlock analysis (Saldaña, 2015). Hence the researcher has to be careful in recognising if that might be the case. If a researcher decides to count, it is essential that s/he also thinks carefully about how to use counts, and what they imply for the later stages of data analysis (Elliott, 2018). To avoid the drawbacks of overreliance on counting codes the researcher in this study avoided the assumption that a factor is unimportant simply because it has low-frequency value.

Comparative analysis of Success conditions, Differentiating conditions, and Underlying conditions:

A comparative analysis of Success conditions, Differentiating conditions, and Underlying conditions identified from interviews is conducted to determine the overlap among these three condition types. Inquiries regarding these three types of conditions are conducted separately in this study. Some conditions belonging to the three constructs may have the same concepts but different titles. For instance, a Success condition and a Differentiating condition may have the same concept but different titles. The comparative analysis for identifying overlaps among these three constructs comprises two steps. Firstly, conditions with same titles across the three constructs are identified to develop a preliminary list of overlapping conditions. Secondly, the descriptions related to overlooked conditions are reviewed. In case a Success condition 'A' has a similar description as a Differentiating condition 'B', but a different title, both conditions are considered one and same. After conducting the second step of review, the final list of overlap among three constructs is generated.

4.5.2. Survey data analysis

The quantitative data obtained from the online survey is related to performance criteria interrelationships and this data is quantitatively analysed for internal consistency, agreement among findings, and to establish trends. First, the internal consistency of the data is checked by calculating the Cronbach alpha value. This is followed by conducting three tests of agreement on the data, including Fleiss' kappa (κ), Kendall's coefficient of concordance (W), and Chi-square. These tests are about determining the level of unanimity or agreement in the interpretation of performance criteria associations by survey participants and determining the rigour of the findings (see Section 4.6.1). Lastly, a descriptive statistical analysis using Mean, Mode, Standard Deviation (SD), Inter Quartile Range (IQR), and Skewness functions, is conducted to identify the trends in survey data. The descriptive analysis helped determine the prevalent associations (that is, positive, negative, and non-existent) among performance criteria.

The quality of research findings depends on the measures of rigour and credibility used in research. The measures used in this study are explained as follows.

4.6. Rigour and credibility of research

Rigour refers to the extent to which the researchers work to enhance the quality of a study (Heale & Twycross, 2015). The rigour and credibility of research depend on different measures when it comes to qualitative and quantitative data. This section describes the measures taken in this study to ensure the rigour of qualitative and quantitative findings.

4.6.1. Rigour of quantitative findings

In quantitative research, rigour is achieved through the measurement of validity and reliability (Heale & Twycross, 2015; LoBiondo-Wood & Haber, 2013). While validity is the extent to which a concept is

accurately measured in a quantitative study, reliability is the accuracy of the research instrument, determining the extent to which a research instrument consistently provides the same results if repeatedly used in the same situation. The validity and reliability of the data collection tools are important to consider when conducting research (Heale & Twycross, 2015).

Content and construct validity are important measures to determine the validity of the research instrument, and are used for the survey questionnaire in this study. Content validity is a category of validity which looks at the extent to which a research instrument accurately measures all aspects of a construct. Construct validity is another category of validity which looks at the extent to which a research instrument measures the intended construct (Heale & Twycross, 2015). In this study, both the content and construct validity of the survey questionnaire (in other words, research instrument) is determined by piloting the questionnaire as explained in detail in Section 4.4.1.2. Based on the assessment from the piloting process, some minor revisions are made in the questionnaire to increase its validity before using it to administer the online survey.

Reliability implies the consistency of a measure and can be measured using internal consistency and equivalence. The idea is based on the concept that a participant using an instrument to provide a response should have approximately the same responses each time the test is completed. Although it is not possible to give an exact calculation of reliability, an estimate of reliability can be achieved through different measures such as internal consistency and equivalence. Internal consistency is an attribute of reliability which can be assessed using Cronbach's alpha (α), the most used test to determine the internal consistency of an instrument. Equivalence which is another measure of reliability is assessed through inter-rater reliability which is a test to determine the level of agreement between two or more observers or research participants (Heale & Twycross, 2015). A number of statistics can be used to determine inter-rater reliability and some options in this regard are Fleiss' kappa and Kendall's coefficient of concordance. For the quantitative data obtained from the online survey in this study, the internal consistency is determined by calculating the Cronbach's α value. To determine equivalence, tests of concordance are conducted, and results have shown the reliability of quantitative findings. A detailed account of these test results is provided in Chapter 6 (Section 6.2.2).

4.6.2. Credibility of qualitative findings

Although the criteria used to evaluate qualitative research are not universal, some methodological strategies can enhance the credibility and trustworthiness of qualitative findings (Noble & Smith, 2015). These strategies used in this study include:

- Acknowledging biases in the sampling process and ensuring an ongoing critical reflection of the methods to achieve sufficient depth and relevance of data collection and analysis (Noble & Smith, 2015; Sandelowski, 1993). Furthermore, accounting for the personal biases which may have influenced the research findings (Morse, Barrett, Mayan, Olson, & Spiers, 2002; Noble & Smith, 2015).
- Meticulous record-keeping, demonstrating a clear decision trail and ensuring that the interpretations of data are consistent and transparent (Long & Johnson, 2000; Noble & Smith, 2015; Sandelowski, 1993). Also demonstrating clarity in the thought process during the analysis and interpretation of data (Noble & Smith, 2015; Sandelowski, 1993).
- Establishing a comparison case and seeking out the similarities and differences across accounts to ensure different perspectives are represented (Morse et al., 2002; Noble & Smith, 2015; Slevin & Sines, 1999). Also supporting the research findings by incorporating the rich verbatim descriptions of the participants' accounts (Noble & Smith, 2015; Slevin & Sines, 1999).

- Inviting the participants/respondents to comment on the interview transcripts and whether the final themes and concepts created by researcher adequately reflect the phenomena being investigated (Long & Johnson, 2000; Noble & Smith, 2015).
- Using data triangulation, whereby a more comprehensive set of findings is produced using different methods and perspectives (Fraser & Greenhalgh, 2001; Kuper, Lingard, & Levinson, 2008; Long & Johnson, 2000; Noble & Smith, 2015; Sandelowski, 1993).

Table 4-5 provides a detailed overview of how the above-mentioned methodological strategies are adopted in this study to enhance the credibility and trustworthiness of qualitative findings.

Table 4-5: Methodological strategies adopted to ensure the credibility of qualitative findings

Strategy	Use of strategy in this study	Chapter section providing a detailed account of the strategy used
Accounting personal biases	An ongoing self-reflexivity of the researcher in the study to reduce the potential bias he may have introduced.	4.4.2.6. Researcher as the research instrument
Acknowledging biases in sampling and ongoing critical reflection of methods	Owing to the criteria used for expert sampling, some systematic bias in sampling may have been introduced. While conducting interviews the researcher practised caution, rigour, and self-reflexivity on an ongoing basis for effective data collection.	4.4.2.3. Sampling of interview participants
Detailed record-keeping, having a clear decision trail and realising consistent and transparent interpretation of data	In terms of record-keeping, the interviews are audio-recorded and fully transcribed. The interviews are coded in NVIVO application, which keeps an electronic record of the entire coding process. Besides its role in record-keeping, this approach also ensured consistency and transparency in data analysis and interpretation.	4.4.2.5. Transcription of interviews 4.5.1.1. Thematic analysis and coding
Providing similarities and differences across accounts to represent different perspectives	During the thematic analysis, the researcher continuously compared the codes in interview transcripts. Similarities and differences in the perspectives of interview participants are used while analysing and interpreting research findings.	4.5.1.1. Thematic analysis and coding
Verbatim descriptions of the participants' accounts	Verbatim descriptions are extensively provided while reporting the participants' accounts in the Thesis report and publications resulting from this research. The verbatims are reported with the IDs of participants to help the readers see who has said something	4.5.1.1. Thematic analysis and coding
Clarity in the thought process while analysing and interpreting data	A theoretical thematic analysis approach is used in this study to analyse the findings based on the preselected theoretical constructs.	4.5.1.1. Thematic analysis and coding
Validation by respondents	In this study, the Interviewee Transcript Review approach is used, whereby the interview participants are requested to review the transcripts	4.4.2.5. Transcription of interviews
Data triangulation	Different approaches are used in this study to help data triangulation: A sampling criterion for interview participants is such that they cover a wide range of demographic settings. Hence, findings are triangulated from different demographic contexts. The interviews also covered a variety of questions to help triangulate the findings. For instance, the interview participants were requested to discuss Success conditions from three different viewpoints.	4.4.2.1. Themes in interviews 4.4.2.3. Sampling of interview participants

4.7. Chapter Summary

This chapter provides an overview of the research design used to address the research questions. The study adopts a critical realism paradigm, whereby a realist ontological position and a relativist epistemology is embraced. While the study has used a mixed-method explanatory design primarily for the findings from an online survey, the study has mainly used an exploratory design using interview findings.

While using online survey data and to some extent the interview findings, the explanatory design explains the interrelationships among sustainability performance criteria (*Environmental, Economic, and Social sustainability*) and project management performance criteria (*schedule, Cost, and Quality*). Prior to administering the survey, the piloting of the survey questionnaire is performed to ensure the quality of data collection. The closed-ended question in the survey covers 30 associations among 6

variables. The expert sampling approach, a form of purposive sampling technique is used for both the online survey and the semi-structured interviews. In the resulting sample set of survey participants, most respondents (n=78; 75%) belong to a design and sustainability consultancy role. Regionally, the survey participants are mainly based in Australia (n=42; 40%), Singapore (n=18; 17%), India (n=16; 15%), and the UAE (n=15; 14%). Upon collecting the survey data, the preliminary analysis has revealed a high variance in the response of some participants. To improve the data quality the participants having high variance in their responses are engaged in the Delphi process as this way they could revise their response based on the overall trends.

While using the findings from semi-structured interviews, the exploratory design investigates the Success conditions, Success criteria, Differentiating conditions, and Underlying conditions. Face-to-face interviews are preferred in this study. Procedures are adopted to ease the access to information, reduce bias in findings, and ensure the quality of collected data. These include the use of digital recording, the role of the researcher as interviewer and transcriber, knowledge acquisition by modularisation, the use of a denaturalised transcription approach, the use of interviewee transcript review process, and the use of computer-aided thematic coding for data analysis. While using the expert sampling approach for semi-structured interviews, saturation is used as the principle measure to determine the sample size. Overall, 75 GB professionals are interviewed belonging to Australia, Hong Kong, Singapore, the UAE, the UK, and Pakistan. Most of the participants (n=69; 92%) had an experience of 5 or more years related to GB projects and the majority of the participants (n=41; 55%) have either worked as design consultants or sustainability consultants on GB projects. The multi-regional and professionally diverse interview participants have enabled diverse perspectives in data collection which is important in terms of the explorative nature of this study.

To interpret the data and test the reliability of findings, qualitative and quantitative analysis are conducted on interview and survey findings. The interview findings are analysed using a theoretical thematic analysis approach. The interview data is extensively classified into groups and categories for analysis and interpretation purpose. The interview findings are also quantitatively analysed, in terms of the frequency of identified factors and by network analysis. The findings from survey data are analysed using the test for internal consistency and tests for determining the level of unanimity or agreement among findings. These tests also helped determine the rigour of quantitative findings. Beside these, a descriptive statistical analysis of data is also conducted to identify trends in findings.

To ensure the credibility and trustworthiness of qualitative findings, a number of methodological strategies are adopted, including the accounting of personal biases, accounting of biases in sampling, ongoing critical reflection of methods, detailed record-keeping, having clear decision trail, consistent and transparent interpretation of data, providing similarities and differences across the participants' accounts, clarity in the thought process in data analysis and interpretation, validation of transcripts by respondents, and data triangulation.

Based on the research design explained in this chapter, the question that is 'How do sustainability requirements set Green Buildings apart from non-Green Buildings?' will be answered in Chapter 5.

5. Differences between Green and non-Green Building projects

With the study aim ‘to promote the development of better Green Building projects’, it is necessary to understand differences between GBs and non-GBs, not only in terms of project outcomes but also in terms of the project development process. This inquiry can help understand why the traditional way of project development may not be usable for GB projects. While investigating “passive houses”, Rohrer (2001) claims that many approaches of a traditional building development are rendered obsolete for a passive house project. The traditional planning procedures, the approaches for component certifications, as well as the quality control practices need to be revised. As an interview participant (UK-M-4) also indicated, “for a Green Building project to work, you need to optimise not only the design but also the process of project development.”

The objective of this chapter is to identify conditions which differentiate GBs from non-GB projects. This chapter addresses the research question *‘How do sustainability requirements set Green Buildings apart from non-Green Buildings?’*

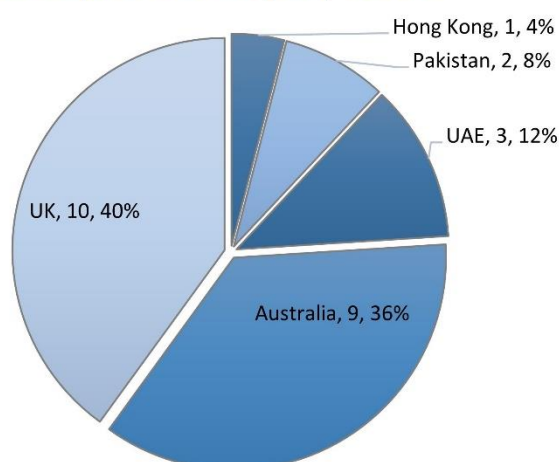
Section 5.1 provides a brief overview of the interview participants. This is followed by Section 5.2, which provides a detailed overview of the conditions which differentiate GBs from non-GBs. Both the outcome-related and process-related aspect of GB projects are discussed. Section 5.3 explains the associations among Differentiating conditions. Lastly, in Section 5.4, a detailed discussion regarding the Differentiating conditions is provided.

5.1. Characteristics of interview participants

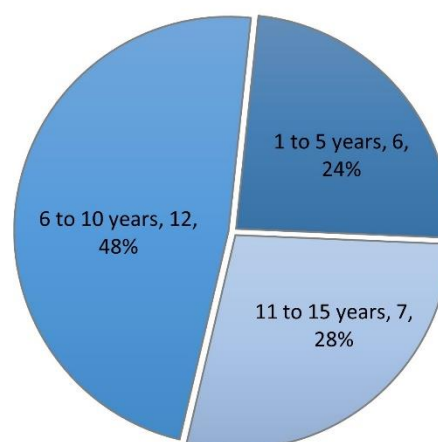
Findings presented in this chapter are informed by semi-structured interviews and based on the opinion of 25 interview participants. The thematic analysis conducted on interview data helped identify the Differentiating conditions of GB projects.

As shown in Figure 5-1, interview participants in case of this inquiry were mainly based in Australia (n=9), and the UK (n=10). The interview participants are highly experienced building professionals as most of them (n=19; 76%) have a minimum of 6 years of experience in developing GB projects. These GB professionals are design consultants (n=5; 20%), sustainability consultants (n=7; 28%), contractor team members (n=3; 12%), engineering consultants (n=2; 8%), commercial specification consultant (n=1; 4%), and sustainability managers working with GB regulatory or certification organisation (n=2; 8%). Up to 5 interviewees had the experience of acting in multiple roles. The details related to the regional origin, role, and experience of interview participants are provided in Appendix B (Section B.7).

Regions where the Green Building experience of interview participants is majorly based



Experience of interview participants in Green Building projects



Role of interview participants in Green Building projects

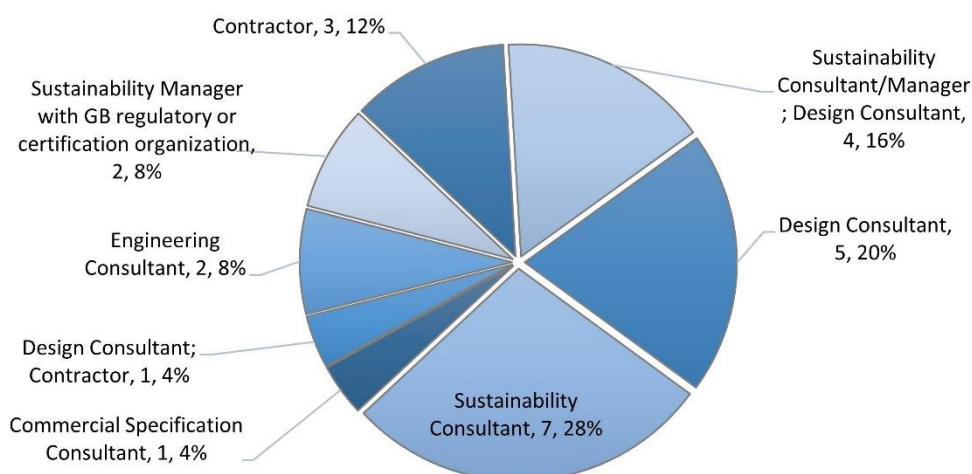


Figure 5-1: Role and experience of interview participants discussing Differentiating conditions

5.2. Conditions differentiating Green Buildings from their traditional counterparts

Upon analysing interview data, the synthesised findings are reported in Table 5-1 which lists the conditions that differentiate GB developments from non-GB developments. The 34 Differentiating conditions identified are grouped in 10 themes.

Table 5-1: Conditions differentiating Green Buildings from non-Green Building projects

Theme	Differentiating conditions	Sub-conditions	Freq.
Budget and Time	Increased budget and delivery time requirement		1
Defining project goals	Setting of a detailed sustainability charter or brief	A detailed description of sustainability requirements in the project brief	1
	End-users' involvement in defining project aspirations	Engagement of end-users in the design process	1
Design methodology	Intense design activity	Intense design activity; Modelling performed on architectural designs by Mechanical, Electrical, and Plumbing (MEP) consultants; Iterative design cycles prior to design finalisation	5
	Level of complexity in project design	Additional design considerations and constraints for consultants	1

Theme	Differentiating conditions	Sub-conditions	Freq.
	Use of integrated design approach	Integrated design process; Focus towards a systems approach (that is how the systems work together)	4
	Use of innovative design approach	Creative design approach	1
	System and material selection	Diligence in the procurement of building materials	3
	Market survey to identify successful building systems	A continuous search for better building materials and technology	1
	Use of context-oriented design approach	Integration of building within its surroundings	1
	Considerations towards potential building occupants	Integration of users within the building	1
	Use of energy-oriented design approach	Increased focus towards the water, energy usage and other environmental aspects; On-site energy generation	3
	Life-cycle based project development approach		1
	Use of holistic design approach		1
Documentation	Higher documentation activity		2
Flow of project information	Use of effective communication tools and strategies	Meetings to resolve clashes in building services	1
Inspection, monitoring and control	Monitoring and controlling operational performance of the building	Metering for quick feedback	1
	Execution of commissioning and fine-tuning	Increased commissioning and tuning requirement	1
Team collaboration	Liaison between sustainability consultant and project team	Coordination of sustainability consultant in the design development process	2
	Project team collaboration	Liaison between mechanical, structural engineer and architect from earlier design stages; Integrated project team	2
Team procurement methodology	Preferences in the contractor's engagement	Engagement of skilled contractors	3
	Pre-qualification of contractors and sub-contractors	Special requirements for the contractor in the tendering process	1
	Engagement of sustainability consultant		1
	Engagement of an independent commissioning agent		1
	Engagement of sustainability consultant in the selection of other team members		1
Timeliness of project activities	Early engagement of project team		5
	Early engagement of sustainability consultant		2
	Early engagement of design consultants		2
Complexity	Complexity in project development		10

While the identified conditions generally differentiate GBs from non-GB projects, it does not imply that these conditions strictly occur within GBs and not in traditional projects. These conditions are relatively stronger characteristics of GB project development, however, they may also occur in non-GB projects. Even the GB project development striving for low levels of sustainability may not be expressively characterised by these Differentiating conditions as an interview participant (UK-M-5) highlighted,

“If the Green Building projects are executed in an integrated manner, then indeed they have a different delivery process from the traditional projects. However, sometimes projects are tagged as Green Building projects but are executed in the same way as traditional projects are. These are the kind of projects striving for low to medium level of sustainability performance.”

The occurrence of Differentiating conditions during the stages of project development is plotted in Figure 5-2. In terms of the project stages, during initiation project goals are defined, during planning project design is developed, during execution construction takes place, and during monitoring and control project commissioning is conducted and the operational performance of the building is monitored.

As shown in Figure 5-2, the project team's control over project 'complexity' as well as the 'budget and time' decreases as a project progresses from initiation to monitoring stage. 'Defining project goals', 'Design methodology', 'Documentation', 'Flow of project information', 'Inspection, monitoring and control', 'Team collaboration', 'Team procurement methodology', and 'Timeliness of project activities' affect the development of a GB project. However, their effectiveness in GB project development reduces as a project moves from its initiation to monitoring stage.

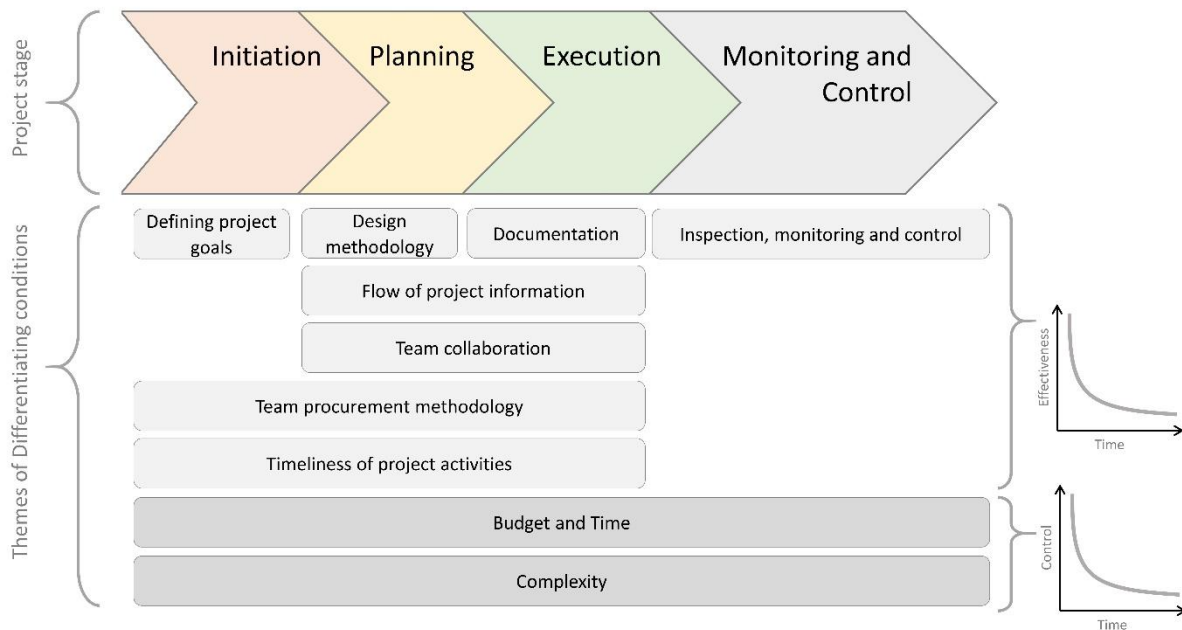


Figure 5-2: Differentiating conditions occurring in different stages of the project lifecycle

A detailed description of these themes is provided below based on interview findings.

5.2.1. Defining project goals

An important difference of GBs from non-GB projects is in terms of the project development goals as an interview participant (AE-M-3) highlighted, "unlike a traditional building, a Green Building project is required to be more efficient in terms of water and energy use. The focus on these different aspects makes a Green Building different from a traditional building."

The difference between GBs and non-GBs begins to appear from the project initiation stage as the project brief is being developed. To ensure the sustainable development of a Green Building project the project brief needs to incorporate green measures as an interview participant (AU-M-2) highlighted, "the difference would be in terms of the project brief which for a Green Building will need to have some description for the sustainability required in the building." To define project aspirations, GBs also engage end-users in the project development as this can significantly contribute towards the operational performance of these buildings.

5.2.2. Design methodology

A sharp contrast between the development of GB and non-GB projects occurs at the stage of project design development. In traditional building projects, the architect develops the shape and decides the building materials. Afterwards, the building services engineers are involved who design the MEP services for the building. In contrast, a GB has different expectations and deliverables (for example, higher energy efficiency and environmental sustainability) and consequently, a GB differs from a traditional non-GB in terms of the design outputs as well as the design process. According to an

interview participant (UK-F-6), “the development process of Green Building projects is different from traditional counterparts as in the Green Building projects additional design considerations and design constraints are added for the design consultants.”

An energy-efficient GB involves a rigorous design thinking to reduce the dependence on fossil fuels and overall energy use. Along with the typical functional planning required in a building, in GBs it is necessary to consider design aspects such as surroundings, orientation, and glazing. Some of the prominent design development aspects differentiating GBs from non-GBs, outlined by interview participants are as follows:

- **The intensity of design activity:** Compared to a traditional building, in a GB the design activity is more intense, especially when a GB certification is being targeted. A high level of social sustainability on building projects requires excessive upfront consultation with the design team which can also result in higher costs and longer delivery times. According to an interview participant (UK-M-6),

“When the building is operated, it should be in a way that is genuinely low impact. A consultant needs a far bigger fee to do that work because it actually involves a lot more engagement and effort.”

- **Integration in design:** GBs require more integrated design approaches. According to an interview participant (AE-M-1), “Green Building projects dominantly have an integrated design process where a Green consultant coordinates among different design disciplines to ensure that all sustainable design aspects are implemented and coordinated within the design process.” In a GB the architect develops an architectural design which is then used by MEP consultants to conduct preliminary modelling. This modelling provides an estimate of building efficiency upon which the architectural model is revised. The revised model is then provided to the structural and MEP consultants to develop the requisite drawings and models. Hence, a high degree of design integration is inherently required in GBs.
- **Holistic and Systems approach:** GBs require a holistic and systems approach in design. These approaches are about seeing how building systems work together instead of being considered individually. According to an interview participant (AU-M-21),

“The difference of a 6-Star Green Star and a non-certified building will come, where these different aspects of design are considered holistically or not. Buildings which are going for high-level green certifications look for a holistic approach, the integration of the building within the precinct, and the integration of occupants within the building. It all needs to be considered as a whole. A standard building might be looking at cabinetry, finishes, lobby, and main services related to works, but a Green Building will be looking at how the systems work together, in a systems approach. This is where the difference will lie. It is not something which is visual.”

- **Creativity in design:** Projects opting for higher sustainability performance than minimum requirements, need to follow a creative design approach. This is because owing to the sustainability requirements, GBs face increased constraints and challenges which can only be mitigated by ‘out of the box’ approaches.
- **Material and technology selection:** The selection, sourcing, and procurement of building materials and technology is an aspect which can set GBs apart from non-GB projects. Usually, in traditional projects, all the procurement is locally performed since all the required materials are locally available. However, in the case of GBs, if sustainable materials are not locally available, they may

need to be imported to fulfil sustainability requirements. GBs often involve a search for materials and technologies with increased efficiencies while traditional buildings usually depend on standard technology. Owing to the special material requirements in GBs, a high level of diligence is to be practised in material procurement. According to an interview participant (AU-M-5),

“In case a project has sustainable objectives, a more stringent process is to be managed to result in project outcomes. This can particularly be a case when selecting the building materials and considering the embodied energy in material manufacturing.”

The above-mentioned conditions differentiate GBs from non-GBs in terms of the design process. Some of the most prominent Differentiating conditions are however in terms of design deliverables.

- **Life-cycle perspective in design:** Unlike the case of traditional projects, which often have a short-term focus, a life-cycle perspective drives the process of project development in GBs. New materials in the market with lower environmental impacts and longer service life are the favoured choices in GB development. The thought process involved in GB design even considers the material reuse upon dismantling a building in future.
- **Designing for context, energy conservation and end-users:** During the design development of GBs, social and environmental considerations in the design are required which are otherwise ignored. For instance, the use of on-site energy generation is more prevalent in GB projects as compared to non-GBs. GB developments have a focus towards integrating the building within the surroundings and have emphasis on integrating users within the building.

5.2.3. Team procurement methodology

Unlike traditional buildings, GBs may involve experts such as sustainability consultants and independent commissioning agents to fulfil sustainability requirements. In case a sustainability consultant is hired before the architect and other consultants, s/he may help the client develop prequalification criteria for engaging other team members. However, in case the project team is already shortlisted, the sustainability consultant develops terms of reference, and the final selection of the project team has to fulfil these terms.

Compared to traditional projects, the expertise of key team members in GBs is very important. For instance, in such projects, it is very important to have the involvement of skilled contractors who can support sustainable development by reducing waste on-site, help in the sourcing of Green construction materials and provide their support in the documentation required for third-party GB certifications. GBs also have some special requirements that need to be fulfilled by contractors during tendering.

5.2.4. Timeliness of project activities

One of the major differences in the procurement of a GB from a traditional building is that a GB needs the involvement of team members early in project development as an interview participant (PK-M-1) highlighted, “the major difference of the Sustainable project procurement from traditional project procurement is that the Sustainable projects involve different project trades early in the project.” A sustainability consultant needs to be involved in the early stages of GB development to ensure that the process of such a project is put in place by well-experienced team members and at an appropriate time. In addition to sustainability consultants, design consultants also need to be engaged in the early design stages of a GB project.

5.2.5. Team collaboration

The liaison among project team members and the way different team members interact becomes much more important in GBs as compared to traditional buildings. A very important aspect is the

communication and the contribution of the whole project team as an interview participant (UK-F-2) highlighted,

“The most important difference is the communication and the contribution of the whole project team. In a traditional building, all the different team members are not much connected and work apart, while in a Green Building all the team members are well connected and approach the project development in a combined way.”

Unlike traditional buildings, GBs face an increased requirement to be well integrated from the early design stages particularly in terms of the liaison between the mechanical, structural engineer, and the architect. In GB projects, a sustainability consultant has to coordinate across the whole project team and s/he is to ensure that all sustainable design aspects are implemented within the design process across disciplines.

5.2.6. Flow of project information

Joint meetings take place during the design development process of a GB in which team members try to solve each other's issues and resolve clashes in building services. Upon understanding the project requirements of a GB, the MEP consultants coordinate with the architect and iterative cycles of design activity are conducted before the design is finalised. Since non-GB projects may not require design optimisation for energy efficiency, the flow of project information in non-GB projects may not be as critical as for GB projects.

5.2.7. Documentation

GB projects as compared to non-GBs have more extensive documentation activity, often because of the third-party GB certifications. With a focus on GB certification in Australia (that is Green Star), an interview participant (AU-F-1) highlighted,

“Achieving Green Star rating is a documentation-based process and people need to demonstrate the sustainable design and operation of buildings. A lot of times, things are not documented, and they are just inside people's heads, so an effort is required to document what actually takes place in a project. This is all good practice, but it may not be done in case a project is not pursuing Green Star rating.”

The documentation process benefits a project in many ways. For instance, information can be passed on to the facility management team. In case the facility management team is changed, the building record can be transferred to the substitute team ensuring that the project information is preserved, and the operational performance of the project meets the aspirations.

5.2.8. Inspection, monitoring and control

During the stages of project inspection and monitoring, the conditions which differentiate GBs from non-GBs are the commissioning and tuning requirements, and the needs of excessive metering.

- **Commissioning and tuning requirements:** GBs as compared to conventional building projects have an increased focus on commissioning and tuning. Commissioning and tuning ensure the optimum performance of building systems in the project's operational stage. Commissioning is promoted in GBs through the requirements of GB certification systems as an interviewee (AU-F-5) indicated, “the sign off by an independent commissioning agent is something that was introduced by Green Star [in Australia]. Commissioning previously was focused on HVAC systems, but now it is being used for other systems as well.”

- **Monitoring and controlling operational performance of building:** GBs are different from non-GBs since they are focused towards monitoring and controlling of operational performance and for this purpose, they incorporate excessive metering. Such metering enables quick feedback for the building users regarding the use of energy and water. Metering is emphasised so much in GBs that in the GB certification systems some credit points are also awarded to buildings for extra metering.

5.2.9. Budget and delivery time requirements

GBs as compared to their traditional counterparts have special considerations towards socio-economic and environmental aspects of development. These considerations which distinguish GBs from non-GBs require additional time and budget. However, time and budget are not only the function of project sustainability but also depend on other conditions such as the timeliness of project activities.

5.2.10. Green Buildings as complex projects

The increased complexity in GB projects differentiates them from their traditional counterparts. The complexity of project development is itself attributable to mutually contradicting project deliverables, timeliness of project activities, and project design approach.

Green building projects are more complex than non-GBs as they involve a reasonably higher number of deliverables. An interview participant (UK-F-5) highlighted, “the level of green certification aspired for a GB project also matters as for a high level of certification, the requirements in terms of the delivery process are quite different. For instance, engagement of the project team, specialised MEP consultancy, etc.”

The deliverables and constraints (for example, cost and environmental performance) in GBs may be mutually contradictory depending on certain conditions. It is challenging to optimise mutually conflicting deliverables for achieving the desired project performance. Hence, the increase in GB development complexity is attributable to a higher number of design constraints and deliverables. As an interview participant (UK-M-7) said,

“The delivery of Green Building projects is complex in comparison to their traditional counterparts because more variables [liveability-related consideration, environment-related factors] need to be considered. When you have to build a Green Building, you have to consider many aspects other than just technical compliance. When you add more items into deliverables, it always makes it more complex.”

An example of the complexity in GBs is the often contradicting relationship between environmental and economic sustainability. Since environment-friendly building components often have higher capital costs, they associate negatively with economic sustainability. The complexity resulting from such contradictory relationships among project deliverables, render many design and development alternatives unfeasible and therefore require increased effort in developing project proposals which satisfy a number of deliverables. An Australia-based interview participant (AU-M-4) with experience of working on GBs as a design consultant, said, “in case of a commercial project, if you increase the wall thickness two folds to get better insulation, it would mean that the leasable floor area drops. So, it is paramount to keep things in balance, otherwise, it may affect the project’s feasibility. In designing a project, we are trying to find the golden mean.”

The complexity in GB development can also be a function of the project stage at which sustainability is considered in a project. If it is a part of the project from the onset, there is a high level of possible optimisation and the number of constraints for incorporating green aspects are far less as compared to a situation where a project is partially or fully developed. For instance, if the base structure of a building

has already been developed without considering sustainability, then the opportunity of appropriate building orientation and massing to reduce the operational energy use is already missed. Sustainability considerations at this stage may only be limited to the selection and sizing of the building systems which cannot offset the capital cost and energy savings otherwise possible.

It must be kept in consideration that the sustainable performance of a GB is not necessarily about the technical complexity of a building. While the delivery and development of a GB project may be complex, the final output, that is the GB itself, may not be complex in terms of its installed systems, technology and operations. Talking about this issue, an interviewee (UK-F-4) said,

“In principle, Green Buildings need not be complex. As realised from many research studies and case studies, buildings with good environmental performance can be achieved by simple techniques such as a better layout, thoughtful placement of windows, local material sourcing and thermal properties of the building structure. For compliance, LEED and BREEAM rating tools do not require highly complex systems.”

Although, a GB does not need to be a technically complex end-product, owing to its mutually contradicting objectives (that is realising environmental sustainability at low costs) the process of its development continues to be complex. The interview findings are also corroborated by Hawken, Lovins, and Lovins (2013, p. 98) who found that in terms of indoor environment quality and comfort, the systems used in some advanced buildings have low capital costs and surprisingly low energy use and noise accredited to the highly efficient fans and low-friction ducts they use. However, “most innovative buildings” use computational fluid dynamics and do not even require fans as those buildings are designed to passively and noiselessly move the air through them.

5.3. Associations among Differentiating conditions

Among the Differentiating conditions shown in Table 5-1, some core conditions also lead to other conditions. To understand these core Differentiating conditions, it is necessary to identify the associations among Differentiating conditions. For instance, high budget and delivery time requirement of GBs is a Differentiating condition. However, this condition is itself an effect of some other conditions such as design methodology. Interview findings have identified the associations among Differentiating conditions as shown in Figure 5-3.

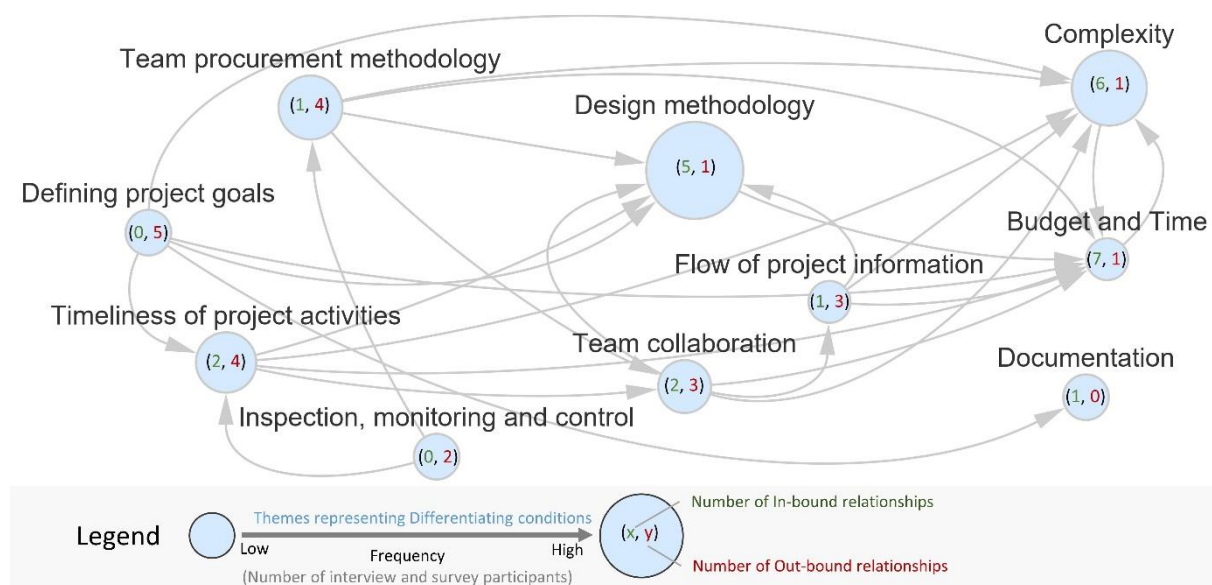


Figure 5-3: Associations among Differentiating conditions identified from interview findings

As the network (Figure 5-3) shows, 'timeliness of project activities', 'team procurement methodology', and 'defining project goals' are associated with 'design methodology', 'complexity', and 'budget and time.' Although, 'Complexity in project development' is highly cited by interviewees (n=10), the associations suggest that complexity is determined by other aspects. The 'timeliness of project activities' and 'defining project goals' may affect 'complexity' which may eventually affect 'budget and time' as an interviewee (AE-M-1) indicated,

"Sustainability in such projects should ideally be considered during early design stages and such a practice can help avoid the cost overruns and time delays in Green Building projects. In the case of early incorporation of sustainable aspects, there would be no technical complexity involved in Green Building projects. The project client should formulate the project brief and requirements such that instead of considering sustainability as an add-on project feature, it should be considered a part of the project to reduce the technical complexity."

These associations are also highlighted by another interview participant (AE-F-1),

"If a client decides to certify a building using green building standard and communicates it to the design team at a very early stage, it is easier and not complex to ensure sustainability implementation. However, in a lot of cases, this is not communicated to the team until it is too late. The design team then has to revise the design and amend it, increasing the complexity and cost."

The key associations among Differentiating conditions (Figure 5-3) suggest that conditions related to 'complexity', 'design methodology', as well as 'budget and time' are affected by conditions occurring in other themes such as 'team procurement methodology', 'timeliness of project activities', and 'defining project goals'. Procurement methodology, timeliness of activities, and defining goals can therefore be considered as the core aspects differentiating GBs from non-GBs. As shown in Figure 5-2, the effectiveness of 'timeliness of project activities', 'defining project goals', and 'team procurement methodology' is during the early project stages. 'Complexity' as well as 'Budget and Time' extend throughout the project development stages, however, the control of project team over these reduces as the project moves to later stages.

5.4. Discussion

Among Differentiating conditions, some explicitly account for sustainability in a project namely: 'setting of a detailed sustainability charter or brief', 'liaison between sustainability consultant and project team', 'engagement of sustainability consultant', 'engagement of sustainability consultant in selection of other team members', 'use of energy-oriented design approach', 'life-cycle based project development approach', and 'early engagement of sustainability consultant'. Apart from these conditions and the conditions related to budget, time, and complexity, all the other 25 conditions are about effective project development practices. In light of the above, it can be stated that GBs are different from non-GBs mainly because of the approaches highly necessary for their development. Data from some online survey responses (n=3) also reinforced the findings from 25 semi-structured interviews.

This also implies that in comparison to a non-GB, for a GB project the use of effective project development approaches is very critical. Since a GB is more likely to follow effective project development approaches, it can mean that a GB project may have a higher quality performance compared to a non-GB project. While these conditions can result in a good performance in non-GB projects, they may not be essential to achieve aspired outcomes in these projects. Contrary to this, these Differentiating conditions appear as indispensable for the development of GB projects.

A recurrent theme in the interviews was a sense amongst interviewees that the sustainability requirements which differentiate GBs from traditional buildings are not a sufficient reason for the construction industry to rationalise the need for radically different project development approaches for GBs. Based on this, it can be assumed that the construction industry will continue to use the existing project development approaches for GBs. For instance, similar to the non-GB projects, GBs are also developed using popular Project Delivery Methods in the construction industry (for example, Design-Build, Design-Bid-Build, and Construction Management at Risk). As an interview participant (SN-M-2) highlighted, “the contractual approach to be used in the project is not often decided on whether the building is to be green or not, it is decided based on project size.” According to another interview participant (AU-M-5), “any delivery method can be used for Green Building projects as long as the ecologically sustainable development requirements are contractually binding in both the head contract and all subcontracts.” There are no reported cases in reviewed literature and interview data which state that a GB project was developed based on a PDM especially designed for GBs. On the contrary, many studies have been conducted to explore the effectiveness of already existing PDMs for GB projects. A detailed discussion regarding this aspect is provided in a conference paper¹ authored by the researcher.

From the interview findings, it is realised that the construction industry professionals are more inclined to think of GBs as construction projects with sustainability requirements rather than thinking of them as sustainable development projects. Thinking of GBs as construction projects helps in their rapid adoption since the readily available project development approaches from the construction industry will drive the process of their development. However, considering GBs as construction projects also means that GBs inherit the constraints and challenges of a typical construction project such as loss of productivity and wastefulness of resources. On the contrary, in case construction industry professionals think of GBs as projects of sustainable development instead of construction, the paradigm shift can open many avenues of thought which can help achieve higher levels of sustainability potentials in GBs. As Albert Einstein said, “We cannot solve our problems with the same thinking we used when we created them.”

In this chapter, the conditions differentiating GBs from non-GBs are explained. These two types of projects occur at the extreme ends of the spectrum and there can be many variations of these projects in which the Differentiating conditions may not be much prominent. For instance, a non-GB project may be developed using a highly integrated design while a GB may not.

Some previous studies on GB project success have discussed differences between GBs and non-GBs. However, most of these observations are not based on research except the studies by Bon Gang Hwang and Leong (2013) and Bon Gang Hwang et al. (2016). Bon Gang Hwang and Leong (2013) provided a comparison of traditional and green projects in terms of delays in project development. Bon Gang Hwang et al. (2016) provided a comparison of traditional and green building construction projects in terms of the factors affecting productivity. Key observations from previous studies are identified as follows:

- **Project objectives:** In terms of project objectives, green buildings must accomplish additional goals in comparison to traditional buildings, namely energy, land, water, and material savings, as well as environmental friendliness (Bon Gang Hwang, Shan, & Supa’at, 2017).

¹ Ahmad, T., A. Aibinu, and A. Stephan, *Green Building Projects: Process Innovation Leading to Project Innovation*, in *33rd Annual ARCOM Conference*. 2017: Cambridge, UK

- **Material supply and availability:** Material supply and availability are more critical in green building construction projects compared to traditional building construction projects (Bon Gang Hwang & Leong, 2013; Bon Gang Hwang, Shan, Phua, & Chi, 2017).
- **Project complexity:** Compared to traditional buildings, green buildings encounter more complex problems during the construction process, and project managers are faced with greater challenges (Sang et al., 2018).
- **Integration and collaboration:** The application of sustainability principles in building construction projects adds to the complexity of these projects and thus a greater integration and collaboration among project team members is required as compared to traditional projects (D. R. Riley et al., 2004). According to Rohrer (2001), contrarily to the case of traditional buildings, the successful development of highly efficient GBs considerably depends on a closer interaction of users, professionals, and suppliers. This is because compared to traditional buildings, in GBs the variety of building components have much more complex and stronger mutual dependencies in functional terms. This consequently makes the GBs act like machines in certain ways.

The findings of previous studies corroborate the Differentiating conditions identified in this study. The comparison of the findings with those of other studies confirms that the differences between GBs and traditional buildings are mainly due to the increased complexity in GB projects.

5.5. Chapter Summary

In this chapter, 34 conditions differentiating GBs from non-GBs are identified based on the opinion of 25 interview participants. The identified conditions are grouped in 10 themes which are 'Budget and Time' (number of participants=1), 'Defining project goals' (n=2), 'Design methodology' (n=16), 'Documentation' (n=2), 'Flow of project information' (n=1), 'Inspection, monitoring and control' (n=2), 'Team collaboration' (n=4), 'Team procurement methodology' (n=7), 'Timeliness of project activities' (n=6), and 'Complexity' (n=10). The highest number of Differentiating conditions are related to 'design methodology' (that is 11) and 'team procurement methodology' (that is 5). The overall analysis of Differentiating conditions suggests that GBs are primarily different from non-GBs because of the effective project development approaches they require.

The associations among Differentiating conditions are analysed and these show that the conditions related to 'procurement methodology', 'timeliness of activities', and 'defining project goals' are the core aspects differentiating GBs from non-GBs. Conditions related to 'complexity', 'design methodology', as well as 'budget and time' are affected by conditions occurring in other themes such as 'team procurement methodology', 'timeliness of project activities', and 'defining project goals'.

This chapter has addressed the research question, that is '*How do sustainability requirements set Green Buildings apart from non-Green Buildings?*' But how do sustainability performance criteria and project management performance criteria interrelate in GB projects? and what are the Underlying conditions influencing the associations among the performance criteria? Chapter 6 will answer these questions, using data mainly from the online survey.

6. Associations among sustainability and project management performance criteria¹

This chapter addresses the following research question:

‘What are the associations between sustainability performance criteria and project management performance criteria in Green Building projects and which conditions control these associations?’

The chapter considers project management performance criteria (that is *cost, quality, and schedule performance*) and sustainability performance criteria (that is, *Environmental, Economic, and Social sustainability*). Sustainability is divided into its three common dimensions (that is, *Environmental, Economic, and Social sustainability*) as these dimensions help define sustainability, and also because previous studies have shown that the good performance in one dimension may not necessarily imply good performance in others.

The research question can be addressed by identifying the nature of associations (that is, positive, negative, and no relation) among performance criteria. Furthermore, the Underlying conditions resulting in performance criteria associations need to be addressed. This is because the associations (that is positive or negative) among performance criteria (for example, cost and sustainability) may vary under the influence of different Underlying conditions (for example, regional constraints and client’s vision). Accordingly, the objectives of this chapter are as follows:

- *To identify the associations among sustainability-related and project management-related performance criteria in Green Building projects; and*
- *To identify the Underlying conditions influencing the associations among sustainability-related and project management-related performance criteria.*

The structure of the chapter is such that Section 6.1 provides a brief overview of the research methodology and this is followed by the analysis of quantitative data (Section 6.2). The findings regarding associations among performance criteria are reported in Section 6.3 and the Underlying conditions affecting performance criteria associations are provided in Section 6.4. Finally, Section 6.5 provides a detailed discussion providing the interpretations, implications and limitations of research findings reported in this chapter.

6.1. Research methodology

The inquiry in this chapter is based on an explanatory mixed-method research approach to explore the associations among performance criteria and the Underlying conditions associated with those associations. In terms of the data collection methods, the findings were primarily informed by the online questionnaire survey. Findings from semi-structured interviews also supported and complemented survey findings. The research roadmap for the inquiry reported in this chapter is shown in Figure 6-1.

¹ This chapter is based on:

Ahmad, T., Aibinu, A. A., Stephan, A., & Chan, A. P. (2019). Investigating associations among performance criteria in Green Building projects. *Journal of Cleaner Production*, 232, 1348-1370.
doi:10.1016/j.jclepro.2019.06.013

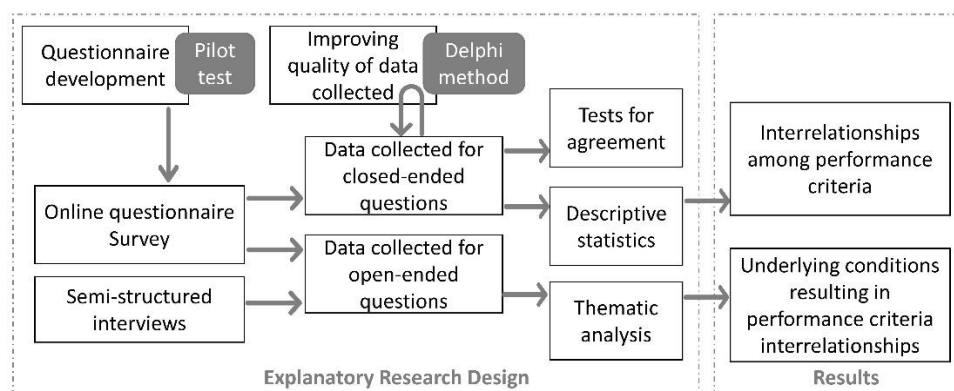


Figure 6-1: Research design to explain the interrelationships among performance criteria

The research inquiry reported in this chapter has two aspects (see Table 6-1). Firstly, determining the performance criteria associations, and secondly determining the Underlying conditions influencing those associations. For the first aspect of the inquiry, it was necessary to collect data from a considerably large sample of GB experts and to use closed-ended questions enabling statistical analysis. An internet survey was used as this approach enables collecting responses from regionally distributed experts within a relatively short duration of time and with minimum resource expenditure (Akbayrak, 2000). The second aspect of the inquiry, focussing on identifying the Underlying conditions responsible for performance criteria associations was addressed by both the questionnaire survey and in-depth interviews. Survey respondents were directed through the online questionnaire to first respond to the closed-ended question (that is criteria associations) and then to open-ended questions (that is reasons behind the associations).

Table 6-1: Questions to investigate performance criteria interrelationships in the online survey and semi-structured interviews

Aspect of inquiry	Question/Theme	Method	Respondents
Performance criteria associations	Question-1: In the closed-ended question, the respondents were asked to relate the performance criteria of green buildings. Respondents could select the effect of good performance in a criterion on other criteria as 'Highly Positive', 'Moderately Positive', 'Not related', 'Moderately Negative', or 'Highly Negative'. The survey respondents were asked to provide their opinion for the potential associations between 6 different performance criteria. Therefore, each respondent had to establish 30 different associations.	Online survey	104
Underlying conditions responsible for performance criteria associations	Question-2: In the open-ended question, the respondents were asked to highlight the conditions behind the associations between performance criteria of green building projects.	Online survey Semi-structured interviews	83 30

Even though the questionnaire survey method is efficient in inquiring the first aspect (Question-1), it is limiting when open-ended questions are used. This is because the researcher cannot actively assist the thought process of a respondent to transform mental constructs into explicitly stated information (Akbayrak, 2000). To compensate for this limitation, findings from in-depth interviews were also used to support and complement the findings from the open-ended questions in the questionnaire survey. The online survey taking up to 25 minutes to fill, was conducted prior to the interviews.

After the preliminary analysis of survey findings, the Delphi technique was used to control dispersion in the data. A detailed explanation regarding the online survey, semi-structured interviews and Delphi process is provided in Chapter 4, Section 4.4.

While most respondents (n=78) were design and sustainability consultants, the sample also had respondents belonging to six other roles in the construction industry. In terms of regional belonging, the respondents worked mainly in Australia (n=42), Singapore (n=18), India (n=16), and the United Arab

Emirates (UAE) (n=15). The demographics of the sample set played an important role in data analysis as it enabled a comparison of the agreement among survey responses (Section 6.2.2) based on geographical locations, professional roles, and experience. Furthermore, since the survey also included an exploratory open-ended question for identifying Underlying conditions affecting associations among performance criteria, a variety in the participants' demographics was found useful. This is because some conditions may have a stronger role in some regional contexts than in others. Furthermore, professionals with different role and experience of GBs can have a varying foci on the conditions being inquired. Hence, the identification of these conditions benefitted from the diversity in the professional and regional background of participants.

Apart from 7 telephone-based interviews, the remaining 23 interviews were conducted face-to-face. The convenience sample of interview participants (n=30) originates from Australia (n=12), Hong Kong (n=1), Pakistan (n=2), Singapore (n=3), the UK (n=10), and the UAE (n=2). A large number of these professionals have acted in the role of sustainability consultants (n=14) and design consultants (n=11) in GB projects. In terms of sampling, the interview participants did not participate in the survey. Hence their input could be used for supporting and complementing responses from survey participants.

6.2. Data Analysis

The quantitative data obtained from the online survey is quantitatively analysed for internal consistency, the agreement among findings, and to establish trends. First, the internal consistency of these data is checked by calculating the Cronbach alpha value. This is followed by conducting three tests of agreement on the data, including Fleiss' kappa (κ), Kendall's coefficient of concordance (W), and Chi-square. These tests are about determining the level of unanimity or agreement in the interpretation of performance criteria associations by survey participants. Lastly, a descriptive statistical analysis using Mean, Mode, Standard Deviation (SD), Inter Quartile Range (IQR), and Skewness functions is conducted to identify the trends in survey data. The descriptive analysis helped determine the prevalent associations (that is, positive, negative, and non-existent) among performance criteria.

6.2.1. Data consistency check

The survey responses obtained for the performance criteria associations were subjected to an internal consistency test. The Cronbach alpha (α) value for the results of Question-1 (highlighted in Section 6.1) was 0.9183. Since $\alpha \geq 0.9$ means 'excellent' internal consistency, the data from survey results can be regarded as internally consistent.

6.2.2. Tests for agreement among survey respondents

Determining agreement is necessary to highlight the level of unanimity in the interpretation of performance criteria associations by survey participants and for this purpose tests of agreement are conducted. Besides, the wide demographical distribution in the sample set (explained in Section 6.1), can highlight that GB professionals can be unanimous in their interpretation in case some level of agreement is observed among survey findings.

Three tests including Fleiss' kappa (κ), Kendall's coefficient of concordance (W), and Chi-square are used to measure the agreement and consistency of responses given by GB experts (n=104). While measuring the agreement among the overall sample, these tests also helped measure the agreement in responses from participants with different experience (Group 1-3), regional origins (Group 4-7), professional roles (Group 8-11), and response to open-ended questions (Group 12-13). The results of these tests are provided in Table 6-2.

Table 6-2: Test results of Fleiss' kappa, Kendall's coefficient of concordance, and Chi-square

		Kendall's W	Chi-Square	P-value (Chi Square Test)	Fleiss' kappa (κ)	Standard Error Kappa	P-value (Kappa test)	Agreement
	Total Sample (n=104)	0.134	404	0	0.054	0.001	0	Slight
Sample segregation based on experience	Group-1: Low level experience (n=40)	0.118	137	0	0.041	0.004	0	Slight
	Group-2: Medium level experience (n=33)	0.145	139	0	0.047	0.004	0	Slight
	Group-3: High level experience (n=31)	0.214	193	0	0.058	0.005	0	Fair
Sample segregation based on origin	Group-4: Pakistan and India (n=19)	0.126	70	0	0.027	0.008	0.0006	Slight
	Group-5: UAE (n=16)	0.17	79	0	0.035	0.01	0.0001	Slight
	Group-6: Singapore (n=18)	0.139	72	0	0.046	0.008	0	Slight
	Group-7: Australia (n=43)	0.258	322	0	0.085	0.003	0	Fair
Sample segregation based on role	Group-8: Design and Sustainability Consultants (n=42)	0.173	211	0	0.05	0.004	0	Slight
	Group-9: Design Consultants (n=11)	0.192	61	0.0004	0.034	0.016	0.0181	Slight
	Group-10: Project Managers (n=12)	0.129	45	0.0305	0.005	0.013	0	No agreement
	Group-11: Sustainability Consultants (n=25)	0.222	161	0	0.076	0.006	0	Fair
Sample segregation based on response to open-ended question	Group-12: Participants responding to open-ended question (n=83)	0.142	342	0	0.054	0.001	0	Slight
	Group-13: Participants not responding to open-ended question (n=21)	0.139	84.5	0	0.055	0.007	0	Slight

Note: 'Outcome' in the last column is the level of agreement based on Kendall's W and Fleiss' kappa (κ) test
For chi-square statistic Degree of freedom (Df) is 29

Kappa which ranges from -1 to $+1$, measures the degree of agreement of the nominal or ordinal assessments made by multiple appraisers when assessing the same samples. A Kappa value of ' 1 ' reveals a perfect agreement and a value of ' 0 ' means a chance agreement. For the ordinal data, Kendall's coefficient of concordance is often used in addition to kappa statistics. Since the data of the online survey are of ordinal nature, Kendall's coefficient of concordance is also measured. An aspect which differentiates the two tests is that Kappa statistics represent an 'absolute agreement' between ratings while Kendall's coefficients measure the 'associations' between ratings. Kendall's concordance (W) is a non-parametric statistic measuring the agreement among several judges that are assessing a set of n objects of interest ("Encyclopedia of Research Design," 2010). The value of W ranges from 0 to 1. A high level of agreement among respondents results in a W value closer to 1; a lack of agreement, however, means a W value closer to 0. While conducting this test, the null hypothesis (H_0) is that no agreement exists among the responses given by respondents. With W value at low significance ($p \leq 0.001$), the null hypothesis can be rejected (Benjamin et al., 2018), implying that a degree of consensus exists among the responses from respondents. In determining the significance of observed W value, Chi-square provides an approximate distribution with $N-1$ degrees of freedom. Since Kendall's coefficient of concordance and Kappa value of $+1$ respond to a perfect agreement, while using a relative scale in this inquiry, the agreement is considered 'slight' for $W=0.118-0.192$ and $\kappa=0.027-0.055$, and considered 'fair' for $W=0.193-0.258$ and $\kappa=0.056-0.085$.

Based on Kendall's W and Fleiss' kappa (κ) tests, the highest agreement among the respondents exist in case of Group-7 comprised of GB experts from Australia ($W=0.258$; $\kappa=0.085$); Group-11 comprised of sustainability consultants ($W=0.222$; $\kappa=0.076$); and Group-3 comprised of high-level experience ($W=0.214$; $\kappa=0.058$). Hence, it can be concluded that participants who are sustainability consultants

(Group-11), have a high-level of experience (Group-3), or are based in Australia (Group-7) have a high level of agreement in their interpretation of performance criteria associations. The least agreement exists among Group-4 comprised of GB experts from Pakistan and India ($W=0.126$; $\kappa=0.027$). For Group-10 (that is Project Managers), as shown in Table 6-2, the P-value is 0.0305 and therefore the null hypothesis is accepted: an agreement does not exist among the respondents.

In case of Groups 1 to 3, it can be observed that there is a stronger agreement among Group-3 participants ($W=0.214$; $\kappa=0.058$) with a high-level of experience compared to Group-2 participants ($W=0.145$; $\kappa=0.047$) with a medium-level of experience. Group-2 itself has a stronger agreement compared to Group-1 participants ($W=0.118$; $\kappa=0.041$) with a low-level of experience. This implies that with the increase in experience of developing GBs, the perception of different GB experts regarding performance criteria associations begins to converge.

For Groups 4 to 7, it can be observed that the participants from Asian countries (such as UAE, Singapore, Pakistan, and India) have a notably lower level of agreement compared to Australia-based participants. This points to the possibility that the perception of GB experts regarding performance criteria associations is a function of the regional context. Many regional aspects, such as industry norms and GB-related awareness, can influence the perception of GB experts. Yet, a detailed discussion on this matter is beyond the scope of this study.

In the case of Groups 8 to 11, sustainability consultants have a relatively stronger level of internal agreement compared to other professionals. This can be because the professional role of sustainability consultants usually requires a focus on sustainability, while design consultants and project managers work on a diverse set of projects which include GBs as well as non-GBs.

The comparison of the level of agreement of participants from Group-12 ($W=0.142$; $\kappa=0.054$) and Group-13 ($W=0.139$; $\kappa=0.055$) showed that the participants responding to only closed-ended questions and the participants responding to both the open-ended and closed-ended questions in the survey had a similar level of agreement among themselves. This means that to some extent, the commitment of participants in responding to survey influences their response in the survey.

6.2.3. Descriptive statistics

A descriptive statistical analysis using Mean, Mode, Standard Deviation (SD), Inter Quartile Range (IQR), and Skewness functions is conducted (shown in Table 6-3), to identify the trends in survey data. In essence, it helped determine the prevalent associations (that is, positive, negative, and non-existent) among performance criteria (reported in Section 6.3). Positive and negative association imply that the higher level of performance in a criterion is likely to be associated with a higher and lower level of performance in another criterion, respectively. Since the data were originally of the ordinal nature, for conducting the statistical analysis, they were converted into numerical values. To avoid the issues related with potential misinterpretation of data while converting them from ordinal to numerical values, positive associations are given the same value (that is, Highly positive=1 and Moderately positive=1), and negative associations are also treated equally (that is, Moderately negative=-1 and Highly negative=-1). 'No effect' is assigned a '0' value. Assigning these values is useful as the objective is to determine the types of associations instead of the intensity of associations.

Table 6-3: Descriptive statistical analysis of performance criteria associations in Green Building projects

Cases	Mean	Mode	SD	IQR	Skewness	Association
'Environmental Sustainability' affecting 'Economic Sustainability'	0.394	1	0.84	1	-0.86	Positive
'Environmental Sustainability' affecting 'Social Sustainability'	0.76	1	0.6	0	-2.34	Positive
'Environmental Sustainability' affecting 'Quality'	0.462	1	0.77	1	-1.02	Positive
'Environmental Sustainability' affecting 'Cost'	0.154	1	0.89	2	-0.31	Positive
'Social Sustainability' affecting 'Environmental Sustainability'	0.683	1	0.63	0	-1.81	Positive
'Social Sustainability' affecting 'Economic Sustainability'	0.596	1	0.7	1	-1.46	Positive
'Social Sustainability' affecting 'Quality'	0.692	1	0.5	1	-1.3	Positive
'Social Sustainability' affecting 'Cost'	0.115	1	0.86	2	-0.23	Positive
'Economic Sustainability' affecting 'Environmental Sustainability'	0.721	1	0.57	0	-1.93	Positive
'Economic Sustainability' affecting 'Social Sustainability'	0.519	1	0.67	1	-1.07	Positive
'Economic Sustainability' affecting 'Quality'	0.5	1	0.7	1	-1.05	Positive
'Economic Sustainability' affecting 'Cost'	0.442	1	0.79	1	-0.97	Positive
'Cost' affecting 'Schedule'	0.202	1	0.81	1	-0.39	Positive
'Cost' affecting 'Economic Sustainability'	0.26	1	0.87	2	-0.53	Positive
'Schedule' affecting 'Cost'	0.404	1	0.82	1	-0.87	Positive
'Quality' affecting 'Social Sustainability'	0.577	1	0.62	1	-1.18	Positive
'Quality' affecting 'Economic Sustainability'	0.519	1	0.7	1	-1.12	Positive
'Quality' affecting 'Environmental Sustainability'	0.702	1	0.57	0	-1.8	Positive
'Social Sustainability' affecting 'Schedule'	0.019	0	0.65	0	-0.02	No effect
'Economic Sustainability' affecting 'Schedule'	0.096	0	0.7	1	-0.14	No effect
'Schedule' affecting 'Social Sustainability'	0.077	0	0.66	1	-0.09	No effect
'Schedule' affecting 'Environmental Sustainability'	0.039	0	0.74	1.75	-0.06	No effect
'Environmental Sustainability' affecting 'Schedule'	0.25	1	0.77	1	-0.47	Unclear
'Cost' affecting 'Quality'	0.096	1	0.91	2	-0.19	Unclear
'Cost' affecting 'Social Sustainability'	-0.048	-1	0.82	2	0.09	Unclear
'Cost' affecting 'Environmental Sustainability'	0.077	1	0.84	2	-0.15	Unclear
'Schedule' affecting 'Quality'	0.039	0, 1	0.81	2	-0.07	Unclear
'Schedule' affecting 'Economic Sustainability'	0.24	0, 1	0.73	1	-0.41	Unclear
'Quality' affecting 'Schedule'	-0.087	-1	0.83	2	0.16	Unclear
'Quality' affecting 'Cost'	-0.077	-1	0.89	2	0.15	Unclear

Note: SD=Standard Deviation; IQR=Interquartile Range

While responding to Question-1 in the online survey, each participant opted for 30 associations among 6 performance criteria. Table 6-3 presents the statistical data analysis for each case. The arithmetic mean values for the survey data suggest that the cases in which the mean values are closer to 0, either a majority of respondents have opted for the 'no effect' option (that is '0') or the majority had a similar distribution for both the positive and the negative associations. For instance, for 'Schedule Performance affecting Quality Performance', the low mean value (that is 0.039) is due to a similar number of respondents opting for both the positive (n=34%) and negative associations (n=31%). Similarly, for 'Social Sustainability Performance affecting Schedule Performance', the low mean value (that is 0.019) means a high number of participants (n=58%) opted for the 'no effect' option (that is '0'), while the number of participants opting for positive (n=22%) and negative associations (n=20%) is both relatively small (n=44%) and similar.

In Table 6-3, a negative skewness value suggests a relatively higher number of respondents opting for 'no effect' or positive associations. While a positive skewness value suggests a relatively higher number of respondents opting for 'no effect' or negative associations. Within the survey data, only 3 cases of positive skewness are identified while the remaining 27 cases reveal negative skewness which means that most participants have indicated positive associations among performance criteria. For the survey data, the mode value of 1, -1, and 0 indicates that the most appearing associations in a case are positive, negative, and non-existing respectively. Within the overall 30 associations studied, three cases have a value of -1, four cases have a value of 0, and two have both the 0 and 1 value. The remaining 21 cases have a value of 1 which indicates that most associations assigned are positive in nature.

For the survey data, a low Standard Deviation (SD) value indicates that a large number of respondents have opted for 'no effect' along with one of the two associations, that is 'positive' or 'negative'. A high SD value indicates that a similar number of participants have opted for both the positive and the negative associations. In terms of Interquartile Range (IQR), three values mainly occurring in the survey dataset are 0 (n=5), 1 (n=15), and 2 (n=9). The '0' IQR value means that at least 50% of respondents in a case have opted for a positive association. The '1' IQR value means that at least 50% of respondents in a case have opted for a positive association or no association. The '2' IQR value means that many respondents have opted for both the positive as well as negative association, which means that the results in such cases are inconclusive.

Based on the mixed responses from survey participants, performance criteria associations can only be meaningfully presented by reporting the trends. The statistical analysis of the dataset has helped highlight trends reported in the 'Outcome' column in Table 6-3. Along with the use of statistical operations, the identification of trends is also based on the two conditional checks especially developed to suit the survey data.

1. According to the first check, if more than or equal to 40% of participants are inclined towards a certain association (that is, 'positive', 'no effect', or 'negative') between two performance criteria, it is considered a trend. This check was selected based on the fact that 40% value is sufficiently larger than 33%, which stands for a split opinion, that is an equal distribution of participants for positive, negative and no relationship, or 33% each. However, the use of this criterion alone may still not result in conclusive trends, as a similar number of participants may have opined for two competing associations (that is both positive and negative associations).
2. To mitigate the limitation of the first check, a second check is performed, according to which there needs to be a considerable difference ($n > 10\%$) between the highest-selected association and the second-highest association. For instance, the positive associations between 'environmental sustainability' and 'cost performance' is recognised as a trend based on the two principles. First, a high number of participants (n=48%) have selected the positive association. Second, the number of participants opting for the positive association is notably high (n=15%) as compared to the number of participants (n=33%) opting for the negative association. Figure 6-2 provides a visualisation of the trend analysis. With these rules of analysis, 22 out of the overall 30 associations are found to have clear trends (as shown in Figure 6-2), however, for the remaining 8 associations, no clear trends could be found.

6.3. Associations among performance criteria

This section addresses the chapter objective, '*to identify the associations among sustainability-related and project management-related performance criteria in GB projects*'. Figure 6-2 and Appendix C (Section C.1) present the overall findings of the survey question related to the performance criteria associations. From the overall participants (n=104), 83 participants (Group-A) responded to both open-ended and closed-ended questions, while 21 participants (Group-B) responded to only the closed-ended questions. The response of both these groups of participants for the closed-ended question is shown in Figure 6-2. A notable difference in responses of these two groups is observed in case of 8 associations, including the effect of quality on cost, the effect of schedule on quality, the effect of cost on quality and social sustainability, the effect of environmental sustainability on schedule and economic sustainability, and the effect of economic sustainability and social sustainability on quality.

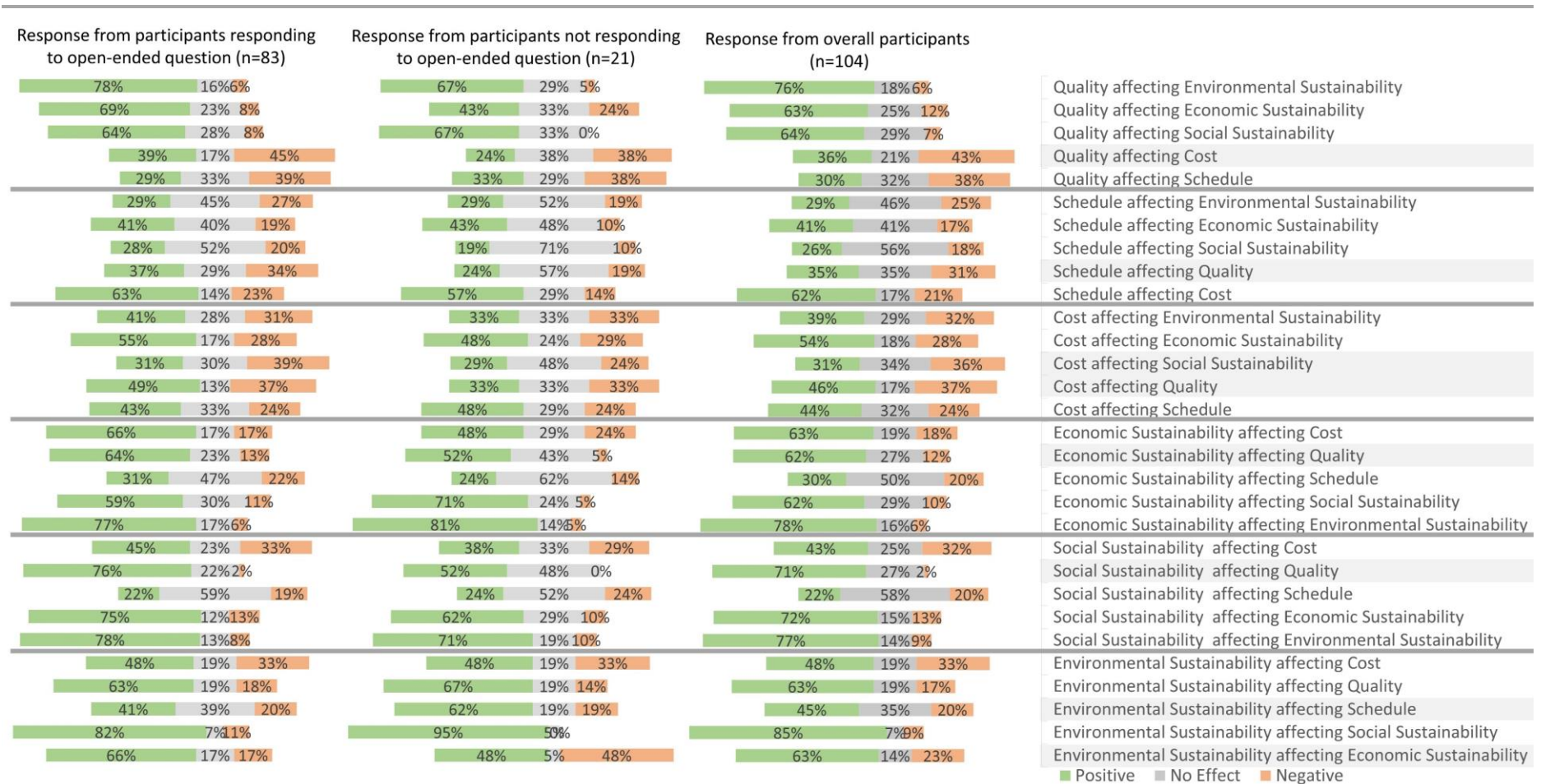


Figure 6-2: Associations between Green Building performance criteria based on survey findings

Upon conducting the descriptive statistical analysis (shown in Table 6-3), the identified trends are shown in Figure 6-3, which is divided into Part-1 and 2 to exhibit the cases of positive and no associations among the performance criteria, respectively.

Positive associations: Positive associations imply that good performance in one criterion leads to a good performance in another criterion. As shown in Part-1 (Figure 6-3), sustainability performance has a positive influence on quality performance and *vice versa*. Interview participants (PK-M-2; UK-M-5; UK-F-1) also corroborated that sustainability and quality performance go hand in hand. The mutually positive associations of quality performance with cost and schedule performance have not been reported in the survey. Cost and schedule performance are reported to be positively associated. Further, cost performance is identified to have a positive effect on economic sustainability. As an interviewee (UK-F-6) mentioned, “schedule and cost are like siblings, if you increase one the other also increases.” It is important to note that the positive effects of cost and schedule performance on social and environmental sustainability have not been identified as trends.

All three sustainability dimensions are reported in the survey to have a mutually positive association among each other. While it may appear that environmental sustainability is achieved at a higher cost, it has a positive effect on economic sustainability. According to an interviewee (AU-M-7), “in the short-term achieving sustainability may seem to cost more as the technology is better and complex. The client, however, will benefit in the long term from the savings. Generally, as the cost goes up, the quality also gets better.”

No associations: No associations imply that good performance in one criterion does not lead to a good or bad performance in another criterion. As shown in Part-2 (Figure 6-3), survey participants are of the view that the associations between schedule and sustainability performance criteria do not exist. Although a direct association between sustainability and schedule performance is not highlighted, the existence of indirect associations between these performance criteria is indicated by interview participants. According to interviewees *UK-F-1* and *AU-F-4*, only in the adequately managed and well-planned projects can sustainability performance be achieved without affecting schedule performance. Interviewee *UK-M-1* flagged that schedule performance affects sustainability performance when project schedules are not developed in consultation with sustainability consultants. This highlights that even though direct associations may not seem to exist among some performance criteria, these associations may become prominent in case of unsuitable project conditions.

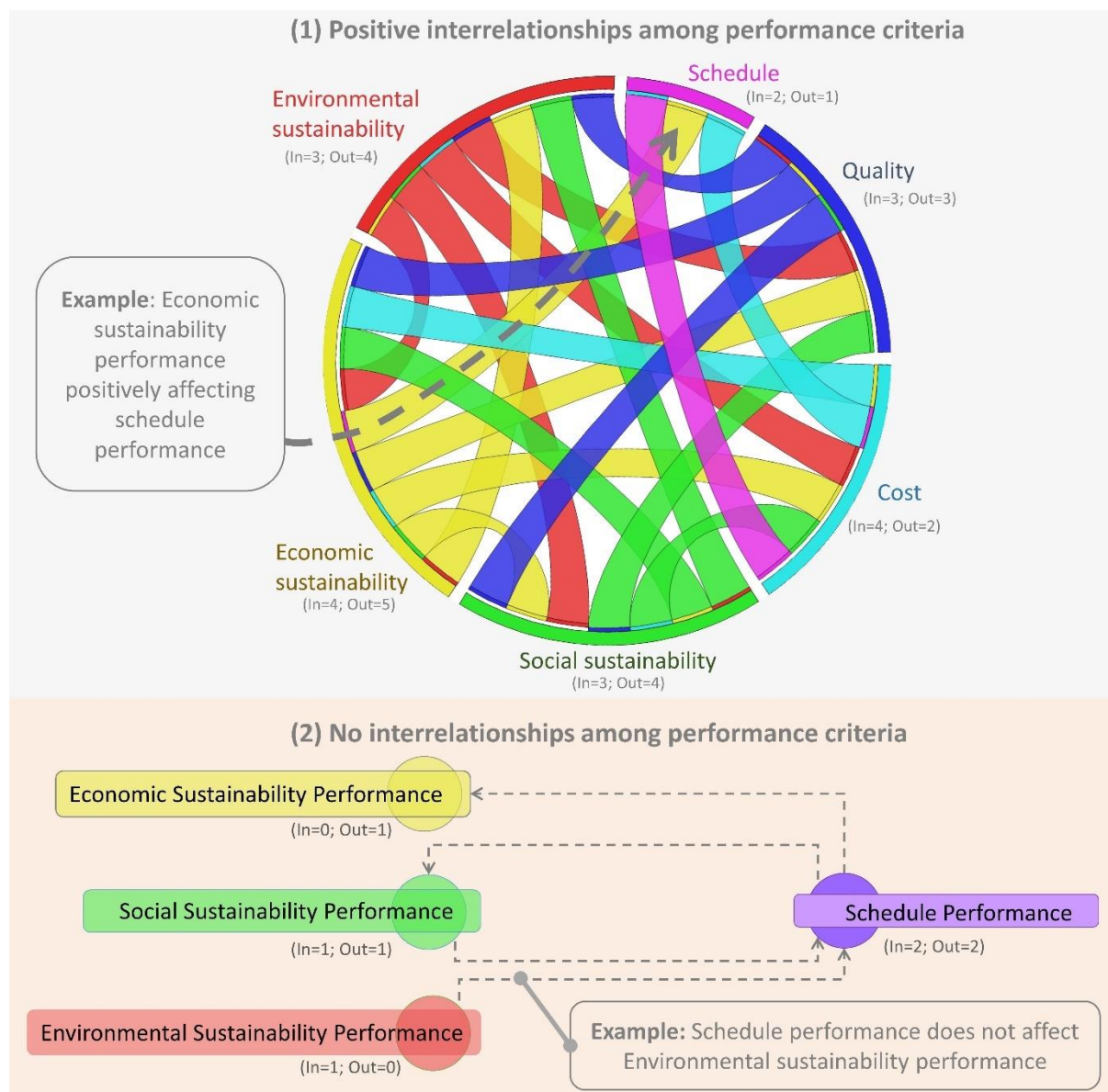


Figure 6-3: Clear trends of associations between performance criteria

Unclear associations: It is necessary to also provide an account of unclear trends in performance criteria associations. All three types of associations (that is, positive, negative, and no effect) have been highlighted in case of some performance criteria. For instance,

- 'Cost performance' may either have a positive, negative, or no effect on 'environmental sustainability' and 'social sustainability'.
- 'Quality performance' may either have a positive, negative, or no effect on 'schedule performance' and *vice versa*.

Both the positive and negative associations have been highlighted in case of cost and quality performance.

- 'Quality performance' may either have a positive or a negative association with 'cost performance' and *vice versa*.

Both the 'positive' and 'no effect' have been highlighted as associations in case of economic sustainability, environmental sustainability, and schedule performance.

- 'Schedule performance' may either have a positive effect or no effect on 'economic sustainability'.
- 'Environmental sustainability' may either have a positive effect or no effect on 'schedule performance'.

The mixed responses and associated unclear trends exist mostly for project management-related performance criteria but not for sustainability performance criteria.

6.4. Conditions affecting performance criteria associations

This section responds to the chapter objective, that is '*to identify the Underlying conditions influencing the associations among sustainability-related and project management-related performance criteria.*' Upon conducting a qualitative analysis of the survey responses to the open-ended question (that is Question-2), 56 Underlying conditions affecting associations among performance criteria were identified. In conceptual terms, some of the closely related conditions were grouped together and represented by 37 conditions shown in Table 6-4. The originally identified conditions and their representative conditions are shown in Appendix C (Section C.2). These 37 representative conditions have been further grouped into 11 theme areas. Effects of conditions on each other and on performance criteria are shown in Table 6-4. Conditions occurring in rows affect conditions or performance criteria occurring in columns. The associations among performance criteria and the Underlying conditions are provided in a network diagram (Figure 6-4). The network not only shows the associations of different Underlying conditions with performance criteria but also the mutual associations among different conditions.

Some of the identified conditions are directly linked with the performance criteria. However, other conditions such as 'Focus on the capital cost of the project', have a direct as well as an indirect association with performance criteria. The indirect association occurs as 'Focus on the capital cost of the project' results in 'reworking because of poor workmanship', 'system and material selection', and 'inappropriately conducted value engineering exercises'. These conditions in-turn affect performance criteria, therefore carrying the indirect effect of 'Focus on the capital cost of the project'. The Underlying conditions having indirect and direct effects on performance criteria are as follows:

- 'Adequate time allocation for project development' and 'early incorporation of sustainability in project' affect 'use of integrated design approach'
- 'Use of integrated design approach', 'involvement of project team in defining project requirements', 'use of clearly defined and standardised approaches for GB development', and 'early incorporation of sustainability in project' affect 'project team's understanding of project goals and aspirations'
- 'Setting of a detailed sustainability charter or brief' and 'using appropriate project delivery method' affect 'adequate time allocation for project development'
- 'Using appropriate PDM' affects 'adequate allocation of project budget'
- 'Monitoring of project development' affects 'Execution of sustainable design during construction'.
- 'Rigour of project design development' can affect 'Use of energy-oriented design methodology'. Rigour implies that the fundamentals are considered as a project is developed. In case the fundamental design aspects are correctly executed in a project, an energy-efficient design can be achieved with ease. According to an interviewee (SN-M-11), "to us, the design of such [GB] projects appears very natural. When we are developing the building design, we are already considering the orientation and the context of the building. We are definitely working on the concept designs which can reduce the building's energy use, and all of this is very fundamental."
- 'Complexity in design' affects 'Suitability of the project design for execution'. This is because a simplistic design is relatively easier to execute.

- 'Considerations towards potential building occupants' can result in 'Life-cycle based project development approach'. In case the Facility Management professionals are involved in the project development process they can guide a design consultant in the design of building systems and the selection of materials which may require lower maintenance.
- 'Focus on the capital cost of the project' affects 'Value Engineering exercise'. For GB projects, a high focus on reducing project costs can result in a value engineering exercise which may adversely affect the incorporation of sustainable features.
- 'Preferences in contractor's engagement' affects 'access to sustainable building materials'. In case an experienced contractor is brought on-board early in a project, s/he can suggest the design consultants about easily available building materials.

'System and material selection' is an Underlying condition which affects all six performance criteria. Some conditions affecting all three sustainability criteria include 'monitoring and controlling operational performance of building', 'life-cycle based project development approach', and 'value engineering exercise'. Some conditions (n=15) have a direct association with only one out of six performance criteria and a significant number of conditions (n=21) directly associate with multiple performance criteria. There are 11 conditions highlighted which affect the overall project performance. Most conditions have been associated with economic sustainability (n=18) and schedule (n=15) while less have been associated with cost performance (n=7). It is important to flag that the six performance criteria used in this inquiry contribute towards overall project performance, but the overall project performance is not limited to the six performance criteria only. This aspect is discussed in detail in Chapter 7.

Table 6-4: Associations of Underlying conditions with performance criteria

Theme	Identified conditions	Adequate allocation of project budget	Access to sustainable building materials	Life-cycle based project development approach	Suitability of the project design for execution	Use of energy-oriented design methodology	Execution of sustainable design during construction	Adequate time allocation for project development	Project team's understanding of project goals and aspirations	Rework because of poor workmanship	System and material selection	Use of integrated design approach	Value Engineering exercise	Cost performance	Quality performance	Schedule performance	Economic sustainability performance	Environmental sustainability performance	Social sustainability performance	Overall project performance
Building maintenance	Monitoring and controlling operational performance of building																x	x	x	
	Quality of maintenance																x			
Constraints	Access to sustainable building materials															x				x
	Material delivery time															x				
	Regional climate																x	x	x	
	Innovation in building industry																x	x	x	
Preferences towards different objectives in project development	Preferences in contractor's engagement		x												x					x
	Focus on the capital cost of the project									x	x		x			x		x		
	Focus on reducing operational costs																	x	x	
	Team working on project with value management mindset															x				x
	Considerations towards potential building occupants			x															x	
Project design approach	Complexity in design				x									x		x				
	Life-cycle based project development approach																x	x	x	
	Rigour of project design development					x											x		x	x
	Suitability of the project design for execution																			x
	System and material selection													x	x	x	x	x	x	
	Use of energy-oriented design methodology																x			
	Use of integrated design approach								x										x	x
Project planning approach	Adequate allocation of project budget													x	x					
	Adequate time allocation for project development											x				x				x
	Early incorporation of sustainability in project								x			x				x	x			
	Attention towards details															x				

An inquiry of conditions and criteria associated with Green Building project success

Theme	Identified conditions	Adequate allocation of project budget	Access to sustainable building materials	Life-cycle based project development approach	Suitability of the project design for execution	Use of energy-oriented design methodology	Execution of sustainable design during construction	Adequate time allocation for project development	Project team's understanding of project goals and aspirations	Rework because of poor workmanship	System and material selection	Use of integrated design approach	Value Engineering exercise	Cost performance	Quality performance	Schedule performance	Economic sustainability performance	Environmental sustainability performance	Social sustainability performance	Overall project performance
	Use of buffers and contingencies in project planning													x		x	x	x		
Realisation of design intent during construction and hand-over	Execution of commissioning and fine-tuning														x	x	x	x		x
	Execution of sustainable design during construction														x					
	Monitoring of project development						x								x		x			x
Defining and understanding project aspirations	Setting of a detailed sustainability charter or brief							x									x	x	x	
	Sustainability brief aligned with project budget													x						x
	Involvement of project team in defining project requirements								x							x				
	Project team's understanding of project goals and aspirations														x					
	Use of clearly defined and standardised approaches for GB development								x						x		x	x	x	
Project control and management	Value Engineering exercise																x	x	x	
	Rework because of poor workmanship													x						
	Proficiency of Project Management team													x	x	x	x	x	x	
Project delivery method	Using appropriate project delivery method	x			x			x	x			x				x	x			x
Client's vision and motivation	Client's commitment towards sustainable outcomes														x			x	x	
Project requirements	High consultation requirements															x	x			x
Sum		1	1	1	2	1	1	2	5	1	1	3	1	7	10	15	18	14	14	12

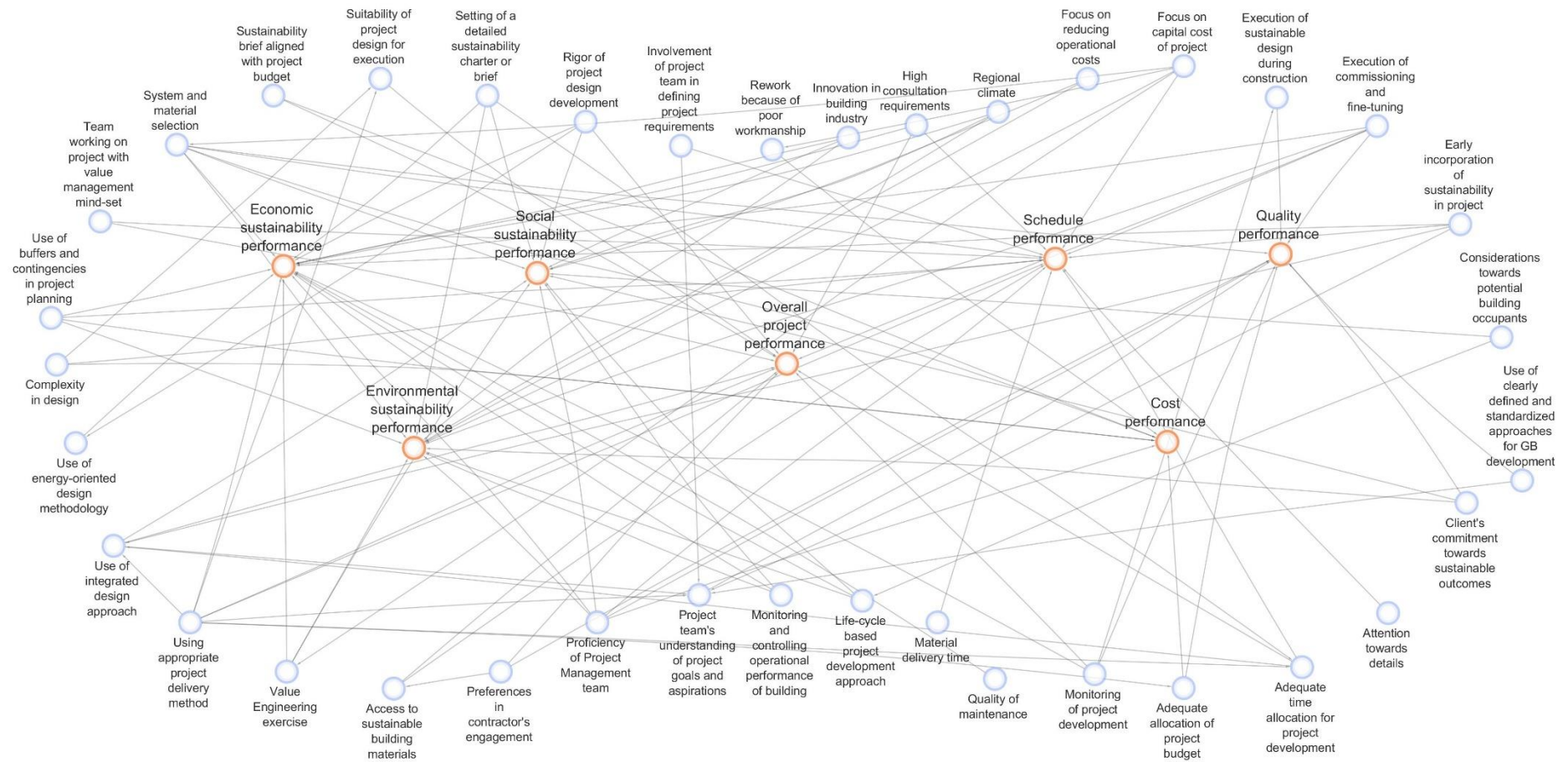


Figure 6-4: Interrelationships among Green Building performance criteria and the associated Underlying conditions

Survey participants have emphasised some Underlying conditions by providing detailed discussions to contextualise these conditions. These findings are also verified by the semi-structured interviews. Important conditions are discussed in detail in this section.

6.4.1. Regional constraints

Some conditions specific to the regional contexts of GB projects can affect the associations among performance criteria in GBs. According to survey participants, these conditions include ‘limited tenders on sustainable materials’, ‘local sourcing of materials’, and ‘non-standard materials, practices, and requirements’. These conditions highlight that the ease of developing GBs can vary from region to region.

6.4.1.1. Regional climate

Regional climatic constraints can pose limits for the sustainability performance of building projects and can affect the associations among sustainability performance criteria. According to some survey participants, high indoor air quality requires high ventilation rates. Increases in outside air rates over the required statutory regulations because of social sustainability requirements (such as occupants’ health considerations) leads to an increase in plant capacity to treat the additional fresh air volumes. Whilst heat exchange may be used to reduce energy requirements, it is not always efficient at treating latent heat energy. In case the climate allows economy cycle operation for substantial periods of the year, the increase in ventilation rates do not result in increased Life-Cycle Cost (LCC) or environmental degradation. On the contrary, for climates unsuitable for ventilation, realising high indoor air quality costs more and becomes a hindrance in achieving low emissions target; therefore resulting in a higher LCC. This example reveals how regional climatic conditions can have a considerable effect on the associations among sustainability performance criteria.

In terms of ‘regional constraints’, previous studies have considered the geography and climatic conditions as success factors (Iluah et al., 2014). The limited supply of sustainable materials and products have been considered as barriers to GB development (Ahn et al., 2013; Dalibi et al., 2017).

6.4.2. Life-cycle perspective

Life-cycle perspective is an important aspect during the development of a GB project. According to survey participants, both the economic and environmental sustainability highly rely on the life-cycle approach which in turn benefits a project in terms of other performance criteria. Economic sustainability requires a holistic life-cycle approach and long term thinking in the design process which also leads to stronger environmental results, subsequently affecting social sustainability performance in a positive way. Furthermore, a focus on environmental sustainability also brings about long-term considerations with effective solutions for a project, therefore increasing the performance of other criteria. Whether the project sustainability is driven by economic or environmental aspirations, the holistic life-cycle approach is an outcome, which positively affects both sustainability and quality performance. Previous studies have also emphasised the use of a life-cycle perspective for GB development (Qin, Mo, & Jing, 2016; Sourani, 2011).

6.4.3. Vision and motivation of the client

Since the performance of a project across different criteria is mainly achieved by meeting pre-set goals, the vision of clients about these goals and their motivation to pursue them can have much importance in determining performance criteria associations. Projects in which clients are willing to pay for sustainability may also perform well in other performance criteria. According to survey participants, owners opting for higher environmental sustainability targets and mandates, generally “spend more

effort in getting things right”, which automatically improves quality due to “greater scrutiny and ownership”.

In case the project clients have clear goals, visions and priorities, the project team can easily follow these. However, when lacking clear goals, the team may not know which criteria to focus on and this can subsequently result in conflicts among performance criteria. As a British interview participant (UK-M-7) put it,

“The interactions among sustainability dimensions depend upon the drivers of the job and the client’s involvement. When the client’s intentions and vision are not clear and aligned, then the dimensions contradict each other. With a clear vision, the dimensions strengthen each other. The approach to deliver the outcome matters a lot in deciding how the dimensions would interact because if the approach is right, the outcome would get delivered in the right way.”

As the client’s motivation for sustainability is a critically important factor for project performance, a major hindrance for sustainability performance is created in case of a client’s financial, cost-driven mentality, and the points pursuing approach for GB accreditation. Often the drivers of GB development are from the regional governments or the market and therefore the developers/clients are interested in pursuing the bare minimum of the sustainability requirements which can make the building inhabitable and help achieve a substantial return on investment.

According to survey participants, most GBs exist due to the prestige that comes with attaining a high level of GB certification. Most owners want to do just the bare minimum to achieve a certification or incentive, rather than the holistic goal of environmental sustainability. Although the mindset is slowly changing, there is still a long way to go. While presenting the scenario of a GB development, a survey participant stated that a client would have a meeting with the architect and the builder, and as a result, a “Grand Sustainability Plan” originates. The associated cost is then calculated, and the client would review the budget and ask, ‘what can I afford’ and ‘when will it pay back the investment?’ If the design team can reduce outgoings, cram more people into the same space such as a hot desk environment, and embellish the project with green certification, then the client would usually approve the revised design. “It is all about the money. They often spend as little as they can to get the green certification and use the visible external gestures to proclaim how ‘green’ their building is.”

Clients who aspire for sustainable outcomes not exclusively for regulations and higher profit may be willing to leave more cost and time contingency for meeting sustainability requirements. However, the clients primarily driven by the economics of project development may take initiatives resulting in the reduced sustainability performance of a GB project. An interview participant (UK-M-4) compared two types of clients and stated:

“A client or developer often always likes to put a price tag on a project. However, the people who believe in making the planet a better place intend to put more effort into their projects from this perspective rather than from the monetary perspective. The problem with today’s world is to quantify everything and to show added value and this is not easy. So, the reason it is more expensive to build a Green Building is that a client can always find someone who can build a building in a cheaper way while compromising some intangible values. There is always a cheaper way to build a bad building.”

Regarding ‘client’s vision and motivation’, some studies have emphasised the commitment and involvement of clients in GB projects (Bakar et al., 2009; Enache-Pommer & Horman, 2009; Olanipekun et al., 2018; Ruparathna & Hewage, 2015b). Other studies have also highlighted the importance of the

owner's ability in defining project scope and making decisions (Gultekin et al., 2013; S. Korkmaz et al., 2011; Molenaar et al., 2009).

6.4.4. Rigour of the project development process

Compared to traditional building projects, the different project development processes in GBs are given more attention and are more rigorously performed, which results in increased performance on different criteria. According to survey participants, because of the better design, installation, commissioning and tuning resulting from environmentally sustainable development, social sustainability performance is also positively affected in GBs.

Regarding 'rigour of project development process', some studies have emphasised the use of good design practices in GB projects (Attia et al., 2017; Qin et al., 2016; Worzala & Bond, 2011). Integrated design approaches and integrated work environment in GB development have also been emphasised (Ahn et al., 2013; Council, 2011; B. Li & Yao, 2012; Swarup et al., 2011). The importance of constructability of designs has also been highlighted (Qin et al., 2016). Furthermore, the important role of the commissioning process in GBs has also been discussed (Enache-Pommer & Horman, 2009; Kantola & Saari, 2016).

6.4.4.1. Integrated design approach

The integrated design results in more value for individual building features. Consequently, an integrated and holistic design approach can substantially affect the associations among performance criteria by helping achieve different performance goals in an optimised way. While each design component will have multiple functions, it will become difficult to eliminate design features in a Value Engineering (VE) exercise. While reflecting on this point, an interview participant (AE-M-2) stated:

"In an ideal situation, an integrated design process needs to consider the cost element and a value engineering process should not be required. The integrated design process if executed properly can be so beneficial that it can produce a Green Building project with low capital cost as compared to a traditional project."

Another interview participant (AU-F-6) reflected:

"It depends on whether sustainability has been integrated into the design or not. In case the sustainability consultant has made a thorough effort while working beside the architect to develop a façade system, the façade will be serving many purposes simultaneously and is unlikely to be value managed out. However, in case an element has only one purpose [to enhance sustainability], for instance, a rainwater tank or PV panels, then they might be easily value managed out."

The increased design synergies because of the integrated design approach result in mutually positive associations among performance criteria.

6.4.4.2. Constructability considerations

As some of the survey participants argued, there is an increased focus on different constructability considerations in the case of GB project development. This has a positive influence on all performance criteria. Constructability considerations include the 'Suitability of the project design for execution', a condition presented in Table 6-4. According to interviewee UK-F-2, to achieve the constructability of a project design, good communication among the design team is necessary. According to interviewee UK-M-7, a contractor can also play an important role in ensuring the constructability of design and specifications. However, to achieve that constructability, a contractor needs to be involved early in the

project and sufficient time needs to be allocated to the contractor to review the design. Constructability considerations or in other terms the 'Suitability of the project design for execution', is affected by the communication among the design team, the early involvement of the contractor in the project, and adequate time allocation for design review (see Table 6-4).

6.4.4.3. Commissioning and tuning process

Commissioning and tuning are the delivery-related aspects of well-executed projects. The main objective of commissioning is to achieve a safe and orderly handover of the project, from the builder to the owner, guaranteeing its operability in terms of performance, reliability, safety and information traceability. Commissioning conducted in a planned and effective way can affect the achievement of schedule, cost, safety and quality-related targets of a project.

According to some survey participants, paying attention to the quality aspects of a project ensures that functional, operational and maintainability issues are addressed during the construction of the project and handover stages. Commissioning is a critical aspect of quality control and is critical to the delivery of a successful project. Buildings that are commissioned properly, have a better-quality performance. For instance, the process ensures better performing lighting and HVAC systems. According to an interview participant (PK-M-1), "in the case of Green Buildings, there is a significant rise in quality because of the more stringent commissioning process for such buildings." Commissioning ensures that when operational, building systems will perform up to the mark, which means that the building will perform sustainably in its operational life as well. However, in case the commissioning is not already a part of the cost and schedule planning of a project, executing it may negatively affect the schedule and cost performance.

6.4.5. Compliance requirements

Often, GB projects also receive third-party GB certifications such as LEED certification in the US and Green Star certification in Australia. To comply with those certification requirements, projects need to follow a process, which helps achieve both sustainability and quality performance. Although a project meeting the compliance requirements may take longer and require more budget to be delivered, considering these aspects in the project planning phase can help avoid cost and time overruns. According to survey participants, using a formal sustainable building rating scheme is an effective way of quality assurance as it helps verify that sustainable design attributes have been incorporated into a building and are correctly operating. This effectively contributes to sustainability performance. However, for the building to be certified green, extra time is associated with documentation and this also affects the initial capital cost. Overall, because of the typical requirement of GBs to comply with third-party certifications, a mutually positive association exists between sustainability and quality performance criteria.

6.4.6. Project Delivery Method

The Project Delivery Method (PDM) used in a project determines the level of integration, which subsequently results in an association among different performance criteria. According to survey participants, most projects are delivered through a Design and Construct (D&C) approach. The D&C approach has largely been adopted in commercial projects. While the D&C approach is aimed to reduce project delivery cost and time, it works against the greater integration of sustainability outcomes whilst also affecting other performance criteria. In contrast to D&C, the Integrated-Project-Delivery (IPD) can be suitable for GB projects as it results in increased integration. The association of a PDM with project integration is discussed in detail by a British interview participant (UK-M-7) involved in GB projects for

12 years as a design consultant as well as a contractor. While providing a detailed comparison of different PDMs in terms of their effectiveness for GB projects, UK-M-7 said:

“The extreme end delivery approaches are good while the midway approaches are not so good. For instance, Integrated-Project-Delivery approach with a fully integrated design team and earlier contractor’s involvement is good in terms of delivering sustainable performance. Everyone is on board, share the same targets and goals in design and construction. The lines of communication are very clear, and the team players know the answer to the “WHY” question, very well. The traditional method in which the contractor is brought on-board upon the design completion also works well. The fun part of the traditional delivery is that it has an integrated design element. The design deliverables are very clear, and the design team does not rely on the contractor’s input for design development. Design and Build as a delivery system in terms of delivering sustainability goals can get very muddy very quickly. This is because design development knowledge can get lost. The contractor is brought on board at the end of the design development. In this delivery approach, there is less cost overrun but more schedule overrun involved. Sometimes with this delivery approach, there are good experiences and often time, bad experiences. Fundamentally in this approach, the client’s design team is paid to develop the design to a certain level and afterwards, the contractor and his design team are brought on board. Some part of the design is developed, and the rest of the design is left for the specialist subcontractors within the team of the main contractor to develop. The details regarding the project are not passed properly from the client’s team to the contractor team and because of this, the sustainability-related details can get missed. In these two teams, there is a limited knowledge transfer because of which the project suffers. The only sustainability knowledge that gets passed between the two teams is the one written within the specifications report. In case the knowledge is not there, the contractor might not be able to get hold of it.”

The interview findings highlight that a PDM affects performance criteria associations by affecting the interests of the project team, team communication, the team’s understanding of project objectives, the clarity of design deliverables, and the transition of information from the design team to the contractor team. A PDM also affects project planning, constructability considerations, as well as value engineering. The effect of different PDMs on different performance criteria including sustainability criteria have been extensively investigated for GBs in previous studies (Bilec, 2008; Carpenter, 2005; El Asmar et al., 2013; Gultekin et al., 2013; Hanks, 2015; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Sinem Korkmaz et al., 2011; Molenaar et al., 2009; Swarup et al., 2011).

6.4.7. Innovation in the building industry

Associations among sustainability performance criteria can be subject to the innovation in building materials, systems, designs, and technology to some extent. Many sustainable approaches in building designs and building systems are not mainstream and might require additional research and development to adopt them commercially. Many sustainable approaches in building design and building systems have still not become a trend, and a reason for this may be that there is further innovation required in this area to adopt the solutions to commercial use. While highlighting such a case, an interview participant (AU-M-4) mentioned,

“I wouldn’t eliminate the HVAC system from a building being developed. To make the innovative approaches work in large commercial scenarios, you have to be a little bit pragmatic. For instance, in case of a commercial project, if you increase the wall thickness two

folds to get better insulation, it will mean that the leasable floor area drops. So, it is paramount to keep things in balance, otherwise, it may affect a project's feasibility."

With advancements in building-related innovation, the three sustainability performance criteria can start to have increasingly positive associations with each other. According to an interviewee (AU-M-4), "in terms of sustainability, the technology and the products are changing so fast that what was relevant 3 years ago is not relevant anymore. So today, you can get much better outcomes without having to compromise on human comfort in any way." With further innovations in building-related solutions, interventions where the user's comfort and well-being (that is social sustainability) will not be achieved at the expense of higher LCC (that is economic sustainability) or higher emissions (that is environmental sustainability) may become commonplace. Some studies, for instance by Y. Y. Li et al. (2011), have also emphasised the use of innovative technological approaches for GBs.

6.4.8. Project management

Effective project management can play a very important role in balancing the attention of a team towards multiple performance criteria. As an interviewee (SN-M-9) stated, "project management is quite important to make a project successful as you have to consider the time, cost and quality aspects." According to UK-M-7, while the project team is focussing on building construction, sustainability, cost, and quality performance can drop off. A project manager with a good oversight of different GB aspects can play an important role by keeping different aspects in balance. Hence, project management can play an important role in determining the associations among performance criteria. The importance of the competence and skilfulness of the project manager for GB development has also been highlighted by some previous studies (Y. Y. Li et al., 2011; Shen et al., 2017).

6.4.9. Value Engineering

A Value Engineering (VE) exercise is often conducted in case the project scope exceeds its budget. In case the VE exercise is conducted in a GB with a disregard of sustainability considerations, in an attempt to reduce cost, sustainability performance and quality performance may be negatively affected. While eliminating green features to reduce capital costs, a VE exercise may not consider lifecycle cost, resulting in an increased operational cost (Chalifoux, 2006). While reflecting on the UAE-based projects, an interview participant (AE-M-2) mentioned, "[often] during the project design development, a stage comes when the estimated cost of the project becomes significantly higher than the budgeted amount. This is a problematic situation where Value Engineering is performed. During this process, the tendency is to cut the costliest project aspects, which is an erroneous practice as the costly aspects of a project are often also the key aspects to benefit the project." For instance, efficient building glazing can have a significantly higher cost as compared with inefficient glazing. In case the VE exercise substitutes such glazing with a low-efficiency counterpart, it can significantly increase energy use and GHG emissions. In such a situation, improvement in cost performance is achieved at the expense of sustainability performance. Hence, in a case where VE is unavoidable, it is important to consider all the potential issue while a certain design feature is being eliminated.

6.4.10. Project planning

Early and appropriate decision-making, preparation and planning in a GB project have a strong influence over the associations of GB performance criteria. Appropriate planning in a GB project can mean a well-defined scope and early consideration of sustainability in the project. Appropriate planning also implies a well-defined schedule and an appropriate budget corresponding to the project scope. As a result of aptly conducted planning, the negative associations among performance criteria may be reduced or avoided.

For 'project planning', the importance of adequate planning in GBs has been highlighted by previous studies (Bakar et al., 2009; Ihuah et al., 2014). The significance of adequate time allocation in the case of GBs has been amply addressed in the literature (Ahn et al., 2013; Bakar et al., 2009; Bon-Gang Hwang & Tan, 2012; Ihuah et al., 2014; Lam, Chan, Chau, Poon, & Chun, 2009; Qin et al., 2016; Shi, Zuo, Huang, Huang, & Pullen, 2013; Sourani, 2011; Wai et al., 2012). The significance of adequate budget allocation has also been covered (Bakar et al., 2009; Ihuah et al., 2014) and the role of good resource allocation has been highlighted (Wai et al., 2012). Furthermore, the importance of the early introduction of sustainability in GB development has been extensively discussed (Enache-Pommer & Horman, 2009; Gultekin et al., 2013; S Korkmaz et al., 2010; Swarup et al., 2011).

6.4.10.1. Early incorporation of sustainability vision

Along with survey participants, some interview participants (UK-M-4; UK-M-3) have also argued that the late incorporation of sustainability in a project can lead to negative associations of environmental sustainability with economic sustainability performance as well as schedule and cost performance. Sustainability is a highly integrated aspect of project design. In case sustainability outcomes are outlined earlier in a project design development, they can be integrated into design elements at the minimum potential cost. The late incorporation of environmental sustainability measures can lead to a redesign activity adding to project cost. Furthermore, the late incorporation of sustainability in a project may not be able to significantly reduce LCC. Considering 'green goals' in the later project stages may also result in a negative effect of schedule performance on sustainability performance.

According to an interview participant (PK-M-1),

"The incorporation of sustainability features at the concept stage of a project would not cost much but the same feature, incorporated later in the project through change orders, can result in significant cost overruns [...] When sustainability is well-executed and brought on early in the project, it should improve the project quality [...] When sustainability is well-executed it does not increase the timeframe [...] In case the process of development is faulty, and later in the project development the need of incorporating sustainability is realised, it will definitely lead to a significant rise in the cost and delivery time of the project, since the project design would require a redo along with many other things."

If the project is conceived as green from its inception, the sustainability targets might be achieved without affecting the schedule. However, considering 'green goals' in the later project stages may result in a negative effect of schedule performance on sustainability performance. The early incorporation of sustainability in a project also depends on other factors. An example is the client's awareness of developing a GB project. According to an interview participant (UK-M-3), "delays happen because sometimes the client is not aware of the process involved in ensuring project sustainability as he may only think of sustainability in terms of getting a certificate."

6.4.10.2. Appropriate time and cost allocation

It is important to note that determining appropriate cost and time for all the sustainability-related aspects in a project pose some difficulties. According to an interview participant (AE-M-1):

"It is always hard to identify the impact of targeting a certain level of Green certification on the cost of a project. However, if considered earlier in the project, the Green aspects would be accounted for in a project's cost estimate. There exist examples of projects in which the project in the tender documents had specifications mentioned equivalent to the LEED Gold-

certified projects and the price estimated for the project was similar to non-Green Building counterpart.”

Cost and time allocation in a project can considerably determine the performance criteria associations. According to survey participants, the early considerations of sustainability within the project scope can render the sustainability performance independent of the cost and schedule performance, as appropriate time and budget are allocated to different aspects related to GB project development. The importance of time and budget allocation in GBs is primarily due to the additional project development-related activities, resulting from the inclusion of sustainability considerations. Rigorous project implementation approaches, for example, soft landing processes mean that performance targets will less likely affect schedule or cost because these have already been planned and allowed for early in the process. Cost performance for sustainable projects depends on the cost planning performed for the sustainability initiatives included in the project, and it does not depend on the nature of the sustainability initiatives.

According to a Singapore-based interview participant (SN-M-9):

“When cost is being planned for the project, it is important to give due consideration to the green systems being installed in the building. Otherwise, a contractor may have to work within the already set low cost and the quality of construction may be affected because of it.”

According to survey participants, the importance of time and budget allocation in GBs is primarily due to the additional project development-related activities, resulting from their inclusion of sustainability considerations. According to another interview participant (AU-F-8): “the more we evaluate and inquire the properties of materials, the longer it takes in design. Sustainable solutions for lighting and HVAC also require more modelling and designing time.”

Project planning is dependent on some factors. Appropriate time and cost allocation are achieved by a good project team. As according to an interviewee (UK-F-6): “When sustainability is well executed and there is a robust project team involved, the cost will remain the same and the sustainable performance would go up [.....] If the Quantity Surveyors are well experienced, which is the case with most of them, they account for all the sustainability considerations in the project budget.” Appropriate schedule planning also depends on the engagement of sustainability consultants. For instance, according to an interview participant (UK-M-1), “sustainability is ignored when sustainability consultants are not kept on-board while the schedules are being established. Such a case doesn’t happen all the times, but it happens once in 10 times.”

6.4.10.3. Use of buffers and contingencies in project planning

An important aspect of project planning is to leave contingencies in resources, as well as in time and project budget. These buffers can play an important role in determining the performance criteria associations, as according to an interviewee (UK-F-3), “achieving sustainability within a set capital cost is a difficult thing to do, particularly when the capital cost is fixed.” Another interviewee (AU-M-8) states, “if the project funding allows for additional project measures, it is easy to make a case for sustainable aspects. However, if the cost is under pressure, then sustainability is often found a low-hanging fruit, and it is often one of the first elements to be sacrificed.” Contingency for sustainability performance can also occur within project design as discussed by some interview participants (AU-M-2; AU-F-4). According to an interview participant (AU-M-2), “as architectural consultants, we design projects with 10% margin in terms of Green credit points and we also ask our contractors to keep this margin in consideration. Because of this margin, the projects get the overall aspired certification rating even in case it cannot meet some individual credit points.”

6.5. Discussion

The detailed analysis shows that the associations among sustainability performance and quality performance of GB projects are mutually positive, that is good sustainability performance is associated with good quality performance and *vice versa*. This can be due to the fact that sustainability considerations are a part of the project design in case of GB projects, and project quality is about realising the originally conceived design and specifications. The identified Underlying conditions confirm that performance criteria are related in different ways (that is positively and negatively) under different circumstances (that is under the influence of different variable states of the identified conditions). This means that the associations among performance criteria can be modified by controlling the Underlying conditions. This also implies that sustainability performance does not essentially need to be achieved at the expense of project management-related performance criteria. This highlights that instead of reducing GB development to the performance criteria, consideration of Underlying conditions provides better understanding and control of project performance. This indicates that the complexity perspective which is about using non-reductionist approaches to observe the behaviour of all elements in totality is befitting for the inquiry conducted in this chapter.

The findings of this chapter also validate the suitability of using the contingent approach to project success research. As the inquiry has revealed, changes occurring in Underlying conditions lead to changes in performance criteria interrelationships. This can be considered a validation of the contingent approach to project success which has a situational view of project success and implies that there is no one best account of project success (Ika, 2009). A detailed account of the contingent approach is provided in Research Design (Chapter 4 - Section 4.2).

For GB project development, the identified conditions have different values. The project clients and project team have little or no control over external environment-related conditions (such as 'regional constraints', 'regional climate', 'compliance requirements', and 'innovation in building industry'). The changes in these conditions are subject to time and region. With the developments in the construction industry in a region, these conditions can undergo changes. This is in coherence with the philosophical paradigm adopted in this study, that is Critical Realism, which implies that the research findings are based in a historical context. Apart from the external environment-related conditions, other conditions are project-specific and are controllable by the project team and decision-makers. This highlights that with effective project planning and management strategies, good outcomes on individual performance criteria can be achieved. 'Client's vision and motivation' is a critically important condition as it can determine the preferences for performance criteria. This condition also has indirect effects on performance criteria associations since it influences multiple Underlying conditions responsible for performance criteria associations. While most of the discussed conditions can occur in non-GB projects as well, some of the identified conditions are intrinsically related to GBs, including 'Life-Cycle perspective', 'Regional Constraints', and 'Compliance requirements'. Most of the identified conditions occur within the earlier project stages. This highlights that the decisions made, and the actions taken in the earlier project stages considerably determine how the performance criteria interrelate.

The Underlying conditions affecting associations among different performance criteria have much importance. The more strongly they associate with performance criteria and the higher the number of performance criteria they affect can be the two functions determining their criticality for GB project performance. A detailed account of the criticality of Underlying conditions is beyond the scope of this study.

Since the identified conditions are reported to affect project performance on multiple criteria, these conditions may also qualify as Success conditions. However, besides their seemingly important role in

GB project performance, the Underlying conditions cannot be defined as Success conditions since they are not identified as success leading/enabling aspects by survey and interview participants. Even though by definition the Underlying and Success conditions are of two different types, it is possible that some of the Underlying conditions are also Success conditions. A detailed account of this possibility is provided in Chapter 9 (Section 9.1).

Previous studies have considered multi-objective optimisation and the effect of different factors on performance criteria of GBs, however, they have not exclusively addressed how performance criteria are interrelated in the case of GBs. The inquiry reported in this chapter has filled this research gap by characterising associations between sustainability performance criteria and project management performance criteria in Green Building projects. Underlying conditions affecting the associations among performance criteria have also been reported in this chapter. The importance of many of these underlying conditions for GB projects has been established in previous studies. However, in previous studies, these have not been considered as Underlying conditions.

As a scientific endeavour, the findings presented in this chapter are limited in certain aspects. The associations among performance criteria are determined using an online survey methodology. While the use of a survey method was useful in engaging a large number of participants, the researcher had limited control over the data collection process as he could not actively engage with the participants to provide clarity in case of potential confusion. The Underlying conditions resulting in performance criteria associations also have some limitations. It is possible that some other conditions in addition to the identified conditions are responsible for performance criteria associations, and these additional conditions are left unidentified because of the limited survey sample (that is $n=104$) and interview sample ($n=30$). Furthermore, another limitation is that the effects of the key Underlying conditions on performance criteria associations have only been discussed qualitatively. Future research may focus on developing multi-objective optimisation models based on the conditions identified in this study. This may require establishing the quantitative measure of the effect of Underlying conditions on performance criteria associations. Furthermore, to determine the criticality of Underlying conditions, future studies may need to establish quantitative relationships.

The inquiry reported in this chapter has both practical and theoretical implications. For the practice of GB development, the study identified a number of Underlying conditions determining performance criteria associations. Practically, by understanding the pivotal role of conditions, decision-makers would be able to consider these conditions in their project development plans. The control of these conditions by the project client or the project team can help achieve optimal results for a project across different performance criteria. In theoretical terms, holistic decision-making and project management-related frameworks can be developed from the findings. The identified conditions can lead to more comprehensive multi-objective optimisation models specifically designed for GB projects.

6.6. Chapter Summary

This chapter used an explanatory research design to address the research question, that is '*What are the associations between sustainability performance criteria and project management performance criteria in Green Building projects and which conditions control these associations?*' A multiregional online questionnaire survey and semi-structured interviews were used as data collection methods. Primarily, the questionnaire survey data were quantitatively analysed, and the interview data were qualitatively analysed.

Based on the questionnaire survey data, the associations among performance criteria were identified. While the positive associations were prevalent among performance criteria, some cases of negative, and no associations were also identified. All three sustainability dimensions (that is, *Social, Economic,*

and *Environmental sustainability*) have a mutually positive association among each other. No associations are reported between schedule and sustainability performance criteria.

Underlying conditions which affect associations among performance criteria have also been identified. The analysis showed that variations in these conditions lead to different associations among performance criteria. These conditions are to be controlled to ensure that achieving higher performance on a sustainability criterion would not affect performance on other criteria. Desirable performance criteria associations could be achieved upon optimising these Underlying conditions. Some key conditions identified and discussed in detail include, 'project planning', 'quality of project development process', 'life-cycle perspective', 'project management', 'project delivery method', 'client's vision and motivation', 'regional constraints', 'regional climate', 'compliance requirements', and 'innovation in building industry'. Sustainability performance in a Green Building may not influence schedule and cost performance in case the identified Underlying conditions can be appropriately controlled while developing a project. The identified conditions have been covered to some extent in the existing literature. This coverage gives confidence in the results.

This chapter explained the interrelationships between sustainability performance criteria and project management performance criteria in Green Building projects. While sustainability and project management performance are important criteria for GB performance, success in GB projects may also be defined by other criteria. What are the criteria defining success in a GB project? What are the associations among those criteria? How are those criteria prioritised? Chapter 7 will answer these questions, using the data from semi-structured interviews.

7. Green Building Success criteria

The aim of this chapter is to investigate Success criteria in GB projects. Accordingly, the research sub-question posed in this chapter is: *'What are Success criteria in Green Building projects and how do they interrelate?'*

The specific objectives of this chapter are:

1. to identify Success criteria of GB projects
2. to identify associations among Success criteria
3. to investigate the priorities placed on these success criteria in practice

The structure of the chapter is such that, first the characteristics of interview participants in the inquiry are reported briefly (Section 7.1). Afterwards, the results are presented in three parts. First, the Success criteria identified from interview data are presented and their theoretical interpretation is provided (Section 7.2). The associations among the Success criteria are explained in Section 7.3 followed by the priorities of success criteria (Section 7.4). Results are followed by a discussion of the findings (Section 7.5).

7.1. Characteristics of interview participants

This chapter follows an exploratory research design and is based on an in-depth analysis of qualitative data obtained from the semi-structured interviews. The thematic analysis conducted on interview data helped identify the Success criteria for GB projects. Using the in-depth understanding of GB Success criteria provided in interviews, the importance of different criteria was also identified. A detailed overview of the data collection from interviews is provided in Chapter 4 (Section 4.4.2).

Interview participants were based in Australia (n=18), Hong Kong (n=7), Singapore (n=12), the UAE (n=1), and the UK (n=2). The details related to the regional origin, role, and experience of interview participants are provided in the Appendix B (Section B.7). As indicated in Table B.7.1, the interview participants are highly experienced building professionals as most of them (n=37) have a minimum of 7 years of experience in developing GB projects. These GB professionals are design/architecture consultants (n=11), engineering consultants (n=9), sustainability consultants (n=9), client/developer team members (n=4), contractor team members (n=4) and facility management professionals (n=2). Two interview participants also had a project management role in GB projects. Up to 17 interviewees had the experience of acting in multiple roles in the development of GB projects.

7.2. Success criteria identification and interpretation

This section is related to the first objective of this chapter which is to identify Success criteria in GB projects.

In the semi-structured interviews, the most used words in the discussion on GB Success criteria (as shown in Figure 7-1) include 'building', 'project', 'success', 'green', 'performance', and 'needs'. Some other highly mentioned words refer to project stakeholders, for example, 'users', 'people', 'client', 'occupants', 'community', and 'human'. The word cloud shows that after social aspects, the most used words refer to environmental aspects. Economic aspects (for instance, 'savings') are mentioned the least. Hence, the preliminary analysis indicates that the interview participants did not provide a balanced account of *social*, *economic*, and *environmental* dimensions of GB project success.



Figure 7-1: Word cloud summarising the responses to the interview theme of Green Building Success criteria

As a result of the thematic analysis of interviews, 56 factors defining GB project success are identified. These are classified into 17 criteria and 39 sub-criteria, as presented in Table 7-1. The identified Success criteria have three properties which are 'overlap', 'inclusiveness', and 'interrelationships'.

An 'overlap' implies a substantial commonality among some criteria, although these criteria also have their unique meaning and identity. For instance, 'Achieving GB development-related certifications' and 'Reducing environmental impact and improving environment' both reduce the environmental footprint of the building. Hence, these criteria overlap. The following are other types of overlaps observed among the Success criteria:

- All the identified Success criteria in a GB project can contribute towards the fulfilment of the client's requirements. Hence, 'meeting project aspirations and client's requirements' overlaps with all the other 16 criteria.
- The sustainable operation of a building can result in meeting the end-users' requirements and reducing the environmental effects of the building. Therefore, 'Realising sustainable and efficient building operations' overlaps with 'Reducing environmental impact and improving environment' and 'Building acting as a human-oriented and occupant-centric development'.

‘Interrelation’ implies that some criteria affect others. Although interrelation seems closely related to the concept of overlap, it is a distinct property. For two criteria to be interrelated, there may not necessarily be overlap among them. For instance, ‘reliability in building’ (that is C-8) is interrelated with ‘building adaptability’ (that is C-9) even though there is no overlap among the two criteria. Although two criteria which overlap are always interrelated, it is not systematically reciprocal. Interrelationships among Success criteria are explained in detail in Section 7.3.

'Inclusiveness' implies that some criteria have an overarching effect because they are a general abstraction of the meanings implied by sub-criteria. For instance, 'achieving tangible benefits of sustainability', is an overarching criterion inclusive of four sub-criteria which are 'reduction in life-cycle cost', 'clearly observable savings resulting from building performance', 'quick return on investment', and 'achieving better outcomes at no additional cost'. Although the overarching criteria are inclusive of sub-criteria, they cannot replace the sub-criteria they represent. Overarching criteria are general abstractions while the sub-criteria they represent are more specific, and both the general criteria and their specific sub-criteria are important in defining project success. Among the 17 criteria, 10 overarching criteria represent 39 sub-criteria.

Table 7-1: Green Building Success criteria identified from interview data

		Theoretical analysis						Analysis with respect to attributes of interview participants								Overall participants identifying a criterion
								Participants' role			Experience		Region			
		Environment	Client/Occupant	Society	Construction Industry	Efficiency	Effectiveness	Design Consultant n=11	Sustainability Consultant n=11	Engineering Consultant n=8	Low to Medium n=23	High to Very High n=17	Australia n=18	Hong Kong n=7	Singapore n=12	
ID	Success criteria	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
C-1	Building acting as a human-oriented and occupant-centric development		x	x			x	x	x	x	x	x	x	x	x	25
C-1.01	Users satisfied from building performance		x				x	x		x	x	x	x		x	10
C-1.02	Users' health and well-being ensured in building		x				x	x	x	x	x	x	x	x	x	8
C-1.03	Users' comfort ensured in building		x				x	x	x		x	x	x	x	x	6
C-1.04	Good Indoor Environment Quality ensured in building		x			x		x	x	x	x		x	x	x	4
C-1.05	Building making users happy		x				x	x			x	x	x		x	3
C-1.06	Building providing an optimum work environment		x				x	x		x	x		x	x		3
C-1.07	Users' requirements efficiently fulfilled in building		x				x	x			x		x		x	2
C-1.08	Users' productivity ensured in building		x				x	x		x	x	x	x	x		2
C-1.09	Users feeling related to building		x				x	x			x	x	x	x		2
C-1.10	Users' engagement ensured in building		x				x	x			x	x	x		x	2
C-1.11	Building making public happy			x			x			x	x		x			1
C-1.12	Building adding value to users' life		x				x				x				x	1
C-1.13	Reduced absenteeism ensured in building		x				x	x			x		x			1
C-1.14	User needs prioritised over building efficiency	x	x			x					x				x	1
C-1.15	Building bringing people’s life close to environment	x	x				x	x				x			x	1
C-2	Meeting project aspirations and client’s requirements		x				x	x	x	x	x	x	x	x	x	16
C-2.1	Meeting the purpose and functional requirements of building		x				x	x	x	x	x	x	x	x	x	6
C-2.2	Meeting economic and financial goals		x				x		x			x	x			2
C-2.3	Meeting client’s expectations of cost performance		x				x			x		x	x			1
C-2.4	Meeting the regulatory requirements		x				x		x		x		x			1
C-3	Realising sustainable and efficient building operations	x	x				x	x	x	x	x	x	x	x	x	15
C-3.1	Reduction in energy consumption	x	x				x	x	x	x	x	x	x	x	x	7
C-3.2	Achieving green operations-related certification	x	x				x		x		x	x	x			4
C-3.3	Achieving good system efficiencies					x			x	x	x		x		x	2
C-3.4	Transparency in building efficiencies					x				x		x			x	1
C-4	Achieving GB development-related certifications	x	x				x	x	x	x	x	x	x	x	x	14
C-5	Reducing environmental impact and improving environment	x					x	x	x		x	x	x	x	x	9
C-5.1	Reduction in water consumption	x	x				x		x		x	x	x	x		4
C-5.2	Reduction in greenhouse gas emissions	x					x	x			x	x	x	x	x	3
C-5.3	Reduction in embodied energy	x					x					x			x	1
C-5.4	Reduction in waste	x					x				x		x			1

ID	Success criteria	Theoretical analysis						Analysis with respect to attributes of interview participants								Overall participants identifying a criterion n=40
		Environment	Client/Occupant	Society	Construction Industry	Efficiency	Effectiveness	Participants' role			Experience		Region			
								Design Consultant n=11	Sustainability Consultant n=11	Engineering Consultant n=8	Low to Medium n=23	High to Very High n=17	Australia n=18	Hong Kong n=7	Singapore n=12	
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O		
C-6	Achieving tangible benefits of sustainability		x				x	x	x	x	x	x	x	x	7	
C-6.1	Reduction in Life-cycle Cost		x				x	x		x	x	x		x	2	
C-6.2	Clearly observable savings resulting from building performance	x	x				x			x	x			x	1	
C-6.3	Quick Return on Investment		x				x			x	x			x	1	
C-6.4	Achieving better outcomes at no additional cost		x				x		x		x	x			1	
C-7	Building project acting as a source of learning			x	x		x	x		x	x	x	x	x	6	
C-7.1	Building promoting green user behaviour		x				x	x		x	x		x	x	2	
C-7.2	Building project supporting industry through innovation				x		x		x				x		1	
C-8	Achieving good results in a reliable and consistent way					x		x	x	x	x	x	x	x	4	
C-8.1	Realising easier maintainability in building		x				x	x			x			x	1	
C-8.2	Building being practical for day to day use		x				x	x			x			x	1	
C-9	Building responding to the variations in use		x				x	x		x	x	x		x	4	
C-9.1	Flexibility in workplace		x				x			x		x		x	2	
C-9.2	Value of building features growing over time		x				x	x			x			x	1	
C-10	Realising smart character in building	x	x			x			x	x	x	x		x	4	
C-10.1	Building requiring minimal intervention from users		x				x	x		x		x			1	
C-11	Building having a balanced design					x		x	x	x	x	x		x	3	
C-12	Building responding to its surroundings	x					x	x		x	x	x	x		2	
C-12.1	Building integrated well within community				x		x	x		x			x		1	
C-13	Building to act as a benchmark				x		x		x	x		x	x		2	
C-14	Achieving the maximum potential sustainability in building project	x					x			x		x			1	
C-15	Sustainability considered during building construction	x					x		x		x				1	
C-16	Building being well-integrative					x		x		x				x	1	
C-17	Innovation involved in building design					x			x			x	x		1	
Total number of Success criteria and sub-criteria related to a theoretical aspect and identified by participants having a specific professional role, professional experience, and regional belonging		16	38	4	3	9	47	35	24	22	43	39	41	23	36	
Normalised number of criteria= Number of Success criteria and sub-criteria identified by participants of a specific group / Number of participants of a specific group								3.2	2.2	2.7	1.9	2.3	2.3	3.3	3	
Notes: The frequency count of identified criteria is shown in Column-O. The frequency of the overarching criteria is shown as the sum of their own frequency as well as the frequency of all the sub-criteria they represent. A similar approach is used for overarching criteria from Column-G to Column-N, although instead of showing the frequency count, these columns show whether a criterion is identified by participants belonging to a particular group or not.																
Low to Medium Experience= Up to 13 years of experience; High to Very High Experience= More than 13 years of experience																

7.2.1. Interpretation of findings based on the viewpoint of interview participants

Project success is a subjective concept. Individual project team members have different roles and responsibilities in a GB project. Hence, a project team member, depending on his/her role and experience in GBs, may develop his/her own perception of project success and allocate different priorities to the Success criteria of GB projects. Interpreting findings with respect to the roles of stakeholders is also important because different stakeholders have a different approach to sustainability in building projects (Herazo & Lizarralde, 2016). The perceptions related to project success can also vary geographically as explained. Hence, when asked, an interview participant provides his/her viewpoint of GB project success based on his/her subjective experience. A detailed explanation is provided in Section 7.4.3 and 7.4.4.

The viewpoints of GB experts belonging to a variety of professional roles have been included in this inquiry. The interview participants are based in five regions, have worked in GB development from 2 to 35 years and have been involved in GB development both as service-providers and service-seekers. The analysed findings related to the viewpoints of interview findings are shown in Table 7-1.

The criteria identified by more than 5 participants as shown in Table 7-1 (Column-O) are about human-oriented development (C-1; n=25), meeting aspirations (C-2; n=16), realising sustainable operations (C-3; n=15), achieving certifications (C-4; n=14), improving environment (C-5; n=9), achieving tangible benefits (C-6; n=7), and learning from project (C-7; n=6). Contrary to this, the criteria identified by the least number of participants are about achieving the maximum potential sustainability (C-14; n=1), sustainability in construction (C-15; n=1), building integration (C-16; n=1), and design innovation (C-17; n=1).

The analysis based on the region of origin (Column-L, M, N in Table 7-1) shows that Australia-based participants (n=18) identified 41 criteria, Hong Kong-based participants (n=7) identified 23 criteria, and Singapore-based participants (n=12) identified 36 criteria. In the case of Hong Kong, Singapore, and Australia two of the top three most highlighted criteria are about human-oriented development (that is C-1) and meeting aspirations (that is C-2). This suggests a high significance of these Success criteria among all three regions. Other than these two criteria, participants from Hong Kong (n=7), have emphasised on the project as a source of learning (C-7; n=3); Singapore-based participants (n=12) stressed on sustainable operation of the building (C-3; n=6) and GB certifications (C-4; n=4); and respondents from Australia (n=18) have emphasised GB certifications (C-4; n=8) and sustainable operation of the building (C-3; n=7).

The analysis based on the professional roles of the majority of participants (Column-G, H, I in Table 7-1) shows that the Design Consultants (n=11) have identified 35 criteria, Engineering Consultants (n=8) have identified 22 criteria while the Sustainability Consultants (n=11) have identified 24 criteria. Although with the same number of participants, the Design Consultants identified 11 criteria more than those identified by Sustainability Consultants. Participants with low to medium experience that is up to 13 years of experience in GB development (n=23) identified 43 criteria (that is 1.9 criteria per participant). Participants with high to very high experience that is more than 13 years of experience in GB development (n=17) identified 39 criteria (that is 2.3 criteria per participant).

Four criteria are highly focused on by at least 2 out of the 3 groups of professionals and these criteria are about human-oriented development (that is C-1), meeting aspirations (that is C-2), realising sustainable operations (that is C-3), and achieving certifications (that is C-4). C-1, C-2, C-3, and C-4 also stand out as the top four criteria for both the groups of participants having low to medium experience and high to very high experience as shown in Table 7-1 (Column-J, K). While 3 criteria and 7 sub-criteria are only identified by participants with high to very high experience, 29 criteria and 14 sub-criteria are

only identified by participants with low to medium experience. The criteria only identified by participants with low to medium experience are about building project as a benchmark (C-13; n=2), sustainability in construction (n=1), and building integration (C-16; n=1). The criteria only identified by participants with high to very high experience are about achieving the maximum potential sustainability (C-14; n=1), and design innovation (C-17; n=1).

In the case of this inquiry, the diverse professional roles, experience, and regional belonging of interview participants has helped develop a comprehensive list of GB success criteria. The interview findings verify the importance of using the explorative research design as this results in a more comprehensive understanding of project success supported by the experts involved in the development of GB projects.

7.2.2. Interpretation of findings based on Effectiveness, Efficiency, and Value-generation views

While considering the role of effectiveness and efficiency in defining project success, the association of identified criteria with these two concepts is analysed (Column-E, F in Table 7-1). Most of the Success criteria and sub-criteria (n=47) associate with the 'effectiveness' of GB projects, while some criteria and sub-criteria (n=9) associate with the 'efficiency' of projects. For instance, instead of being an outcome, good indoor environment quality (C-1.04) is a way of achieving the outcome, that is sustainability. Hence, it associates with efficiency instead of effectiveness.

Schedule, cost, and quality are the criteria know as 'traditional performance criteria', 'iron triangle', and 'project management criteria' and have received much attention in project success-related studies (Ika, 2009). 'Meeting client's expectations of cost performance' is a criterion related to cost performance. Although quality has not been explicitly identified as a Success criterion, in case quality is considered as 'fitness for purpose', it resembles C-2, that is 'meeting project aspirations and client's requirements'. Lastly, criteria related to schedule performance have not been identified in interviews. This highlights that even though some criteria of project success prevail in theory and practice, individuals may not consider those criteria when asked about their practice. The inquiry of project success therefore intrinsically requires the interpretation of stakeholders' definition of success.

The value analysis (Column-A, B, C, D in Table 7-1) shows that 13 criteria and 37 sub-criteria can create value for not only the project clients and occupants but also for the environment, society, and the construction industry. The 'value for clients and occupants' is associated with 7 criteria and 31 sub-criteria; 'value for the environment' is associated with 7 criteria and 9 sub-criteria; 'value for society' is associated with 2 criteria and 2 sub-criteria; and the 'value for Construction Industry' is associated with 2 criteria and 1 sub-criterion. There are 4 criteria and 2 sub-criteria which do not seem to create value for any stakeholder. These criteria are associated with efficiency instead of effectiveness. This means that criteria associated with efficiency may not be directly related to the Value-generation view. The detailed interpretation of Success criteria in terms of the Value-generation view and the Waste reduction concept is as follows,

- 'Reducing environmental impact and improving environment' is a criterion strongly associated with the concept of Waste reduction. Reduction in GHG emissions, embodied energy, waste, and water usage means that the waste of resources occurring in the development and operation of a building is reduced;
- 'Building acting as a human-oriented and occupant-centric development' is a criterion strongly associated with the concept of Value-generation. All its sub-criteria create direct or indirect value for the client. Some of these sub-criteria such as 'Users' productivity ensured in building', 'Reduced absenteeism ensured in building', and 'Building providing an optimum work environment' imply that the waste of end-users' productivity is reduced in the operational life of the building;

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- The criterion of 'achieving tangible benefits of sustainability', and its sub-criteria, are about reducing the operation and maintenance costs of a building. Hence, these criteria reduce the waste of economic resources;
 - 'Realising sustainable and efficient building operations' is a criterion associated with both the Value-generation and the Waste reduction concept. Sustainable building operations are required by clients in GBs hence resulting in Value-generation. Sustainable building operations also reduce the waste of resources and energy;
 - 'Building project acting as a source of learning' is partially associated with the Value-generation concept since one of its sub-criteria may result in value for the client (that is 'Building promoting green user behaviour') while the other sub-criterion (that is 'Building project supporting industry through innovation') may not be the desired outcome for client;
 - 'Building to act as a benchmark' is a criterion which may associate with the Value-generation concept in case this is the desired outcome for the project client. Even if a building is not developed to be a benchmark it can still act as such by presenting lessons for the construction industry to learn through its case study;
 - The criterion of 'meeting project aspirations and client's requirements' and its sub-criteria are strongly associated with the concept of Value-generation as by meeting the client's requirements a direct value for the client is created;
 - The criterion of 'achieving good results in a reliable and consistent way' and its sub-criteria are strongly associated with the concept of Waste reduction. A project performing well on these criteria will continue to create value for the client instead of creating waste scenarios in which the building is not used as intended;
 - 'Building responding to the variations in use' is a criterion strongly associated with the concept of Waste reduction. A project performing well in terms of this criterion and its sub-criteria will adapt to a client's changing needs and therefore potential wastes resulting from no-use of the building may be avoided;
 - 'Realising smart character in building' is a criterion associated with both the Value-generation and the Waste reduction concept. Building smartness can add value for a client and the use of automation can also reduce waste by optimising operational performance (Akram, Franco, & Ismail, 2016);
 - Achieving GB certifications (C-4) and sustainability in construction (C-15) are criteria associated with both the Value-generation and the Waste reduction concept. By resulting in sustainable project development these criteria add value for a client. Even the mere certification is the desired outcome for many clients as highlighted by many interview participants. The use of natural resources and energy wastes are also reduced as these criteria optimise the building performance and reduce the environmental footprint of construction;
 - The balanced (C-11), innovative (C-17), and integrative building design (C-16) criteria have no direct association with the Value-generation or the Waste reduction concept. Since these criteria can contribute towards sustainable building outcomes, they indirectly contribute towards the Value-generation or the Waste reduction;
 - 'Achieving the maximum potential sustainability in building project' is a criterion associated with both the Value-generation and the Waste reduction concept. This is because, within the Value-generation viewpoint, waste occurs when the potentially possible value is not provided (Lauri Koskela, 2000);
 - 'Building responding to its surroundings' is a criterion with no direct relation to the Value-generation or the Waste reduction concept. Although the criterion and its sub-criterion, that is

‘Building integrated well within community’ can result in increased value for the community and ecosystem in building’s vicinity, there may not be a direct value created for the client;

The analysis of Success criteria reveals that some of the identified criteria are strongly related to the concept of creating value for the client while others are strongly related to the concept of Waste reduction. ‘Realising sustainable and efficient building operations’, ‘Sustainability considered during building construction’, and ‘Reducing environmental impact and improving environment’ are the three criteria exclusively associated with the environment. In case Koskela’s definition of Value-generation and waste is considered (explained in detail in Chapter 3 - Section 3.4.3 and 3.4.4), the Success criteria resulting in value for the environment will also generate value for the project clients and occupants. This is because Value-generation for a client involves the concept of avoiding potential waste related to unwanted by-products (that is environmental degradation). Although the popular Value-generation view by Lean Construction provides an explanation for Success criteria resulting in value for client and environment, it does not explain the criteria resulting in value for society and the construction industry. While ‘Building having a balanced design’ and ‘Building responding to its surroundings’ are not directly associated with the client-oriented Value-generation concept, they create value for the environment and society.

While a theoretical understanding of Success criteria is provided by interpreting the findings in terms of Effectiveness, Efficiency, and Value-generation, for an in-depth understanding of Success criteria it is also important to analyse the associations among Success criteria.

7.3. Associations among Success criteria

This section is related to the second objective this chapter aims to address which is to identify associations among Success criteria. The circle chord diagram as shown in Figure 7-2 shows the associations among the Success criteria, and is developed based on the interpretation of interview findings. A relationship matrix was developed in which success criteria associations were coded in a tabular format. By using CIRCOS, an online software package for visualizing data, the relationship matrix was transformed into a circle chord diagram (Figure 7-2).

The association among two criteria ‘A’ and ‘B’ mean that the fulfilment of ‘A’ helps fulfil ‘B’ and/or *vice versa*. The criteria associated with more than 10 other criteria are about meeting project aspirations (C-2), achieving the maximum potential sustainability (C-14), the project as a source of learning (C-7), sustainable building operations (C-3), and the relation of building with its surroundings (C-12). The high degree of associations among the Success criteria shows that good or bad performance in terms of one criterion can influence the performance of other criteria. While most of the associations among the criteria are positive in nature, some are also negative in nature. A detailed account of some of the associations explicitly indicated by interview participants is provided in the following sections.

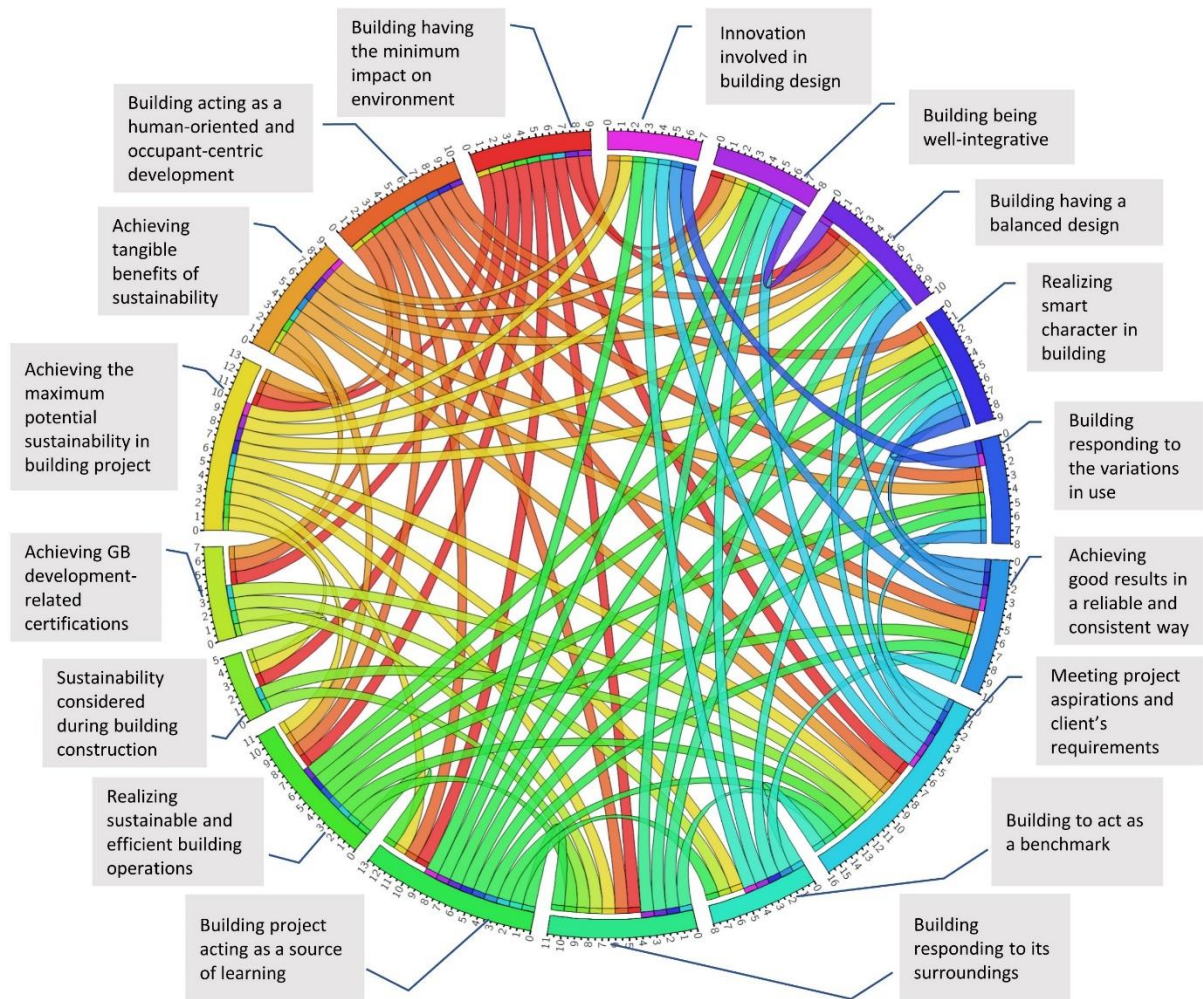


Figure 7-2: Associations among key Success criteria

7.3.1. Innovation involved in building design

‘Innovation involved in building design’ (C-17) has a negative association with reliability-related criterion (C-8) since innovation and reliability can contradict each other. According to AU-M-3, ‘if there is too much focus on the innovation than to develop the base product right, then the sustainability outcomes may get compromised.’

As innovation results in high expenditures in a project, it may also have negative associations with the criteria related to economic aspects (that is C-6 and C-2). As a respondent (AU-F-5) highlighted,

“An engineer often wouldn’t design a system innovatively unless it is made risk free. No one wants to put his name on a non-standard system as it makes him liable for risks. A head contractor also doesn’t try to innovate. This is because innovation costs money and in case the innovation is not part of the documentation, the contractor will not be putting a price for that and therefore will not innovate as it saves him no profit.”

Since smart character in a building (C-10) is currently subject to innovation in building systems (C-17), it can also have a negative association with the reliability-related criterion (C-8). Even though the innovation-related criterion (C-17) has a negative association with reliability-related criterion (C-8) and economic sustainability-related criteria (C-6 and C-2), it associates positively with the learning-related criterion (C-7). This is because innovation in project development can result in a learning experience for project stakeholders as well as the construction industry.

7.3.2. Building project acting as a source of learning

The project as a source of learning is a criterion which has both positive as well as negative associations with other Success criteria. This is because both success and failure in a project can act as a source of learning. According to AU-M-13,

“People may put a lot of money in certain aspects of the project, and they may not be successful. However, these experiences can be learnt from and the lesson can be used in the subsequent applications of a technology.”

7.3.3. Building acting as a human-oriented and occupant-centric development

‘Building acting as a human-oriented and occupant-centric development’ may require the user needs to be prioritised over building efficiency as indicated by its sub-criterion, that is ‘User needs prioritised over building efficiency’ (C-1.14). Therefore, this criterion (C-1) can have a negative association with the criterion requiring the building to have a balanced design (that is C-11).

7.3.4. Building responding to the variations in use

The ability of a building to respond to variations (C-9) may have a negative association with the tangible economic benefits (C-6) since investing in building design for unforeseen future needs may seem to result in unnecessary expenses. Adaptability in the building (that is C-9) also has a negative association with integration (C-16) and environmental sustainability-related criteria (C-3 and C-5). This is because an integrated building design can result in high system efficiencies but reduced opportunities for variations in building use. As an interviewee (UK-M-4) highlighted,

“..... a building using electricity for thermal comfort and lighting purpose will not need to plan the various inside spaces according to the sun path, etc. Contrary to this, a Green Building that minimises the energy use from fossil fuels needs to rely on the environmental factors for daylighting and thermal comfort. Because of these constraints, a Green Building has little flexibility in adaptive reuse to offer, as compared to a traditional building.”

7.3.5. Achieving Green Building development-related certifications

Achieving GB certifications is an important Success criterion in GBs as it may support the project performance in many other criteria as well. While a prevalent opinion is to consider the achievement of GB certifications as a Success criterion, there also exists an argument that GB certifications may not necessarily guarantee sustainability in GBs (Scofield, 2009). The interview findings have offered reasons for the difference in opinions.

The majority of interview participants agree on the importance of GB certifications as a Success criterion. According to interviewees, fulfilling the requirements of the client is a Success criterion in GBs and since clients require certifications for projects, achieving those certifications also acts as a Success criterion. Owing to the standardised and rigorous methods used for achieving GB certifications, the performance in sustainability-related criteria is facilitated in case a project follows the certification pathway. While reflecting on this aspect, AU-M-13 said, “Green Star guidelines can be used for certification and to guide the sustainable development even in case the certification is not required.”

Besides the importance associated with GB certifications, achieving these may not always result in good sustainability performance. While expressing some concerns regarding certifications, an Australia-based participant (AU-M-8) said, “in a practical way, success in GBs is about achieving a particular number of credits on a GB project, as required for a targeted level of Green Star rating. It may not necessarily bear a correlation with the environmental performance or the efficiency of a project.”

For a positive association of GB certifications with sustainability-related criteria, interviewees pointed out that it should be linked to the project objectives. It matters whether certifications are pursued as 'end results' (that is effectiveness) or as 'means' (that is efficiency) towards successful GB development. According to interview participants, when certifications in projects are used as the means of developing a GB, the project performs well in terms of sustainability. However, a project focused on achieving certifications as 'end results' may not have a focus on sustainability performance. Furthermore, following GB certifications as a checklist approach instead of following their intended goal can lead to potential neglect of other important criteria such as users' satisfaction. Hence, achieving certifications (C-4) can have both positive and negative associations with other sustainability-related Success criteria (C-5, C-1, C-6) depending on the way certification approach is used in GB project development.

Success criteria in a GB project are interrelated and resultantly good performance in some criteria results in a good performance in some criteria while underperformance in some other criteria. Success criteria are not given equal priorities in projects. In reality, some criteria are prioritised and the associations among criteria can be one of the reasons why some criteria are prioritised over the others. The next section provides a detailed account of the criteria prioritised in GBs and the reasons why some Success criteria are prioritised.

7.4. Success criteria priorities in Green Building projects

While several criteria can be used to determine the success of GB projects, some criteria may have more importance than others. It is important to determine how GB experts perceive the relative importance of Success criteria. This section is related to the third objective of this chapter: to investigate the priorities placed on success criteria in practice.

7.4.1. Need for balanced attention towards sustainability-related criteria

Different dimensions of sustainability are interrelated in GB projects. Underperformance in one dimension can affect the performance of other dimensions. This indicates the need for balanced attention towards different Success criteria related to sustainability dimensions in a GB. Several interview participants highlight that GBs are different from non-GBs particularly because they tend to provide a similar or better indoor environment but with a reduced environmental footprint. Since the indoor environment, energy use, lifecycle costs and environmental footprint are interconnected, a challenge in developing GBs is to balance these considerations. While emphasising this a respondent (UK-M-6) stated,

"A good project will work well under different models of success such as environmental, social, financial and functional models. These different models are interrelated. If you have a good functional and financial model of a project but ignore its environmental and social sides, then you would need to pay for the poor social and environmental performance later in the life-cycle of the project."

Balanced attention towards sustainability criteria also implies that the end-users' requirements are not ignored and the comfort and well-being are not sacrificed for energy savings.

7.4.2. Success criteria priorities depending on project life-cycle stages

A building project has socio-economic and environmental effects not only at the time of its development but also during its operational stage. Therefore, to achieve sustainability performance in GB projects, the Success criteria related to both its development and operation are important. Hence, sustainability in both the project development and operation needs to be prioritised. Such

considerations can holistically increase the social value of building assets and reduce the environmental footprint of project development.

Unlike sustainability, the level of importance of some other criteria depend on the stage of project development and therefore the priorities towards such criteria may change as the project moves from inception to completion. For instance, according to SN-M-4,

“In the whole project, you have to be aware of the changes Until the building is developed the quality is managed and monitored. But once the building is operational, user experience begins to matter.”

Some aspects of a project are of strategic importance such as the capacity of a building to adapt to future needs. In case the lifecycle perspective is used in the project, compromising immediate economic benefits in favour of the adaptability potential for future variations seems like a difficult but important choice. In this regard SN-M-5 highlighted that, “the concern about Return on Investment [ROI] shouldn’t be so high. It’s not that the ROI is not important. When you design features which grow over time, the ROI can take care of itself.”

7.4.3. Success criteria priorities depending on regional context and industrial development

The priorities towards different building attributes seem to vary from one region to another and this also affects the Success criteria perception for GB projects. According to a Hong Kong-based respondent (HK-M-6), “in developed countries, health and well-being are important criteria for selecting a building to buy or rent.” Hence, for developed economies, a GB project’s success may be determined by its ability to ensure the end-users’ health and well-being.

The complexity related to GBs and the ease of their development is subject to change with time as the local construction industry develops. Owing to this, the perceptions of a GB project success can change and subsequently, the preferences towards Success criteria in GB projects can also change.

In the case of Australia, the preferences towards Success criteria have shifted from innovations in GB designs to sustainable operations of GBs. According to a respondent from Australia (AU-M-14),

“Initially, we used to think of success in the way that how we can change the design industry and bring innovation into the design of Green Buildings. This was around 10 years ago. These days, it is a given Now, the expectation is that, how we can operate the buildings efficiently and there needs some work to be done in this regard.”

The construction industry in Singapore tends to be focused on human-oriented and occupant-centric GB development. According to a Singapore-based interviewee (SN-M-3),

“Now the trend in Singapore is towards occupant-centric development. So, it’s not about a project which is nice to look at according to the architect, easy to maintain according to the facilities management team, but it’s also important that how the building makes people feel. Is it something that people want? Is there enough flexibility in the workplace? Are there any features in the building which add value to the daily life of building users? Such aspects establish if the project is successful or not.”

The priorities of Success criteria related to GBs are subject to the regional context as highlighted by participants belonging to Australia, Hong Kong and Singapore.

7.4.4. Success criteria priorities depending on stakeholders

The priorities towards Success criteria are subject to the role of a person in GB project development. Service-providers and service-seekers associate different priorities to Success criteria of a GB project. Service-providers are contractually required to deliver end results and they may not perceive those aspects as Success criteria which are not a part of their job requirement. According to *SN-M-10*, acting as a design consultant for GB projects in Singapore, “from the building consultant’s viewpoint, the success concept is quite simple. You need to get the aspired Green Mark certificate and for you, it will be a successful green building.” According to *AU-M-7*, a Green Star coordinator in a contractor team, “if the building project has a target for a Green rating system and the target is achieved, then for a builder, it is considered as having success in sustainable outcomes.”

Based on the roles and responsibilities of the service-providers, they may also develop an understanding of project success at the component level instead of systems level. According to *SN-M-6*, acting as an Engineering Consultant for HVAC systems, “we have been in this industry for quite long. In terms of success, we think of aspects like what is the best air-conditioning efficiency which can be achieved. What is the best thermal comfort which can be achieved? If the building fails to meet the aspired performance, we will be concerned that where the potential problem is.”

Being an influential stakeholder, the client’s vision of success can determine the final outcomes of a GB project. However, projects have different types of clients and this can result in varying success definitions from one project to another. A key distinguishing aspect among clients is their relationship with the project. A client who develops a project to own and operate it, may perceive project success differently as compared to a client who develops the project to sell it. According to a participant (*HK-M-7*), “in case the project is an owner-occupied building, then clients are concerned about Green Building performance from a life-cycle perspective.”

While this is the case of a large Australia-based development organisation which owns and operates the projects upon development, this may not reflect the project success perception of other developers who are more interested in selling properties than owning them. According to *AU-M-2*, “there are private developers who use sustainability ratings to sell the building in the market, but these developers are not interested in the operational performance of the building. Once the building is off their hand, it’s not their problem anymore.” While explaining the lack of consideration towards liveability in the building sector in the UAE, *AE-F-2* said, “if we look at the clients and developers involved in a large number of building projects with a focus on selling the projects, then in this case they do not care much about liveability aspects in the buildings.” While presenting the GB project success perception of a typical client, a respondent (*HK-M-2*) stated, “for clients and developers, success often means to get the certification. In case the targeted certification is achieved, they think that the project is successful.” Hence, a variation in a client’s perception of GB project success can be related to his/her relationship with the project.

7.5. Discussion

While using a qualitative methodology the Success criteria related to GB projects have been identified. A detailed inquiry on the difference in the agreement of stakeholders related to GB project success was beyond the scope of this inquiry. However, based on a comparative analysis, the inquiry has revealed that different groups of participants may have different opinions related to GB Success criteria based on their experience, their regional belonging, and their role in the GB projects.

The identified Success criteria are compared against the criteria used in previous GB research (Carpenter, 2005; Enache-Pommer & Horman, 2009; Gultekin et al., 2013; Hanks, 2015; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Sinem Korkmaz et al., 2011; Molenaar et

al., 2009; Olanipekun et al., 2018; Swarup et al., 2011). Table 7-2 shows that some of the criteria occurring in previous GB research are similar to the criteria identified in this study.

Table 7-2: Resemblance between the criteria identified in this study and criteria from previous Green Building research

ID	Criteria identified in this study	Criteria from previous studies					
		Social sustainability	Economic sustainability	Environmental sustainability	Certification as a measure of sustainability	Project Management-related performance	Public recognition
C-1	Building acting as a human-oriented and occupant-centric development	x					x
C-2	Meeting project aspirations and client's requirements	x				x	
C-3	Realising sustainable and efficient building operations			x			
C-4	Achieving GB development-related certifications				x		
C-5	Reducing environmental impact and improving environment			x			
C-6	Achieving tangible benefits of sustainability		x				
C-13	Building to act as a benchmark						x
C-15	Sustainability considered during building construction			x			

Other than the eight criteria shown in Table 7-2, the remaining nine Success criteria identified in this study do not match with those of previous GB-related research studies. Although these nine criteria have not been identified as 'Success criteria' in previous studies, they have been investigated by previous studies, nonetheless. This shows that to some extent the role of these 9 factors for building projects is acknowledged. For instance, studies have investigated reliability in building projects (Wu et al., 2006); adaptability in buildings (Kincaid, 2000; Pinder, III, & Saker, 2013); smart character in buildings (Snoonian, 2003); balanced design for buildings (Ibrahim, 2015); responsiveness of buildings to communities (Plaut, Dunbar, Wackerman, & Hodgins, 2012); innovation in building design (Bossink, 2007); and building projects as a source of learning (Fedoruk, Cole, Robinson, & Cayuela, 2015). The integrated building design has also been discussed in previous studies but instead of a Success criterion, it has been studied as a success factor (Bilec, 2008; Enache-Pommer & Horman, 2009; Gultekin et al., 2013; Hanks, 2015; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Sinem Korkmaz et al., 2011; Molenaar et al., 2009; Swarup et al., 2011). Hence, precedence for the factors identified in this study exists in literature even if they have not been considered as Success criteria.

To see the representation of GB Success criteria identified in this study in the practice of GB development the Success criteria are compared with four GB certification systems, which are Leadership in Energy and Environmental Design (LEED) system by the U.S. Green Building Council, Building Research Establishment Environmental Assessment Method (BREEAM) by the U.K. Building Research Establishment, Green Star system by Green Building Council of Australia, and Living Building Challenge system by International Living Future Institute. Among the selected GB certification systems, BREEAM and LEED are highly popular. BREEAM is one of the earliest GB certification systems in the world, introduced to the market in 1990. Almost all later major GB certification systems such as LEED and Green Star are under the influence of BREEAM. LEED was first launched in 1998 and based on the number of countries where buildings are certified with LEED, it is the most widely adopted rating scheme (Doan et al., 2017). The certification systems are comprised of multiple frameworks focused on different project types and life-cycle stages. To compare with the findings in this study the LEED frameworks used are 'Building Design and Construction' and 'Building Operations and Maintenance'; BREEAM framework used is 'UK New Construction'; Living Building Challenge framework used is 'Buildings'; and Green Star frameworks used are 'Design & As Built' and 'Performance'. These certification systems assess the sustainability performance of buildings using a variety of credit

categories, for example, water and energy. From among the overall 17 criteria identified in this study, 12 criteria are associated with 9 categories of Green Star, 7 categories of Living Building Challenge, 9 categories of LEED, and 10 categories of BREEAM. Some criteria highly associated with the certification systems are 'Reducing environmental impact and improving environment', 'Building acting as a human-oriented and occupant-centric development' and 'Realising sustainable and efficient building operations'. By association, it means that the categories of certification systems provide a complete or partial representation of Success criteria. For instance, 'innovation involved in building design' is a Success criterion associated with the 'innovation' category of the LEED system. The associations of Success criteria with categories of certification systems are shown in Figure 7-3 with the details provided in Appendix E (Section E.2).

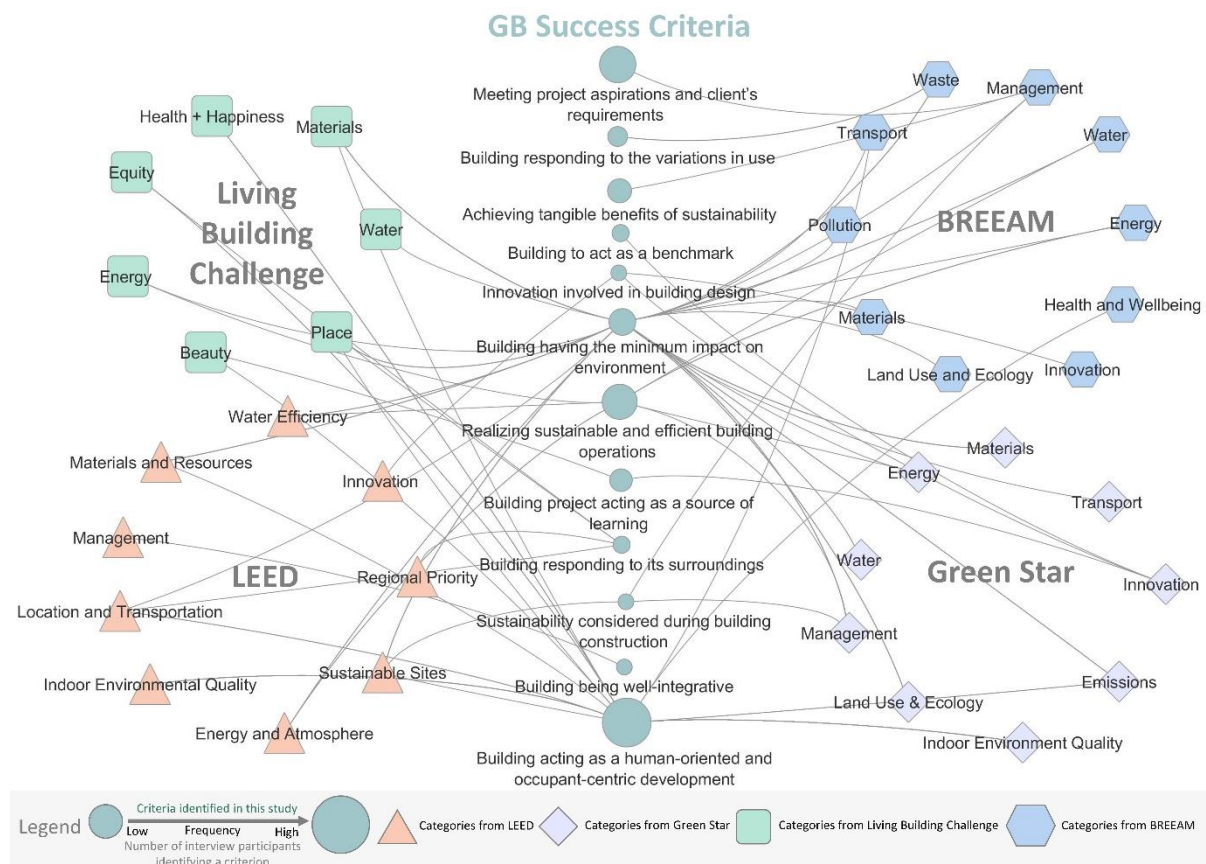


Figure 7-3: Associations of identified Success criteria with credit categories occurring in Green Building certification systems

The LEED, BREEAM and Green Star systems are focused on reducing environmental impact and improving the indoor environment and therefore the categories from these systems are strongly associated with environment and human-oriented Success criteria identified in this study. In addition to these goals, the Living Building Challenge also lays emphasis on the local economy. 'Reducing environmental impact and improving environment' is a Success criterion which implies that success is not only about reducing the environmental footprint of the project but also about positively affecting the environment. Owing to the second aspect of this criterion, it is strongly related to the categories of Living Building Challenge, which is a certification system targeted towards creating a regenerative built environment (Thomas, 2016). While the four certification systems have a focus on environmental and social sustainability aspects, they lack a focus on project-level economic sustainability, flexibility, maintainability, and functionality. This means that although categories of certification systems

substantially represent the identified GB Success criteria, a number of these criteria are still not represented in these systems.

While this exploratory inquiry reported in this chapter provides a comprehensive list of Success criteria for GBs, it may not inform the criteria to be used in case of a GB project developed in a specific context. This is because all the identified criteria may not collectively apply to a GB project. Some criteria may associate more to one project as compared to another project. For instance, 'building responding to the variations in use' is a criterion which is more suitable for projects with long service life. Hence, to tailor the list of Success criteria to a particular project, the criteria identified in this study may need to be reduced to a relevant range for the particular project.

The research inquiry reported in this chapter has both practical and theoretical value. Theoretically, the identification of GB Success criteria informs future research on the dependent variables to measure the success of GB projects. This adds depth to the understanding of building project success and particularly GB success. The identification of Success criteria can benefit practice as project teams may consider a more holistic range of criteria when making decisions related to project development. The criteria list can also be used for the purpose of performance evaluation and for controlling project performance. Moreover, GB certification systems can include the identified criteria in their credit lists to ensure a higher correlation between certification and success.

While the better performance of a project on certain criteria indicates project success, underperformance in those criteria can imply project failure. Project failure is a concept related to project success and can be defined using different perspectives.

7.5.1. Need to redefine project failure

The interview participants have provided two definitions of GB project failure. The first definition states GB project failure as the inability to "harness" the available sustainability potential as *AU-M-3* said, "in terms of sustainability, a failed project is not the one in which no sustainable outcomes have been achieved. In fact, it is the one in which there were a lot of opportunities to harness sustainability and the project failed to capture plenty of it."

The second definition states the project failure as the inability of meeting project aspirations as according to *UK-F-1*, "success in green buildings is not about how much sustainable they are. It is about how many targets they achieve at their delivery as compared to their aspirations." According to another participant (*HK-F-1*), "when developing a project, the failure is not about how green the building is, it's about whether we meet the aspired certifications for the project or not." As compared to the first idealistic definition, the second pragmatic definition of GB project failure is more prevalent among the GB professionals interviewed. In case the project aspirations are not about achieving the sustainability potential in a project, both the definitions of GB project failure contradict each other.

For practical reasons, it may be necessary to revisit the concept of failure considering the two definitions described above. Upon revisiting the definitions of project failure, some approaches identified from interview findings can be adopted to avoid failure. First, an acceptable level of underperformance can be introduced in defining project success and failure. Second, more realistic targets can be set in projects so that the project aspirations can be met, and failures can be avoided. While emphasising the importance of revisiting the prevalent definition of GB project failure, *SN-M-10* said,

"When you say failure, it is in comparison to building's operational performance with the design aspirations. When you start the design, however, there are a lot of assumptions and even your software rely on those assumptions. When you talk of success or failure, you are

comparing the actual performance of the system with a computed model based on assumptions. So, we must be ready for some discrepancies and gaps. This can be because of many different reasons including the weather conditions. A software cannot take into account all the different variables. This is the major argument we have with energy auditors when they mention failures. How can you get the same exact conditions in reality, on which you made assumptions in the design stage?"

Setting an acceptable level of underperformance in defining project failure can be of much importance as according to SN-M-8, "for me, a successful project is the one which achieves the targets. Even if you don't achieve the target but don't deviate too much from the target, it is still acceptable. For instance, originally you designed for 15% of energy savings but eventually achieved only 5% of savings, this is not acceptable." Setting suitable targets for a project can also play an instrumental role in avoiding project failure. The GB certifications identified as a criterion by a large number of interviewees can also play an important role in establishing suitable targets for project teams.

According to a respondent (SN-M-10),

"..... basically, the idea of the Green Mark is about benchmarking in the same city, that how well your building performs as compared to a similar typology building in the neighbourhood. The system does not take into account, what you think the building should be doing. The idea of the Green Star is the same that the 6-star buildings are the top 5% of buildings in the market."

Hence, GB project failure can be avoided by setting acceptable levels of performance and realistic project goals.

7.6. Chapter Summary

In this chapter, an inquiry of GB Success criteria is conducted based on findings of 40 semi-structured interviews conducted with GB professionals spread across Australia, Hong Kong, Singapore, the UAE, and the UK. Based on interview findings, a list of 17 Success criteria and 39 sub-criteria is created. The highly mentioned Success criteria in interviews include 'building acting as a human-oriented and occupant-centric development' (n=25), 'meeting project aspirations and client's requirements' (n=16), 'realising sustainable and efficient building operations' (n=15), 'achieving GB development-related certifications' (n=14), 'Reducing environmental impact and improving environment' (n=9), 'achieving tangible benefits of sustainability' (n=7), and 'building project acting as a source of learning' (n=6).

The data analysis has shown that the professional role, years of experience, and the regional belonging of interview participants result in varying viewpoints on GB project success. A key outcome of this chapter is a list of Success criteria comprised of diverse viewpoints from different GB stakeholders. The majority of the identified criteria are related to effectiveness (n=47) while some criteria are related to efficiency (n=9). The theoretical interpretation of Success criteria with respect to the Value-generation view of the TFV theory has shown that the identified criteria are associated with the environment, the project clients, end-users, society, and the construction industry. The associations among Success criteria are investigated and while most of the criteria have positive associations with each other, some criteria also have negative interrelationships. Priorities related to Success criteria in GB projects are discussed. The priorities of Success criteria depend on the project life-cycle stage, project stakeholders, as well as the regional context of the project.

Upon comparison, some resemblance of the identified criteria with previously discovered criteria is found. The identified criteria are also compared with the credits of GB certification systems. Although the credits of certification systems (that is LEED, Green Star, BREEAM, and Living Building Challenge)

represent the majority of the identified criteria, there is still need for further representation of criteria which can be accomplished by revising the credit list of certification systems. For the practical implementation of identified criteria, the need for tailoring the Success criteria for local project conditions is highlighted. Limitations regarding the scope as well as data collection approach are discussed. The need for revisiting the concept of GB project failure is discussed. Recommendations related to future research in this area are also provided.

This chapter answered the research sub-question, that is '*What are Success criteria in Green Building projects and how do they interrelate?*' But what are the conditions enabling success in GB projects? How do these conditions interrelate? Chapter 8 will answer these questions, using the data from semi-structured interviews.

8. Green Building Success conditions

This chapter aims to address the Sub-question 3.B, that is '*What are Success conditions in Green Building projects and how do they interrelate?*' The findings of this study are informed by semi-structured interviews.

This chapter begins with Section 8.1 which is about the data analysis and reporting approach used in this chapter. In Section 8.2, the identified Success conditions and their interrelationships are discussed within their broader themes. Section 8.3 is about discussing the project stakeholders responsible for and affected by Success conditions. In Section 8.4, the robustness analysis of Success conditions network is conducted to explain the importance of Success conditions when occurring in a network. Thereafter, in Section 8.5, the interpretation of Success conditions in terms of the TFV theory of production is provided. Section 8.6 analyses the identified Success conditions based on the viewpoints used in semi-structured interviews and the attributes of interview participants (that is, the region of belonging, role in GBs, and experience of GBs). In the final part (Section 8.7), the findings of this chapter are reviewed in terms of the theory and practice of GB development by comparison of the identified conditions with findings of previous research on GB projects and credits of GB certification systems respectively.

8.1. Research methodology overview

Following an exploratory research design, the inquiry in this chapter is based on the in-depth analysis of qualitative data obtained from semi-structured interviews. The thematic analysis conducted on interview data helped identify the Success conditions for GB projects. Using the in-depth understanding of GB Success conditions provided in interviews, the importance of different conditions was also identified. A detailed overview of data collection from interviews is provided in Chapter-4 (Section 4.4.2).

The 72 interviews participants responding to the Success conditions *theme* were based in Australia (n=30; 42%), Hong Kong (n=8; 11%), Singapore (n=14; 19%), the UAE (n=5; 7%), and the UK (n=13; 18%). The interview participants are highly experienced building professionals as most of them (n=49; 68%) have a minimum of 10 years of experience in developing GB projects. The participants are mainly design/architecture consultants (n=19; 26%), and sustainability consultants (n=21; 29%). The interview participants also had the roles of clients/developers, contractors, project managers, and facility managers in GB projects. Up to 32 (44%) of these participants had experience in acting in multiple roles during the development of GB projects. The details related to the regional origin, role, and experience of interview participants are provided in Appendix-B (Section B.7).

This chapter presents the interview findings obtained from three viewpoints used in semi-structured interviews. The viewpoint of '*Findings from participants' overall experience*' was intended to highlight Success conditions for GBs, the interview participants had experienced in their overall professional careers of developing such projects. '*Findings from successful/failed projects*' highlighted the success and failure conditions of projects occurring in the professional careers of participants. '*Suggestions for clients*' provided Success conditions in control of the client developing the project. A detailed explanation regarding these viewpoints is provided in Research Design (Chapter 4 - Section 4.4.2.1).

The interview data were analysed using thematic analysis in NVIVO which helped the identification of Success conditions and their associations. A hierarchical structure is developed for rigorous, transparent and detailed analysis and reporting of conditions shown in Figure 8-1. In this hierarchy a '*sub-condition*' is part of a Success condition. A Success condition and its sub-conditions collectively

make a *cluster*. Multiple Success conditions constitute a *theme* which is a classification introduced to collectively explain similar conditions. For instance, ‘Changes during project development and fulfilling design intent’ is a *theme* comprised of three Success conditions. One of the three Success conditions is ‘Scope changes during project execution’ which represents, a *cluster* of two sub-conditions which are ‘Permanence in client’s requirements during project delivery’ and ‘Client’s motivation to achieve original project intent’.

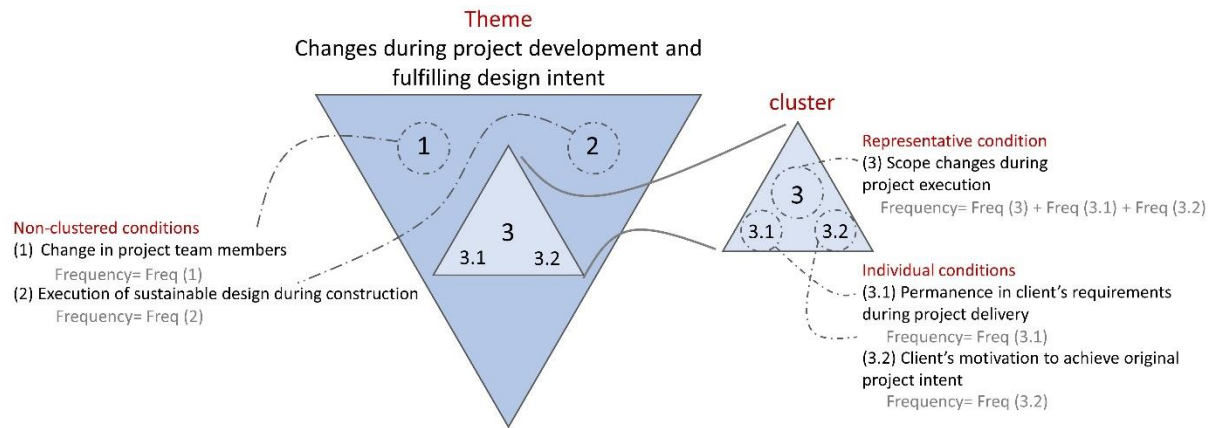


Figure 8-1: Occurrence of Success conditions and sub-conditions within clusters and themes

The detailed analysis of interview findings identified 155 conditions and sub-conditions associated with GB project success. Overall, there are 25 clusters which include 1-15 sub-conditions. While 25 Success conditions and 82 sub-conditions occur in clusters, the rest of 48 Success conditions do not represent sub-conditions and therefore do not occur in clusters. The overall 73 Success conditions and their corresponding 82 sub-conditions are allocated across 20 broad *themes* which emerged from the analysis.

The number of times a Success condition is highlighted by interview participants, that is ‘frequency’, is an important parameter for analysis. As shown in Figure 8-1, the frequency of a Success condition in a *cluster* is the cumulative frequency of the whole *cluster* (that is, Success condition and sub-condition/s). For instance, ‘Scope changes during project execution’ is the Success condition of a *cluster* with two sub-conditions which are ‘Permanence in client’s requirements during project delivery’ and ‘Client’s motivation to achieve original project intent’. Frequency of ‘Scope changes during project execution’ is, therefore, the cumulative frequency of the overall *cluster* (that is 9).

8.2. Success conditions and their interrelationships

This section provides a brief introduction to the identified success conditions occurring within the broader *themes*. In this section, the reasons behind the importance of success conditions are also discussed based on the interrelationships between success conditions.

Key trends emerge by observing the identified Success conditions at the level of broader *themes*, as shown in Figure 8-2. From among the 20 *themes*, 9 are directly related to project stakeholders and most of these are related to the project team. These *themes* are about team characteristics, collaboration, commitment, mind-set, authorities, responsibilities, and procurement methodology. Some of the stakeholder-related *themes* include the client’s characteristics; education of project team, client, and end-users; and the cooperation and interest of external stakeholders.

The remaining 11 *themes* are of technical nature and are indirectly related to project stakeholders. These technical conditions focus mostly on using effective and rigorous methodologies at different project stages, for instance, project goal definition, planning, design development, inspection,

monitoring, and control. Some of the conditions are not specific to a project stage and instead apply to the entire process of project development, for instance, clarity in the development process, the flow of project information, completeness and rigour of deliverables, and managing project changes. Some of the technical conditions are also the project constraints which are beyond the control of the project team and can also be beyond the client's control. Together, the 9 *themes* directly related to project stakeholders and the 11 *themes* of technical nature represent a myriad of 155 socio-technical Success conditions for GB projects.



Figure 8-2: Number of participants identifying conditions within broader themes

The in-depth interview data collection investigating Success conditions has determined 'why' the identified conditions are important for the success of GB projects. Upon conducting a detailed analysis of interview data, the reasons of importance for each condition are identified. Within this list of reasons, 80% (that is 74) of reasons are the factors which are already identified as Success conditions. Hence, in the majority of cases, the reason for the importance of a Success condition is that it results in or associates with other Success conditions. For instance, the importance of 'clarity in process of developing project' is that it results in the 'alignment of team interest with project interest'.

The associations of Success conditions and sub-conditions are collectively shown through a network diagram in Figure 8-3 in which the edges (that is associations) between nodes (that is conditions) tend to imply the reasons for their importance. In such a network, an edge from node A to B not only implies the association among the two conditions, it also means that node A (that is condition A) is important since it is related to node B. These associations in case of each broader *theme* of Success conditions are explained in detail in the individual *theme* sections (for instance, in section 8.2.1). The subsections provide a brief explanation of Success conditions regarding the 20 broader *themes*. Each subsection represents a *theme* and is presented according to the following structure: a figure depicts the conditions occurring in a *theme* and the reasons for the importance of those conditions; the key conditions occurring in a *theme* are mentioned; the associations of conditions with project stakeholder are mentioned; and the associations of conditions with the Transformation, Flow, and Value-generation views of the TFCV theory are explained. Beside this information provided in subsections, a detailed explanation regarding each condition is provided in Appendix D (Section D.1). Only the main takeaway findings are reported in the subsections for brevity and to enhance the clarity of the argument.

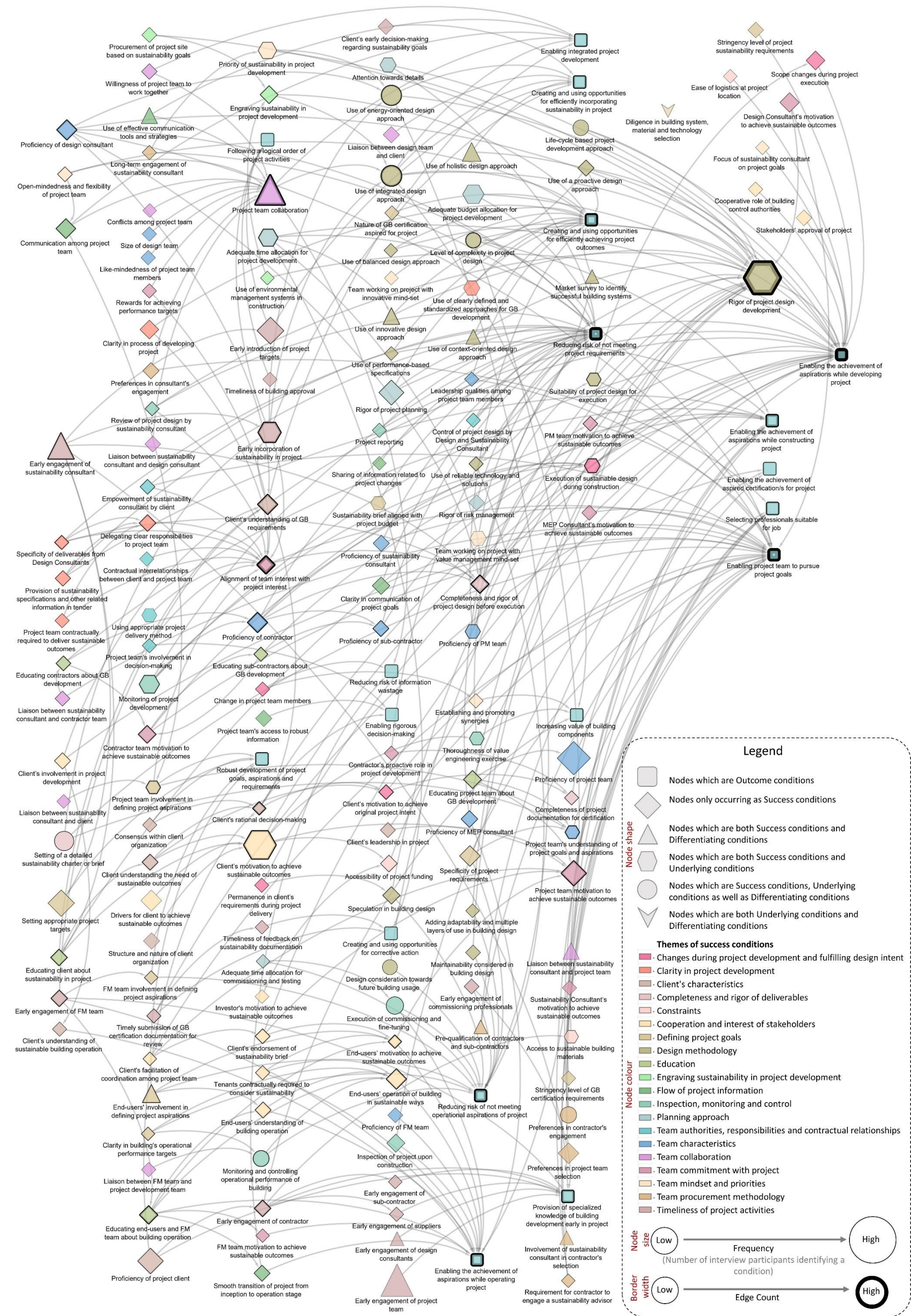


Figure 8-3: Network of Green Building Success conditions

8.2.1. Changes during project development and fulfilling design intent

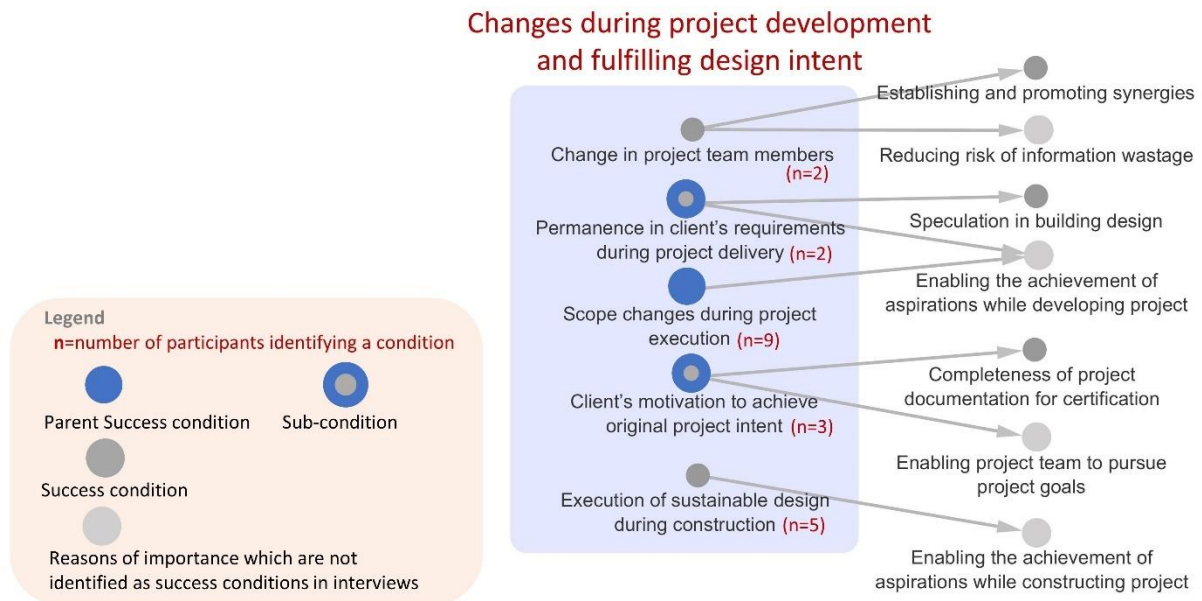


Figure 8-4: Success conditions regarding changes during project development and fulfilling design intent

Changes occurring during project development affect GB project success, and often, when the development follows the plan, it usually results in GB project success. These aspects are considered together in this *theme* since the same conditions account for both. Some key conditions occurring in this *theme* include: 'Change in project team members' (n=2), 'Execution of sustainable design during construction' (n=5), and 'Scope changes during project execution' (n=9). Conditions within this *theme* are related to the project clients, contractors and in some cases the overall project team (Table 8-1 and Figure 8-25). While Figure 8-4 shows the conditions and sub-conditions within this theme, it also depicts the reasons why these conditions are important for project success. Similar figures are used for the rest of 20 themes to present conditions and show the reasons why these conditions are important for project success.

According to the conditions represented by this theme, the likelihood of GB project success increases in case the project team remains unchanged during the project development and project construction is as per design specifications. GB project success is also enabled when the scope changes are reduced during project execution, the client's requirements and the project design remain unchanged, and the client is motivated to achieve the original project intent. These conditions as shown in Figure 8-4 are important for project success as they facilitate team synergies, reduce the gap between design speculations and reality, reduce the risk of losing project information, enable the project team to pursue goals, ensure the completeness of project documentation for GB certification purpose, and ensure the achievement of aspirations in project development.

Conditions within this *theme* can reduce the non-value adding activities in a GB project by reducing the risk of information wastage and by establishing team synergies. These conditions can also help create value for the project client by helping achieve the aspirations during the project development, enabling the project team to pursue project goals, and ensuring the completion of project documentation for aspired certification. The condition regarding the 'execution of sustainable design during construction' is also related to the transformation of the project.

8.2.2. Clarity in project development

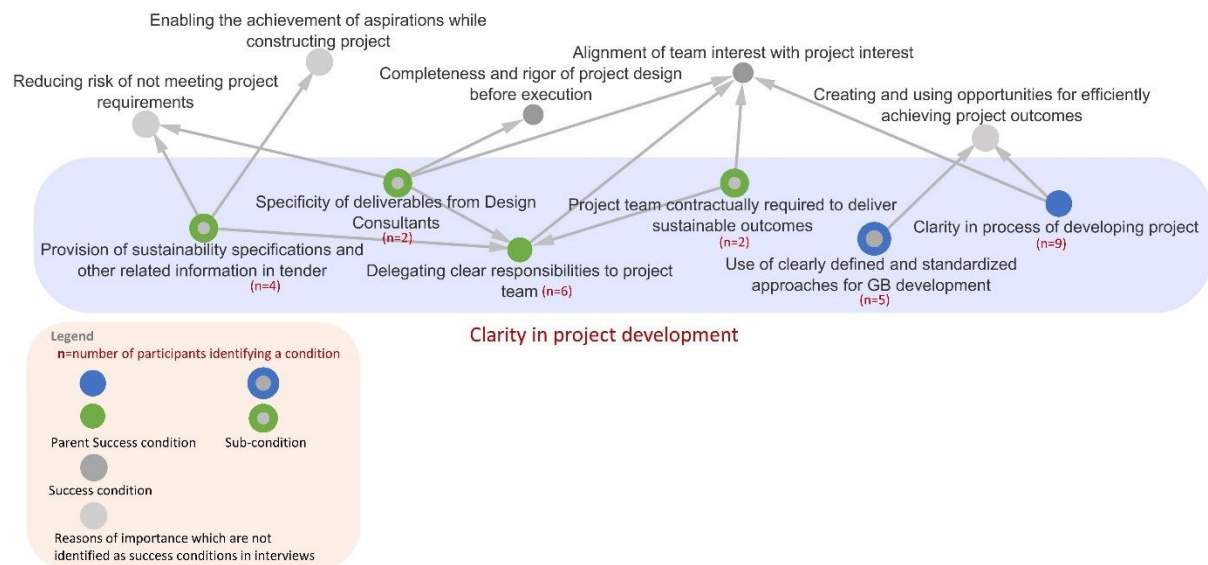


Figure 8-5: Conditions of 'Clarity in project development'

Clarity in the project development process is an important aspect associated with GB project success. This *theme* has 6 conditions among which the key ones are the 'Clarity in process of developing project' (n=9) and 'Delegating clear responsibilities to project team' (n=6). The 'Clarity in process of developing project' is a condition representing a sub-condition which is the 'Use of clearly defined and standardised approaches for GB development' (n=5). 'Delegating clear responsibilities to project team' is a condition representing 3 sub-conditions which are 'Project team contractually required to deliver sustainable outcomes' (n=2), 'Provision of sustainability specifications and other related information in tender' (n=4), and 'Specificity of deliverables from Design Consultants' (n=2). Conditions within this *theme* are related to the client, design team, contractor team, as well as the overall project team (Table 8-1 and Figure 8-25).

According to the conditions represented by this theme, the likelihood of GB project success increases in case clear responsibilities are delegated to the project team and there is clarity and transparency in the project development process. Delegating responsibilities implies that the project team, and particularly the contractor team, is contractually required to deliver sustainable outcomes; specific deliverables are required from the design team; and the necessary project-related information is provided in tender documents. Clarity in the development process implies that a project development strategy exists from the project outset. The importance of these conditions for project success is that they ensure a team focus on project goals and align team interests with project goals; enable the project team to accomplish project goals in an effective way; ensure that the project team particularly the contractor and the design team is held accountable for what they are required to achieve in a project; ensure that the focus on sustainability is maintained during project development; and reduce the possibility of incomplete project design outcomes resulting from unclear deliverables.

The conditions related to this *theme*, as shown in Figure 8-5, ensure a rigorous and complete project design before execution, enable the alignment of team interest with project interest and help create and use the opportunities for efficiently achieving project outcomes. Owing to these reasons, the conditions within this *theme* reduce the non-value adding activities in a GB project. Moreover, these conditions also result in reducing the risk of not meeting project requirements and enable the achievement of aspirations during project construction. This means that these conditions also help create value for the client and reduce the gap between potential value and actual value by enabling the

achievement of aspirations during project development. The condition 'Delegating clear responsibilities to project team' is also related to the transformation of the project.

8.2.3. Client's characteristics

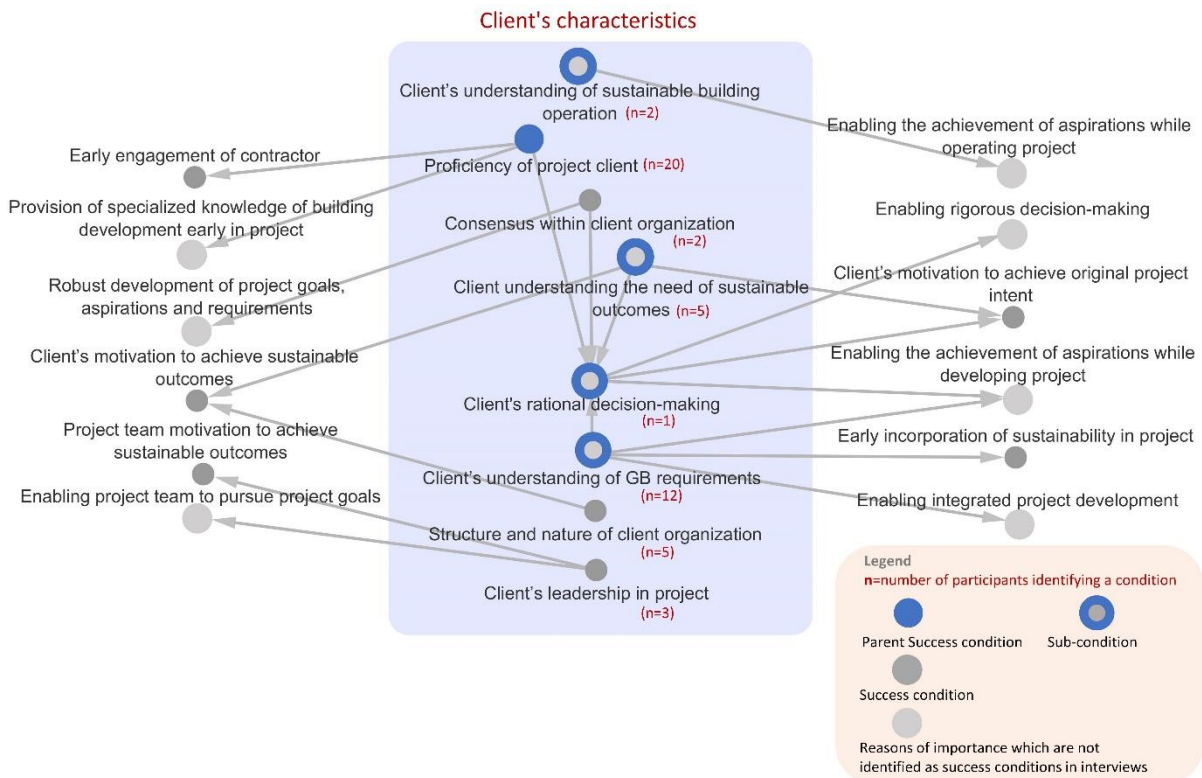


Figure 8-6: Conditions of 'Client's characteristics'

Associations of the characteristics of the client organisation with GB project success are identified. All the 8 conditions identified in this regard are focused on the project client only (Table 8-1 and Figure 8-25). These conditions include 'Proficiency of project client' (n=20), 'Structure and nature of client organisation' (n=5), 'Client's leadership in project' (n=3), and 'Consensus within client organisation' (n=2). 'Proficiency of project client' also represents 4 sub-conditions which are 'Client understanding the need of sustainable outcomes' (n=5), 'Client's understanding of GB requirements' (n=12), 'Client's understanding of sustainable building operation' (n=2), and 'Client's rational decision-making' (n=1).

According to the conditions represented by this theme, the likelihood of GB project success increases in case: the client uses leadership skills during project development, there is agreement among client team regarding project development, there are client's stakes in the operation of the project, and the client has proficiency in GB development. The proficiency of the project client implies that the client is experienced in developing GB projects or construction projects in general and can discern good and bad design; the client has a clarity that why sustainable outcomes are required, understands the requirements of developing GB projects and the sustainable operation of these projects; the client's decision-making is based on logical reasoning instead of prejudices; and the client has confidence in sustainable solutions and is willing to follow project guidelines.

Conditions related to client's characteristics, as shown in Figure 8-6, are important for project success as they enable rigour in the client's decision-making; motivate the client towards sustainable outcomes and towards the achievement of original project intent; ease the early availability of specialised project-related knowledge by early involvement of contractor team; enable early incorporation of sustainability and integrated project development; help define the project requirements; motivate the project team

towards achieving sustainable outcomes; and help achieve the aspirations while developing and operating the project.

Some conditions in this *theme* can reduce the non-value adding activities in a GB project by enabling an integrated project development; ensuring the early incorporation of sustainability in the project; and the provision of specialised knowledge of building development early in the project. All the conditions within this *theme* can help create value for the client and reduce the gap between achieved value and best possible value by motivating the client to achieve original project intent and sustainable outcomes; by robust development of project goals, aspirations and requirements; by enabling the achievement of aspirations while developing and operating project; by motivating the project team to achieve sustainable outcomes; by enabling rigorous decision-making; and by enabling the project team to pursue project goals.

8.2.4. Completeness and rigour of deliverables

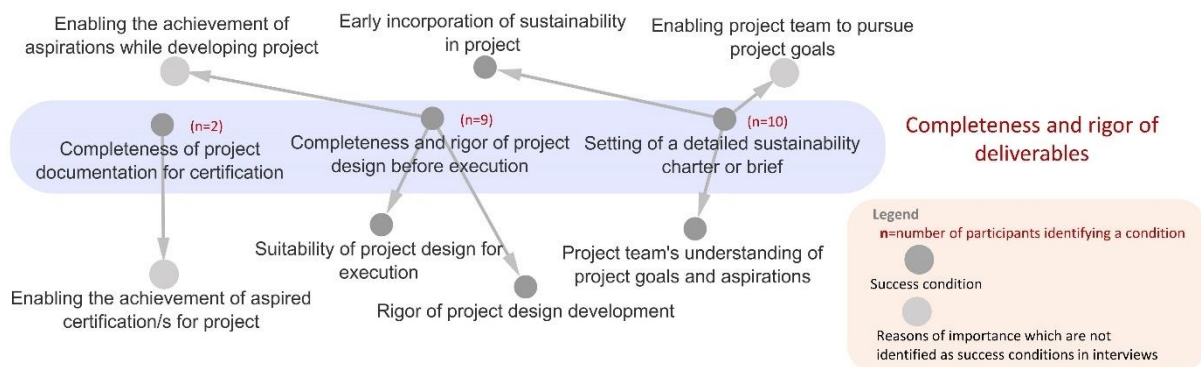


Figure 8-7: Conditions of 'Completeness and rigour of deliverables'

The completeness and rigour of deliverables is an important aspect associated with GB project success. The 3 conditions occurring in this *theme* (Figure 8-7) are 'Setting of a detailed sustainability charter or brief' (n=10), 'Completeness and rigour of project design before execution' (n=9), and 'Completeness of project documentation for certification' (n=2). Conditions within this *theme* are related to the client, contractor team, design team, and the overall project team (Table 8-1 and Figure 8-25).

According to the conditions represented by this theme, the likelihood of GB project success increases in case: a detailed sustainability charter or brief is developed, and the project brief is based on the needs of project stakeholders; the project design is complete and well-defined before the start of execution particularly in terms of sustainability initiatives; and the documentation for third-party GB certification is complete. The importance of these conditions for project success is that they contribute to the project team's understanding of sustainability objectives; enable early incorporation of sustainability in the project development; ensure the suitability of the project design for execution; reduce the possibility of design-related problems during the construction stage; and enable the achievement of aspired sustainability certification and the effective achievement of project goals.

The conditions related to this *theme*, as shown in Figure 8-7, are about the completeness and rigour of project deliverables. Some of these conditions reduce the non-value adding activities in a GB project by ensuring the suitability of the project design for execution, enabling a rigorous design development, ensuring team's understanding of goals, and contributing towards the early incorporation of sustainability. Conditions within this *theme* also help create value for the client by enabling the achievement of aspirations such as GB certifications and enabling the project team to pursue project goals.

8.2.5. Constraints

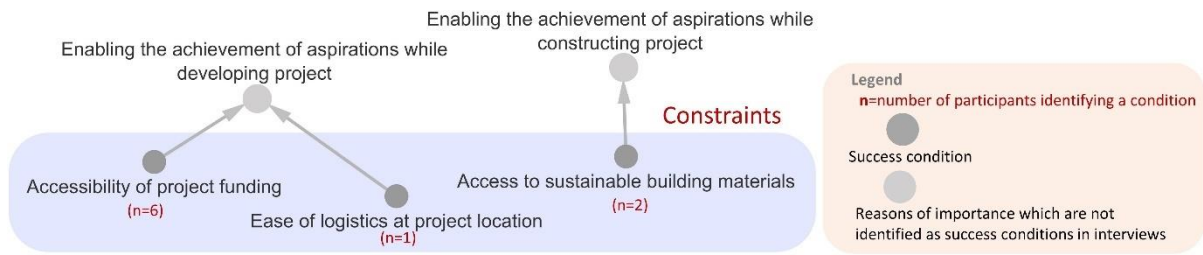


Figure 8-8: Conditions of 'Constraints'

The project constraints are important aspects associated with GB project success. The 3 conditions occurring in this *theme* (Figure 8-8) are 'Accessibility of project funding' (n=6), 'Access to sustainable building materials' (n=2), and 'Ease of logistics at project location' (n=1). Conditions within this *theme* are related to the client, end-users, design team, and suppliers (Table 8-1 and Figure 8-25). According to the conditions represented by this theme, the GB project performance is affected by the access to sustainable building materials, availability of funds to meet the project goals, and the accessibility of project location from a logistics viewpoint. The importance of these conditions for project success is that they enable the achievement of aspirations while developing the project.

The conditions within this *theme* act as constraints in GB project development and these conditions affect the value for the client as they are related to the achievement of aspirations during project development. These conditions are also related to the transformation of the project.

8.2.6. Cooperation and interest of stakeholders

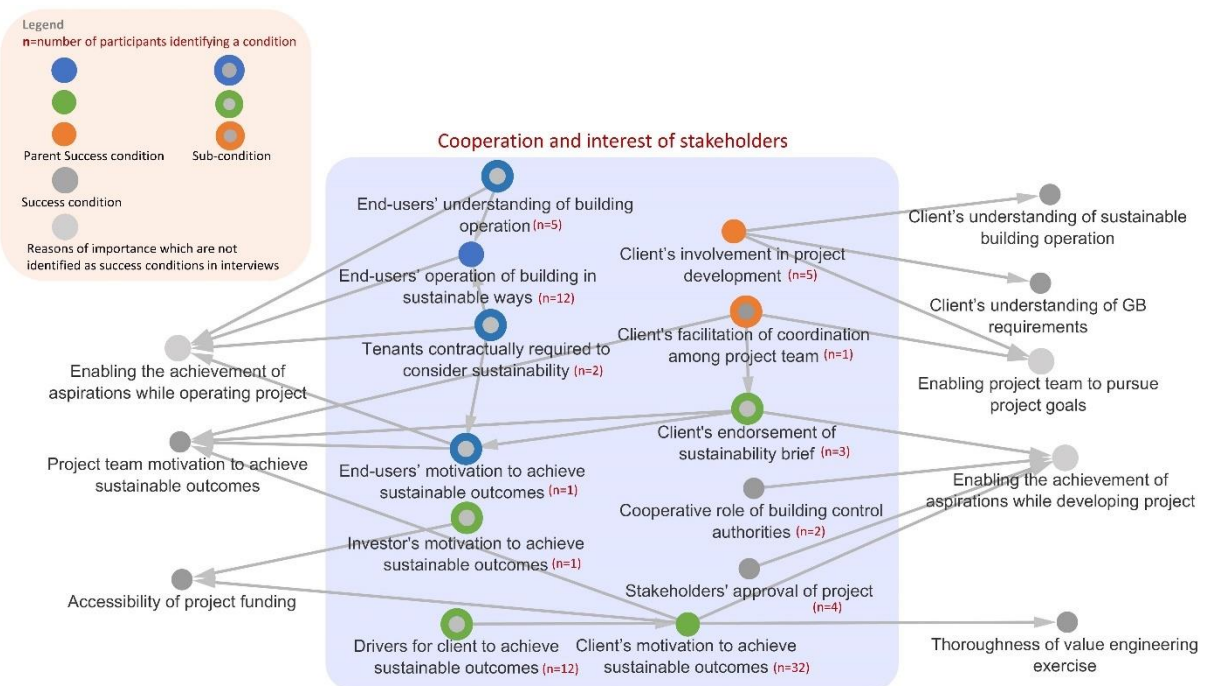


Figure 8-9: Conditions of 'Cooperation and interest of stakeholders'

Cooperation and interest of stakeholders are associated with GB project success. The *theme* has 12 conditions overall, among which the key ones include: 'Client's involvement in project development' (n=5), 'Client's motivation to achieve sustainable outcomes' (n=32), 'Cooperative role of building control authorities' (n=2), 'End-users' operation of building in sustainable ways' (n=12), and

'Stakeholders' approval of project' (n=4). 'Client's involvement in project development', 'Client's motivation to achieve sustainable outcomes', and 'End-users' operation of building in sustainable ways' represent three *clusters* having 1, 3, and 3 sub-conditions respectively. Conditions within this *theme* are related to the project client, end-users, building control authorities, and the neighbouring community (Table 8-1 and Figure 8-25).

According to the conditions represented by this theme, the likelihood of project success increases in case the client is directly involved in project sustainability and is engaged throughout the design process; endorses the sustainability brief; facilitates the coordination among project team members; has stakes in operational performance of the project; and mandates the tenants to follow sustainability guidelines. Alongside the interest and cooperation of project client, the GB project success is also determined by the cooperation of other stakeholders, for instance, cooperation and motivation of investors and building control authorities towards sustainable development, motivation and awareness of end-users to sustainably operate the building according to the design intent, and approval from the neighbourhood community to develop the project.

The importance of these conditions (as shown in Figure 8-9) for project success is that they result in client's awareness regarding the sustainable development and operation of building; ensure project funding to fulfil the sustainability goals; ensure the reduced impact of value engineering on sustainable features; and ensure that the project team takes the project sustainability goals seriously and is motivated to fulfil them. Most importantly, these conditions help achieve the sustainable operation of the building; and enable the development of the project according to aspirations.

Conditions within this theme, as shown in Figure 8-9, can reduce the non-value adding activities in a GB project by resulting in the client's understanding of sustainable building operation and GB requirements. These conditions can also help create value for the client by enabling the team to pursue project goals; enabling the achievement of aspirations while developing and operating project; resulting in the motivation of client, end-users, and project team to achieve sustainable outcomes; facilitating the accessibility of project funding; resulting in the client's endorsement of sustainability brief; and avoiding the elimination of important building features during the value engineering exercise.

8.2.7. Defining project goals

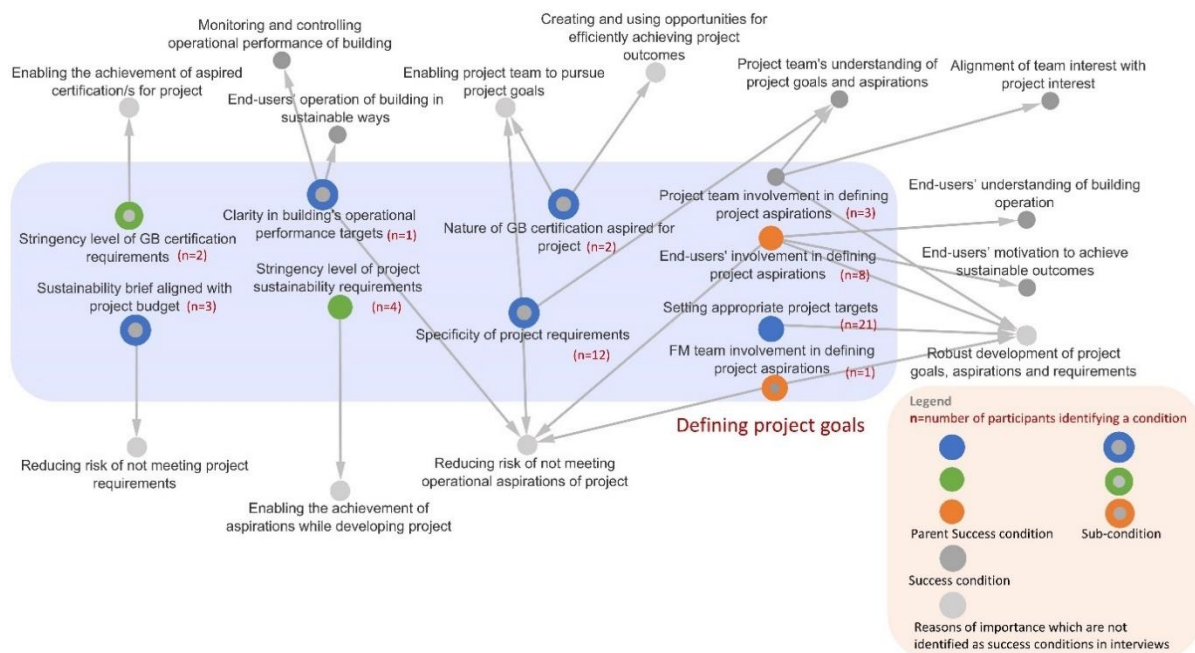


Figure 8-10: Conditions of 'Defining project goals'

The approaches used in defining GB project goals are associated with project success. Ten conditions occur in this *theme* (Figure 8-10) among which the key ones are 'End-users' involvement in defining project aspirations' (n=8), 'Project team involvement in defining project aspirations' (n=3), 'Setting appropriate project targets' (n=21), and 'Stringency level of project sustainability requirements' (n=4). Conditions within this *theme* are related to the project client, end-users, FM team, PM team, as well as the overall project team (Table 8-1 and Figure 8-25).

According to the conditions represented by this theme, the likelihood of GB project success increases in case: the end-users and particularly the facility managers are involved in project decision-making and defining project aspirations; the project requirements are decided in consensus with the project team as the client consults with experts to define the project scope; the project sustainability requirements and aspired certification requirements are not so stringent that they cannot be achieved using the available resources; and the project targets are appropriately set. Appropriately defining project targets implies that: project vision is rigorously developed, outcomes are clearly defined and the project has a well-defined scope; the client provides specific details of the expected building performance; sustainability targets are coherent with the client's aspirations, the project targets mutually benefit all key stakeholders; there is not an overreliance on GB certification systems and point pursuing mentality; sustainability brief is aligned with project budget; and those certification systems are used which acknowledge the sustainability and innovation of project features.

The importance of these conditions for project success is that they help define the appropriate and non-ambiguous targets during early project stages by using the sustainability-related understanding and experience of the project team; help rigorously achieve the sustainability aspirations and ensure that sustainability goals are consistently followed during project development; ensure that the project outcomes are not affected by the limitations of GB certification systems; motivate the project team to deliver project aspirations; and make it easier for the project team to fulfil project goals. These conditions are also important as they ensure that project goals including the operational outcomes are aligned with the client's requirements; enable the end-users to have an understanding of sustainable building operation and take steps to achieve the operational targets; and ensure that the key stakeholders are satisfied from project development.

Conditions within this theme, as shown in Figure 8-10, can reduce the non-value adding activities in a GB project by creating opportunities for efficiently achieving project outcomes, enabling the project team to pursue project goals, ensuring the team's understanding of project goals and aspirations, and aligning team interest with project interest. These conditions can also help create value for the client by ensuring a robust development of project goals, aspirations and requirements; resulting in end-users' understanding and motivation of sustainably operating the building, enabling the achievement of aspirations such as GB certifications while developing the project; and reducing the risk of not meeting project requirements and operational aspirations. The condition 'Sustainability brief aligned with project budget' is also related to the transformation of the project.

8.2.8. Design methodology

The approaches adopted in design development are associated with GB project success. Among the 18 conditions occurring in this *theme* (Figure 8-11), the key ones are 'Market survey to identify successful building systems' (n=1), 'Use of performance-based specifications' (n=1), and 'Rigour of project design development' (n=41). Conditions within this *theme* are mostly related to the design team and in some cases also related to the project client and contractor team (Table 8-1 and Figure 8-25).

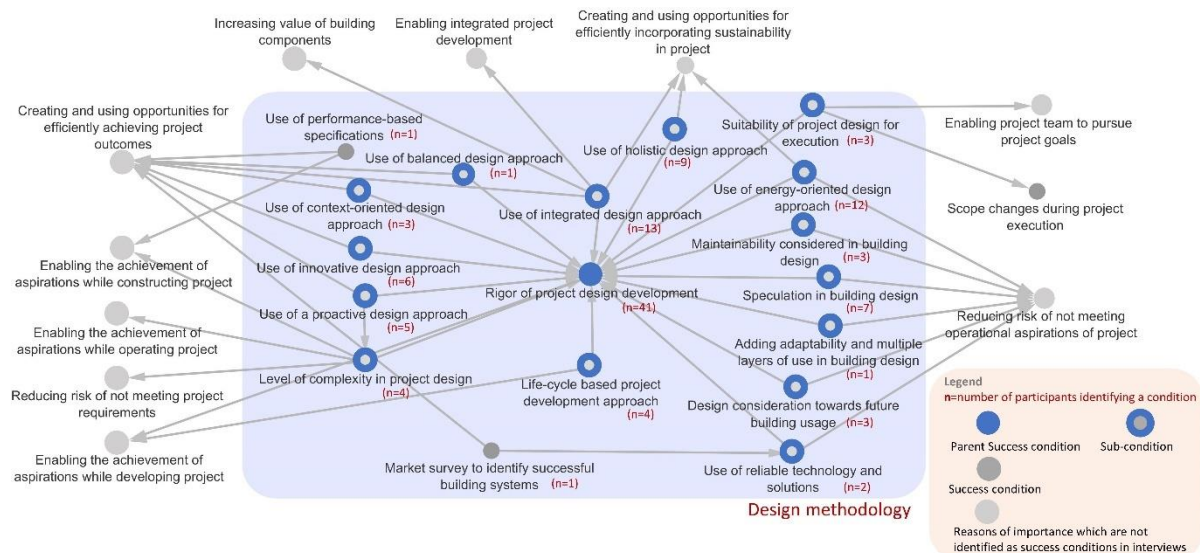


Figure 8-11: Conditions of 'Design methodology'

According to the conditions represented by this theme, the likelihood of GB project success increases in case the successful building systems available in the marketplace are identified, performance-based equipment specifications are used in procurement, and the project design and specifications are rigorously developed. Rigour of design development implies a consideration towards life-cycle-based, energy-oriented, context-oriented, integrated, holistic, and innovative design approach. It means a design consideration towards intended functional use of the building, adaptability of building to multiple natures of usage, reduced complexity, building maintainability, and constructability. Rigour of design development also means the use of reliable technology and solutions; proactive design approach which is about avoiding the practice of making mistakes and then correcting them later; balanced design approach which considers mutually contradicting design objectives; and the approaches which reduce the gap between the speculated design conditions and actual conditions. The importance of these conditions for GB project success is that they reduce the risk of not meeting aspirations; create opportunities to efficiently incorporate sustainability and achieve outcomes while developing and operating the project; enable the project team to pursue project goals; enable integrated project development; increase the value of building components; and reduce the risk of scope changes during execution.

Conditions within this theme, as shown in Figure 8-11, can reduce the non-value adding activities in a GB project by creating opportunities for efficiently achieving project outcomes, enabling integrated project development, and reducing complexity in project design. These conditions can also help create value for the client by enabling the achievement of aspirations while developing and operating the project; reducing the risk of not meeting project requirements and operational aspirations; increasing the value of building components; enabling the team to pursue project goals; creating and using opportunities for efficiently incorporating sustainability in the project; and helping avoid scope changes during project execution.

8.2.9. Education

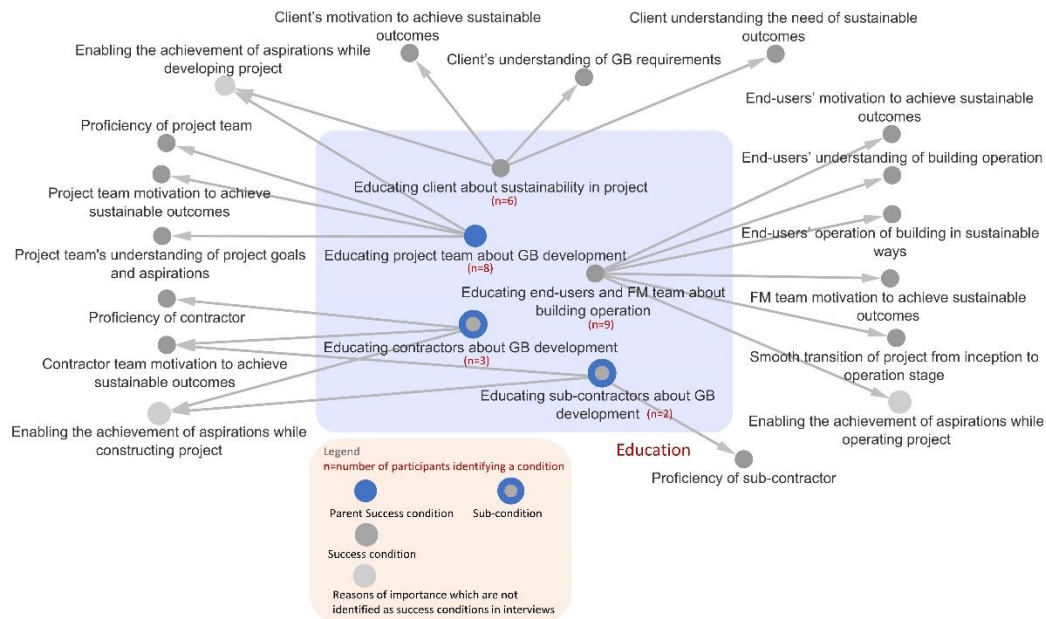


Figure 8-12: Conditions of 'Education'

The education of the project team and key stakeholders (such as client, end-users, and FM team) regarding the importance of sustainable project outcomes and the process of GB development is an important aspect associated with GB project success. Among the 5 conditions occurring in this *theme* (Figure 8-12) the key ones are 'Educating client about sustainability in project' (n=6), 'Educating end-users and FM team about building operation' (n=9), and 'Educating project team about GB development' (n=8). Conditions within this *theme* are related to the project client, end-users, FM team, project team, and contractor team (Table 8-1 and Figure 8-25).

According to the conditions represented by this theme, the likelihood of GB project success increases in case: the client is educated about the project sustainability as well as the tangible (such as ROI) and intangible benefits of sustainable development; the client, end-users and FM team members are educated about sustainable operation of building; and the project team is educated about GB development. Educating project team implies that the orientation of project team is conducted to bring all members on the same page of understanding related to GB development and GB certification systems; and the project team and particularly the contractor team is educated about GB development and their role in the delivery of sustainable outcomes.

These conditions, as shown in Figure 8-12, are important for project success as they ensure that the client sees value in sustainable development, is well-informed to make rational decisions, and supports the project team for the sustainable development of the project; the FM team and end-users understand the requirements and process of sustainably operating the building; a smooth transition of the project takes place from inception to operation stage; the project team members and particularly the contractors and sub-contractors know about the process of GB development and their role in such development; and the entire team is on the same page of understanding related to GB development.

Conditions within this theme, as shown in Figure 8-12, can reduce the non-value adding activities in a GB project by, contributing towards the proficiency of contractor, sub-contractor, and the overall project team; contributing towards the project team's understanding of project goals and aspirations and client's understanding of GB requirements; and a smooth transition of the project from inception to operation stage. These conditions can also help create value for the client by, enabling the

achievement of aspirations while developing and operating the project; motivating the client, end-users, FM team, contractor team and the overall project team to achieve sustainable outcomes; contributing towards the client's understanding of the need of sustainable development; and resulting in end-users' understanding of building operation.

8.2.10. Engraving sustainability in project development



Figure 8-13: Conditions of 'Engraving sustainability in project development'

Engraving sustainability in project development is an important aspect associated with GB project success. The three conditions occurring in this *theme* (Figure 8-13) are 'Engraving sustainability in project development' (n=8), 'Procurement of project site based on sustainability goals' (n=3), and 'Use of environmental management systems in construction' (n=1). Conditions within this *theme* are related to the project client, design team, and contractor team (Table 8-1 and Figure 8-25).

According to the conditions represented by this theme, the likelihood of GB project success increases in case, sustainability is engraved and thoroughly considered in different aspects of project development instead of being considered in a bolt-on approach; well-developed environmental management systems are used in construction stage; and the procurement of project site is in accordance with the sustainability aspirations of the project. The importance of these conditions for project success, as shown in Figure 8-13, is that they result in increased project value and contribute towards the achievement of project sustainability goals during project development.

The conditions related to this *theme* are about engraving sustainability in different aspects of project development. These conditions reduce the non-value adding activities in a GB project by enabling an integrated design approach and by creating and using the opportunities for efficiently achieving project outcomes. Conditions within this *theme* also help create value for the client by enabling the achievement of aspirations while developing the project.

8.2.11. Flow of project information

The flow of project-related information is an important aspect associated with GB project success. Among the 6 conditions occurring in this *theme* (Figure 8-14), the key ones are 'Clarity in communication of project goals' (n=7), 'Communication among project team' (n=11), 'Project team's access to robust information' (n=5), and 'Smooth transition of project from inception to operation stage' (n=5). Conditions within this *theme* are related to project team and FM team (Table 8-1 and Figure 8-25).

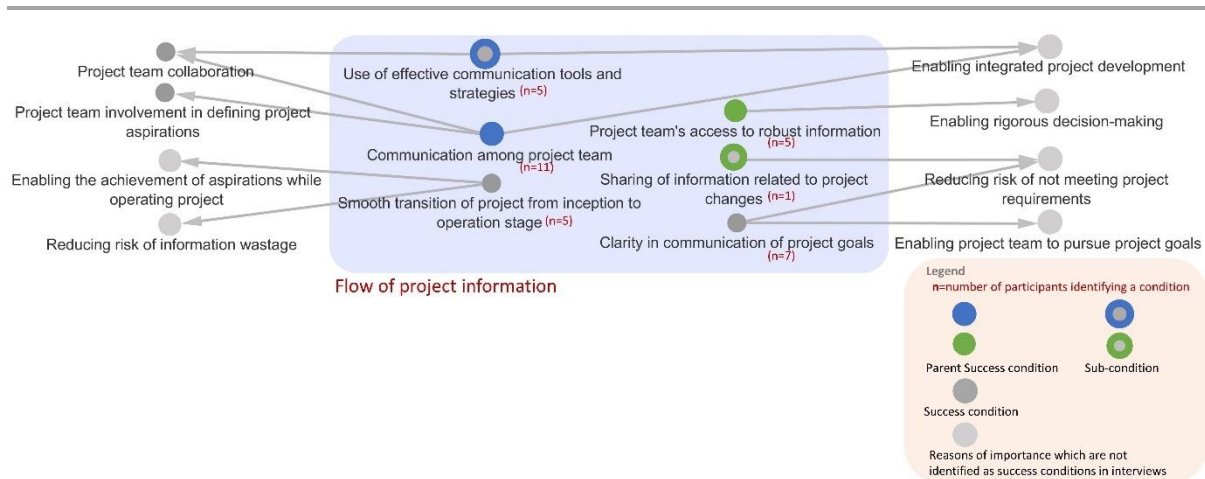


Figure 8-14: Conditions of 'Flow of project information'

According to the conditions represented by this theme, the likelihood of GB project success increases in case: project goals are clearly communicated to project team early in the project, and the client discusses the sustainability brief with design consultant and contractor and emphasises its importance; project team members communicate effectively and have the access to robust information; smooth transition of project occurs from inception to operation stage by using approaches such as Soft Landings; and there is a smooth handing over of the project to the contractor once the tender is awarded. Team access to robust information implies that the team has timely access to information regarding different aspects of project development including building materials; and the project information and specifically the information related to changes in project development is shared among the project team. Effective team communication implies that the project team members communicate effectively and clearly to work collaboratively and resolve project issues; the multi-disciplinary design team has meetings to discuss green initiatives and green implementation; workshops of the project team are conducted on a regular basis from inception to completion; and an open and honest communication process is established with the design team early in the project.

These conditions are important for project success as they ensure that, the project team can make rigorous decisions; the project team members are aware of the project deliverables, know how their work is related to the work of others, and can work together to deliver project outcomes; the project team can provide an opinion that how the changes in project development may affect the sustainability requirements; the design team can contribute in defining sustainability goals; and the loss of project-related information is avoided during the transition of project from one party to another, and in this transition, the awareness of end-users and FM team regarding building operation is ensured.

Conditions within this theme, as shown in Figure 8-14, can reduce the non-value adding activities in a GB project by, enabling integrated project development; empowering project team to pursue project goals; supporting rigorous decision-making; enabling team collaboration; and reducing the risk of information wastage. These conditions can also help create value for the client by, enabling the achievement of aspirations while operating project; ensuring the team involvement in defining project aspirations; and reducing the risk of not meeting project requirements.

8.2.12. Inspection, monitoring, and control

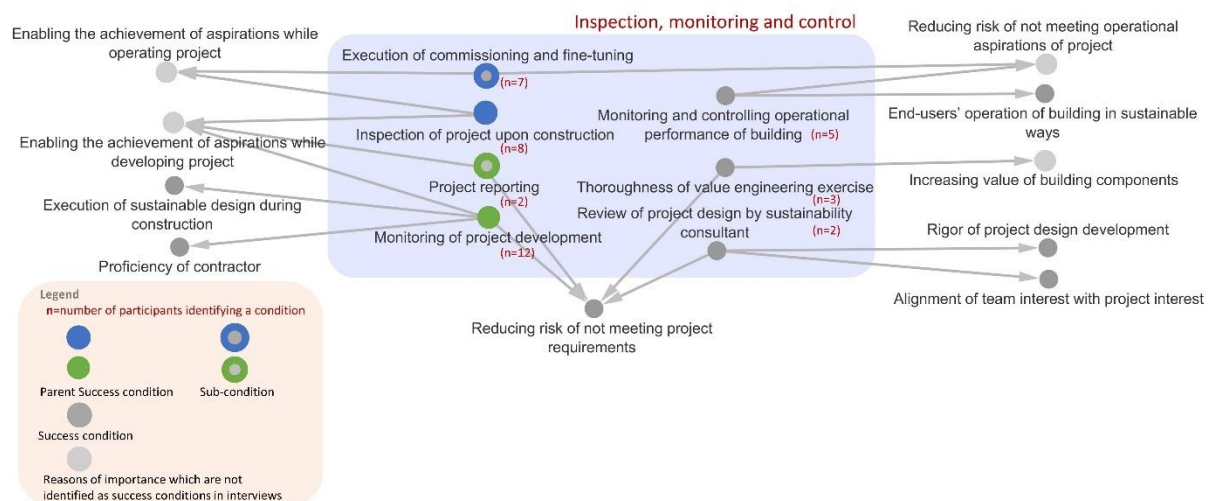


Figure 8-15: Conditions of 'Inspection, monitoring, and control'

The Inspection, monitoring, and control of project development and operation are important aspects associated with GB project success. This *theme* has 7 conditions (Figure 8-15) among which the key ones are 'Monitoring of project development' (n=12), 'Inspection of project upon construction' (n=8), 'Monitoring and controlling operational performance of building' (n=5), 'Thoroughness of value engineering exercise' (n=3), and 'Review of project design by sustainability consultant' (n=2). 'Inspection of project upon construction' is a condition representing a *cluster* with one sub-condition which is 'Execution of commissioning and fine-tuning' (n=7). 'Monitoring of project development' (n=12), is also a condition representing a *cluster* with one sub-condition which is 'Project reporting' (n=2). Conditions within this *theme* are related to sustainability consultant, commissioning team, PM team, FM team, as well as the overall project team (Table 8-1 and Figure 8-25).

According to the conditions represented by this theme, the likelihood of GB project success increases in case: the project is monitored during development and inspected upon construction; the sustainability consultant can critically review project design and other aspects of project development, and can demand revisions in case the project design is inadequate; value engineering exercises are rigorously conducted to reduce the risk of eliminating sustainable features; the FM team monitors the building performance; a follow-through is conducted to ensure that the users understand the sustainable operation of building; and regular audits are conducted to report the operational performance of the building. Project inspection upon construction implies that upon completion, the project is thoroughly inspected for conformance with specifications; commissioning, fine-tuning and seasonal testing of the building is rigorously conducted; and building systems are commissioned by a third party. Monitoring of project development implies that, contract administration, quality assurance and quality control are rigorously performed; quality of design work is managed; building construction is monitored for conformance with specifications; materials used in construction are reviewed; the site is regularly visited by design consultant; the deliverables for different project stages are kept in account; checkpoints are used for reviewing sustainable development; and project reporting is conducted at regular intervals to see if project requirements are being met, and this reporting is continued throughout the different project stages.

The importance of these conditions for project success is that they ensure that, the project team is held accountable for project deliverables and takes interest in the sustainable development of the project; project development is up to the expectations; sustainability aspirations are not compromised during

project development; and the building in its operational life performs according to design intent. In specific terms these conditions are important for project success since they ensure that design and specifications during construction are effectively executed; project aspirations are met in construction; the design team fulfils sustainability objectives during project development; the shortcomings in design are compensated; the end-users and the project client know if the building in its operational life is performing as intended by design; and the end-users understand the sustainable operation of the building.

Conditions within this theme, as shown in Figure 8-15, can reduce the non-value adding activities in a GB project by resulting in, a rigorous design development; alignment of team interest with project interest; and execution of sustainable design during construction. These conditions can also help create value for the client by enabling the achievement of aspirations while developing and operating project; increasing the value of building components; enabling sustainable operation of the building by end-users; and reducing the risk of not meeting project requirements and operational aspirations of the project. One condition that is 'Thoroughness of value engineering exercise', is also related to the transformation of the project.

8.2.13. Planning approach

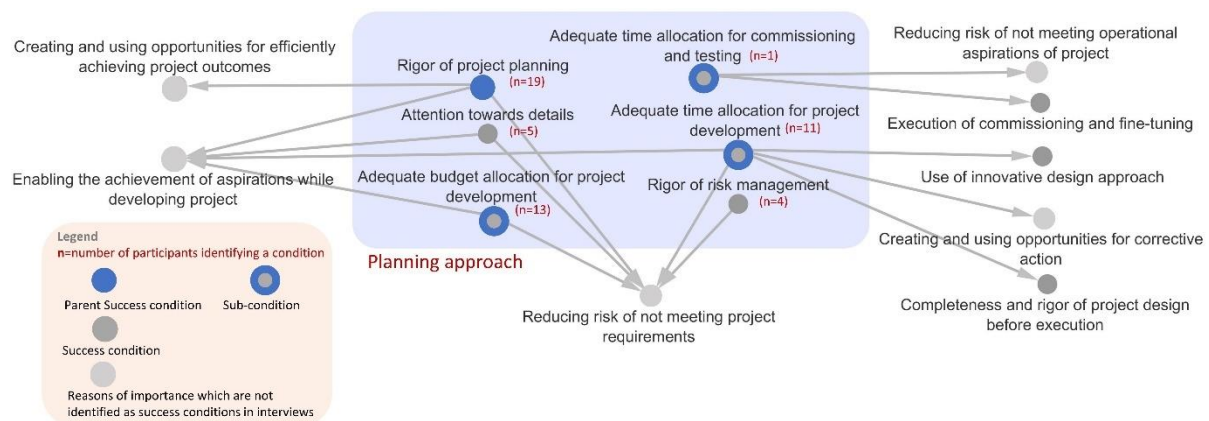


Figure 8-16: Conditions of 'Planning approach'

The project planning aspects are associated with GB project success. This *theme* has 6 conditions (Figure 8-16) among which the key ones include 'Rigour of project planning' (n=19), 'Attention towards details' (n=5), and 'Rigour of risk management' (n=4). 'Rigour of project planning' is a condition representing a *cluster* with three sub-conditions which are 'Adequate budget allocation for project development' (n=13), 'Adequate time allocation for project development' (n=11), and 'Adequate time allocation for commissioning and testing' (n=1). Conditions within this *theme* are related to the project team and mainly to the PM team (Table 8-1 and Figure 8-25).

According to the conditions represented by this theme, the likelihood of GB project success increases in case: the project is rigorously planned to consider all the aspects of development; attention is given to detailing, finishing and workmanship in the project; attention is given to key details in project development and operation and even the small details (for example, instrumentation and measurement of the relative temperatures); and rigorous risk management is performed in which risks are regularly assessed, remediation actions are promptly taken, and risks are managed in terms of the project objectives. Rigour of project planning implies that, there is an appropriate budget allocation to support the sustainability initiatives in project development; the project budget aligns with project scope; buffers are provided in budget; adequate time is allocated for project stages such as inception, planning, and design and particularly the commissioning and testing exercise; and the time allocation considers sustainability aspects in project development.

These conditions are important for project success as they, enable rigour and accuracy in project development; ensure a preparedness while the project is being developed; enable the fulfilment of aspirations while developing the project; reduce the risk of not meeting project requirements; help ensure the completeness of design deliverables before execution; and avoid the lack of innovative design approaches resulting from time shortage. These conditions are also important as they help avoid the risk of inappropriately conducted commissioning and testing resulting from a time shortage, and the risk of eliminating project features resulting from the retrospective realisation that the allocated time or budget is insufficient.

Conditions within this theme, as shown in Figure 8-16, can reduce the non-value adding activities in a GB project by resulting in a complete and rigorously developed project design before the start of construction, and opportunities for efficiently achieving project outcomes. These conditions can also help create value for the client by, enabling the achievement of aspirations while developing the project; creating opportunities for corrective action; and reducing the risk of not meeting project requirements and operational aspirations. Two conditions which are 'Adequate budget allocation for project development' and 'Rigour of project planning', are also related to the transformation of the project.

8.2.14. Team authorities, responsibilities, and contractual relationships

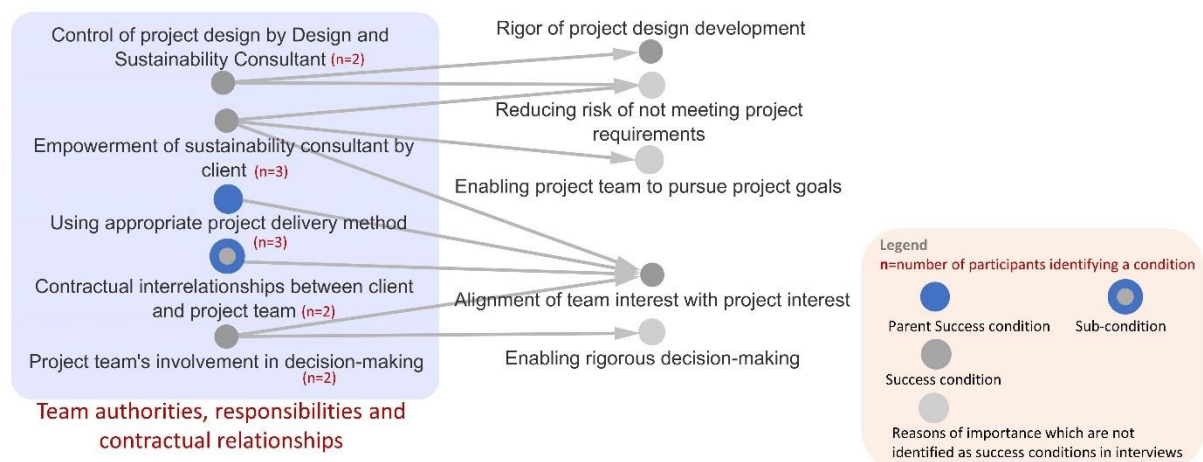


Figure 8-17: Conditions of 'Team authorities, responsibilities, and contractual relationships'

The team authorities, responsibilities, and contractual relationships are important aspects associated with GB project success. This *theme* has 5 conditions (Figure 8-17) among which the key ones are 'Using appropriate project delivery method' (n=3), 'Empowerment of sustainability consultant by client' (n=3), 'Control of project design by Design and Sustainability Consultant' (n=2), and 'Project team's involvement in decision-making' (n=2). 'Using appropriate project delivery method' (n=3) is a condition representing a *cluster* with one sub-condition which is 'Contractual interrelationships between client and project team' (n=2). Conditions within this *theme* are related to the client, sustainability consultant, design team, and the overall project team (Table 8-1 and Figure 8-25).

According to the conditions represented by this theme, the likelihood of GB project success increases in case: the project team and particularly the sustainability and design consultants are involved in project-related decision-making; the design and sustainability consultants have the authority to control project design development; and the sustainability consultant is empowered by the client and considered a coordinator in the project. GB project performance is also affected by the delivery method used and the contractual links which a client has with the project team and particularly the design and sustainability consultant. These conditions are important for project success since they, ensure that the

project team can control the project development to meet sustainability aspirations; ensure that the project team seriously considers the sustainability objectives advocated by sustainability consultant; help capitalise on the specialised knowledge of different team members for benefitting the project; help keep the project team motivated towards the project; and affect associations among the project team and client which benefit the project.

Conditions within this theme, as shown in Figure 8-17, can reduce the non-value adding activities in a GB project by enabling rigorous decision-making and aligning team interest with project interest. These conditions can also help create value for the client by, resulting in rigorous design development; enabling the project team to pursue project goals; and reducing the risk of not meeting project requirements. One condition that is 'Using appropriate project delivery method', is also related to the transformation of the project.

8.2.15. Team characteristics

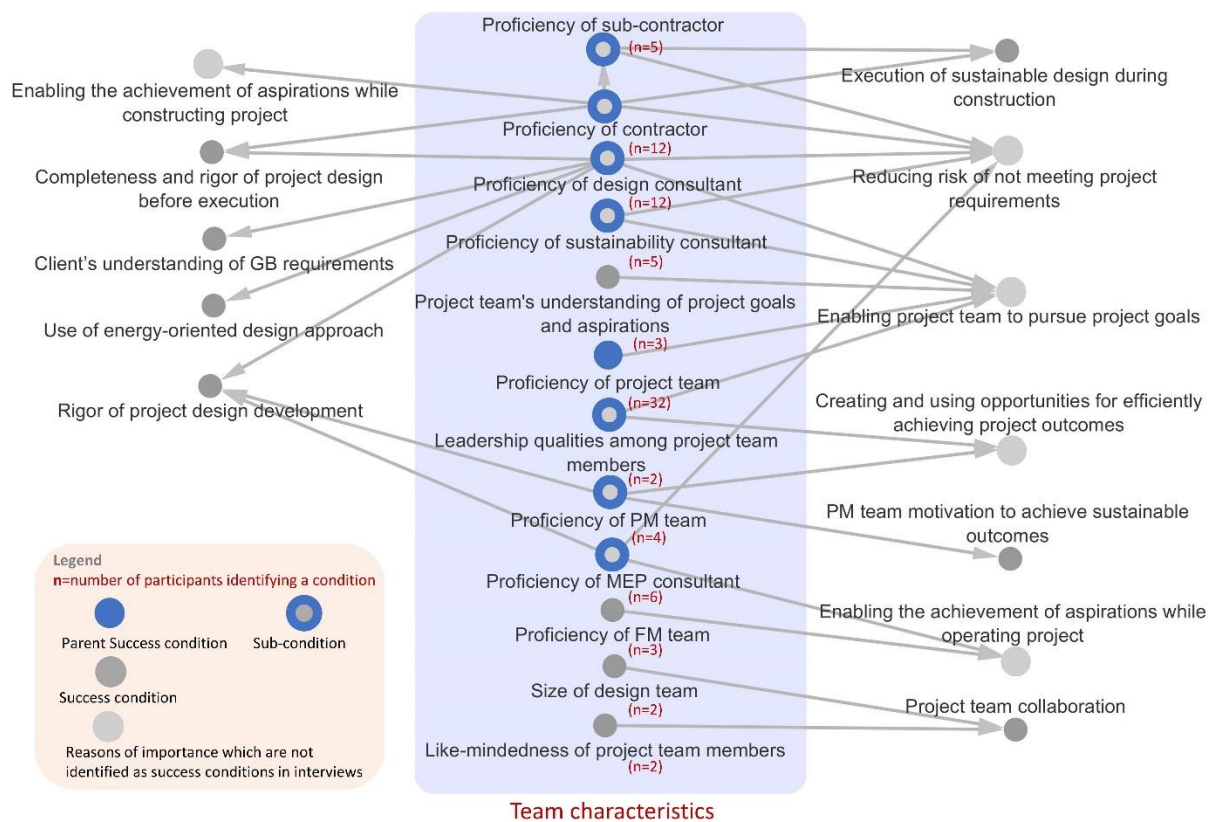


Figure 8-18: Conditions of 'Team characteristics'

The team characteristics are important aspects associated with GB project success. This *theme* has 12 conditions (Figure 8-18) among which the key ones are 'Proficiency of project team' (n=32), 'Project team's understanding of project goals and aspirations' (n=3), 'Proficiency of FM team' (n=3), 'Like-mindedness of project team members' (n=2), and 'Size of design team' (n=2). 'Proficiency of project team' is a condition representing a *cluster* with 7 sub-conditions which are about leadership qualities in project team members (n=2), and the proficiency of contractor (n=12), design consultant (n=12), MEP Consultant (n=6), PM team (n=4), sub-contractor (n=5), and sustainability consultant (n=5). Conditions within this *theme* are related to FM team, contractor team, design consultant, MEP Consultant, PM team, sub-contractor, sustainability consultant, as well as the overall project team (Table 8-1 and Figure 8-25).

According to the conditions represented by this theme, the likelihood of GB project success is associated with, the differences in knowledge, thinking approach, and skill-sets of project team members; the size of the design team; and the number of design consultant organisations involved in project development. The likelihood of GB project success increases in case: the FM team members have a good understanding of building features and building operation; the project team has a detailed understanding of project vision, goals, aspirations, and quality targets; and the project team is proficient to develop GB projects. Proficiency of project team implies that the project team is experienced in GB development; has the appropriate technical expertise required for GB projects; understands the process of GB development and certification; and has the leadership qualities to pursue project goals, push status-quo, and innovate. In specific terms, the proficiency of project team means that the sustainability consultant has the experience of GB development and the ability to engage with the project team; the design consultant has the understanding and expertise of GB development and certification; the design consultant is aware of local regulations and design requirements regarding efficient MEP systems; the MEP consultants have the experience of working on GBs, the experience of problem rectification in building systems, and the ability to make better design speculations; the Project Management team has the experience of delivering GBs, the ability to discern good and bad design, and can appropriately delegate the project tasks among the project team; the contractor has the awareness and experience of GB development, can bridge the knowledge gaps, understand design intent, review sustainability compliance by sub-contractors, and administer documentation related to GB certification; and the sub-contractors have the awareness and expertise of GB development.

The importance of these conditions for project success is that they, ensure team collaboration; enable the team to work towards the achievement of project aspirations, to work on innovative solutions, and focus on goals even in challenging circumstances; ensure that the project team can contribute towards the development and certification of a GB project; and help guarantee that the potential problems in building systems can be rectified once the project is operational. The importance of these conditions for project success is also because they ensure that, the sustainability consultant can lead the project team to deliver sustainable outcomes; the MEP consultants can design the building systems which meet the sustainability aspirations; the design consultants can design the project rigorously, meeting sustainability aspirations in design, avoid the regulatory barriers, create conditions to achieve higher efficiencies in building systems, and compensate the client's lack of awareness regarding GB development; the contractor can monitor the deliverables from sub-contractors and suppliers for compliance, can compensate the lack of sub-contractors' expertise, can complete the documentation required for GB certification, and deliver the project aspirations even in case design deliverables are incomplete and flawed; the sub-contractors can deliver the project tasks assigned to them while meeting sustainability aspirations; the PM team can focus its attention towards fulfilling sustainability outcomes, can monitor and control the design development to meet the project aspirations, and ensure an appropriate delegation of responsibilities among suitable professionals; and the FM team can effectively operate the GB project.

Conditions within this theme, as shown in Figure 8-18, can reduce the non-value adding activities in a GB project by resulting in project team collaboration, ensuring a complete and rigorously developed project design before the start of construction; and creating opportunities for efficiently achieving project outcomes. These conditions can also help create value for the client by, enabling the achievement of aspirations while developing and operating project; enabling the project team to pursue project goals; ensuring the rigorous design development; reducing the risk of not meeting project requirements; ensuring the client's understanding of GB requirements; and a rigorous execution of sustainable design during construction.

8.2.16. Team collaboration

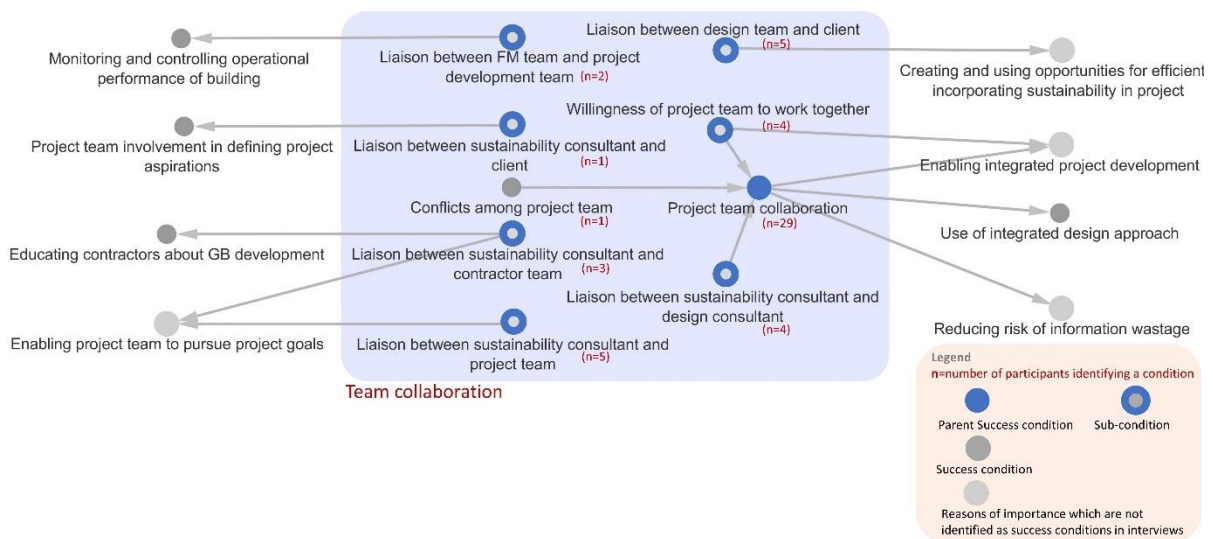


Figure 8-19: Conditions of 'Team collaboration'

The team collaboration-related aspects are associated with GB project success. This *theme* has 9 conditions (Figure 8-19) among which the key ones are 'Project team collaboration' (n=29) and 'Conflicts among project team' (n=1). 'Project team collaboration' is a condition representing a *cluster* with 7 sub-conditions which are about team willingness to work together (n=4); and liaison between the design team and client (n=5), FM team and project development team (n=2), sustainability consultant and client (n=1), sustainability consultant and contractor team (n=3), sustainability consultant and design consultant (n=4), and sustainability consultant and project team (n=5). Conditions within this *theme* are related to the client, FM team, contractor team, design consultant, sustainability consultant, as well as the overall project team (Table 8-1 and Figure 8-25).

According to the conditions represented by this theme, the likelihood of GB project success increases in case the misunderstandings and conflicts among team members are avoided as the project develops and the project team collaborates for achieving aspirations. Team collaboration means that the project team is willing and excited to collaborate for the project; the team has effective working dynamics and starts collaborating from the project onset. Project team collaboration also implies that there is an active communication link between the design team and the client; sustainability consultant and the client; sustainability consultant and contractor team; architect, MEP consultant and sustainability consultant; sustainability consultant and the overall project team; and the facility management team and project development team.

The importance of these conditions for project success is that they, enable the project team to work together for achieving project goals; help ensure that the team supports the project sustainability agenda; and help achieve the sustainable outcomes in the project. In specific terms, these conditions are important as they reduce the risk of design sub-optimisation and ensure an integrated design approach; help develop the client's trust in the design consultant enabling the consultant to incorporate sustainable building features; enable a long-term assessment of building sustainability spanning from project development to operation; enable a mutual consensus among the sustainability consultant and client regarding the sustainability aspects for project development; and enable the sustainability consultant to lead the project team including the contractor team towards sustainability goals.

Conditions within this theme, as shown in Figure 8-19, can reduce the non-value adding activities in a GB project by educating contractors about GB development; enabling an integrated project

development; reducing the risk of information wastage; and creating opportunities for efficiently incorporating sustainability in the project. These conditions can also help create value for the client by enabling the project team to pursue project goals; ensuring team involvement in defining project aspirations; and controlling the operational performance of the building.

8.2.17. Team commitment to the project

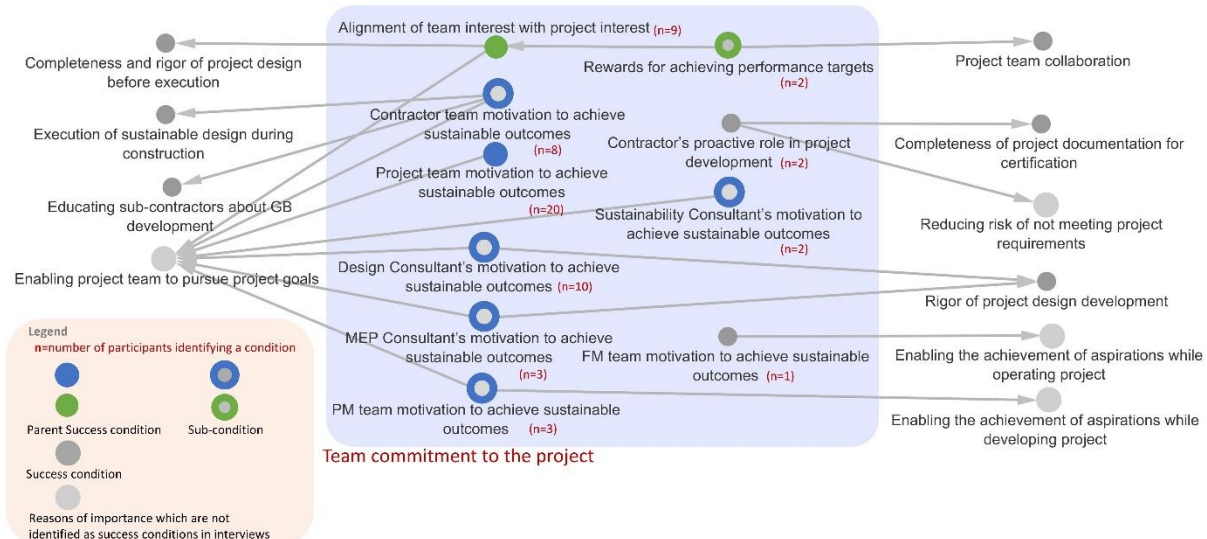


Figure 8-20: Conditions of 'Team commitment to the project'

The team commitment to the project is an important aspect associated with GB project success. This *theme* has 10 conditions (Figure 8-20) among which the key ones are 'Project team motivation to achieve sustainable outcomes' (n=20), 'Alignment of team interest with project interest' (n=9), 'Contractor's proactive role in project development' (n=2), and 'FM team motivation to achieve sustainable outcomes' (n=1). 'Alignment of team interest with project interest' is a condition representing a *cluster* with one sub-condition which is 'Rewards for achieving performance targets' (n=2). 'Project team motivation to achieve sustainable outcomes', is also a condition representing a *cluster* with 5 sub-conditions which are exclusively related to the motivation of Design Consultant (n=10), Contractor team (n=8), MEP Consultant (n=3), PM team (n=3), and Sustainability Consultant (n=2). Conditions within this *theme* are related to Design Consultant, Contractor team, MEP Consultant, FM team, PM team, Sustainability Consultant, as well as the overall project team (Table 8-1 and Figure 8-25).

According to the conditions represented by this theme, the likelihood of GB project success increases in case: the team interests are aligned with project interest and the project team is on-board to achieve project goals; there are incentives for the team to achieve the project goals; the contractor plays a proactive role by ensuring the buildability of design and avoiding the potential risks in the project; the FM team is motivated to achieve sustainable outcomes and operates a GB with special considerations; and there is interest and motivation of the project team towards sustainable outcomes. The motivation of project team implies that the sustainability consultant is committed to achieving sustainable outcomes; the sub-contractors, suppliers, head contractor team and particularly the environmental manager in contractor team are cooperative and motivated towards sustainable development; Design Consultants and MEP Consultants are motivated to deliver sustainable outcomes and are willing to develop the designs by accepting the recommendations from sustainability consultant; and the project management team takes interest in sustainable outcomes of the project and considers them as important aspects of project development.

The importance of these conditions for project success is that they help the project team to work collaboratively towards the project goals; and enable the project team to maintain a focus on sustainability and strive for sustainable outcomes. More specifically, these conditions are important for project success as they enable the sustainability consultant to lead the project team towards sustainability objectives; enable the Design Consultants and MEP Consultants to rigorously develop the project design which fulfils the sustainability aspirations; enable the contractor to deliver the project outcomes and ensure the completion of project documentation for green certification; and help the FM professionals to achieve the sustainable operational goals of the project.

Conditions within this theme, as shown in Figure 8-20, can reduce the non-value adding activities in a GB project by resulting in, project team collaboration; alignment of team interest with project interest; completeness and rigour of project design before execution; and awareness of contractor team about GB development. These conditions can also help create value for the client by resulting in, completeness of project documentation for certification; rigorous execution of sustainable design during construction; ease of project team to pursue project goals; reduced risk of not meeting project requirements; and the achievement of aspirations while developing and operating the project.

8.2.18. Team mindset and priorities



Figure 8-21: Conditions of 'Team mindset and priorities'

The team mindset and priorities are important aspects associated with GB project success. This *theme* has 6 conditions (Figure 8-21) which are 'Priority of sustainability in project development' (n=9), 'Team working on project with value management mindset' (n=5), 'Open-mindedness and flexibility of project team' (n=3), 'Establishing and promoting synergies' (n=2), 'Focus of sustainability consultant on project goals' (n=1), and 'Team working on project with innovative mindset' (n=1). Conditions within this *theme* are related to the Client, Sustainability Consultant as well as the overall project team (Table 8-1 and Figure 8-25).

According to the conditions represented by this theme, the likelihood of GB project success increases in case, synergies among project team are established and promoted during the course of project development; the project team works with a value management mindset and explores suitable economic solutions to ensure cost-benefit optimisation; the project team has the flexibility to adapt to the GB project requirements; and the project team has an innovative mindset and does not consider the project in terms of business as usual. Moreover, the sustainability consultant has a focus on project goals and can prioritise important aspects in the project; the design team members have the open-mindedness to accept each other's opinions; and sustainability is prioritised in project agenda and the guidelines from sustainability consultant are seriously followed.

These conditions are important for project success as they result in increased value for different project features; enable the project team to deliver aspired sustainability outcomes in project development;

result in effective solutions and approaches to sustainable project development; reduce the risk of eliminating project features in the later stages of project development; enable better communication among design team; and drive the project team to achieve sustainability in project development.

Conditions within this theme, as shown in Figure 8-21, can reduce the non-value adding activities in a GB project by, resulting in communication and collaboration among project team; and creating opportunities for efficiently achieving project outcomes. These conditions can also help create value for the client by, reducing the risk of not meeting project requirements; enabling the achievement of aspirations while developing the project; and increasing the value of building components. One condition that is 'Team working on project with value management mindset' is also related to the transformation of the project.

8.2.19. Team procurement methodology

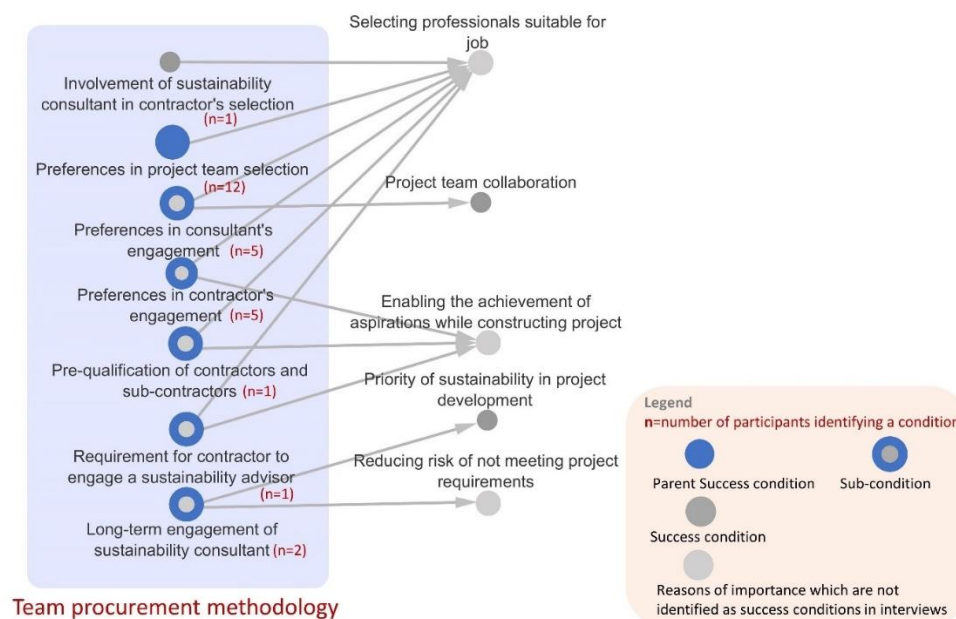


Figure 8-22: Conditions of 'Team procurement methodology'

The team procurement methodology is an important aspect associated with GB project success. This *theme* has 7 conditions (Figure 8-22) among which the key ones are 'Preferences in project team selection' (n=12) and 'Involvement of sustainability consultant in contractor's selection' (n=1). 'Preferences in project team selection', is a condition representing a *cluster* with 5 sub-conditions which are 'Long-term engagement of sustainability consultant' (n=2), 'Preferences in consultant's engagement' (n=5), 'Preferences in contractor's engagement' (n=5), 'Pre-qualification of contractors and sub-contractors' (n=1), and 'Requirement for contractor to engage a sustainability advisor' (n=1). Conditions within this *theme* are related to Design Consultant, Contractor team, Sustainability Consultant as well as the overall project team (Table 8-1 and Figure 8-25).

According to the conditions represented in this theme, the likelihood of GB project success increases in case, the project team is carefully selected based on some criteria including the behavioural aspects; the sustainability consultant is engaged for the whole duration of project development and is involved in contractor's selection; a pre-qualification process of contractors and sub-contractors is conducted; the contractor team is required to have a sustainability advisor; the contractors selected are motivated to work on GBs, can adapt themselves to project requirements and have the experience, knowledge and skill set necessary for GB development; and the design consultants are carefully selected

considering their ability to work on GB projects and their ability to adapt themselves to the project requirements. The importance of these conditions for project success is that they, help engage a project team proficient in GB development which can effectively collaborate for delivering the project; enable the sustainability consultant to incorporate sustainability aspirations in the project; ensure a continuous focus on sustainability as the project is developed; and reduce the risk of not meeting project aspirations.

Conditions within this theme, as shown in Figure 8-22, can reduce the non-value adding activities in a GB project by resulting in project team collaboration and the selection of suitable professionals for the project. These conditions can also help create value for the client by, reducing the risk of not meeting project requirements; enabling the achievement of aspirations while constructing project; and prioritising sustainability in project development.

8.2.20. Timeliness of project activities

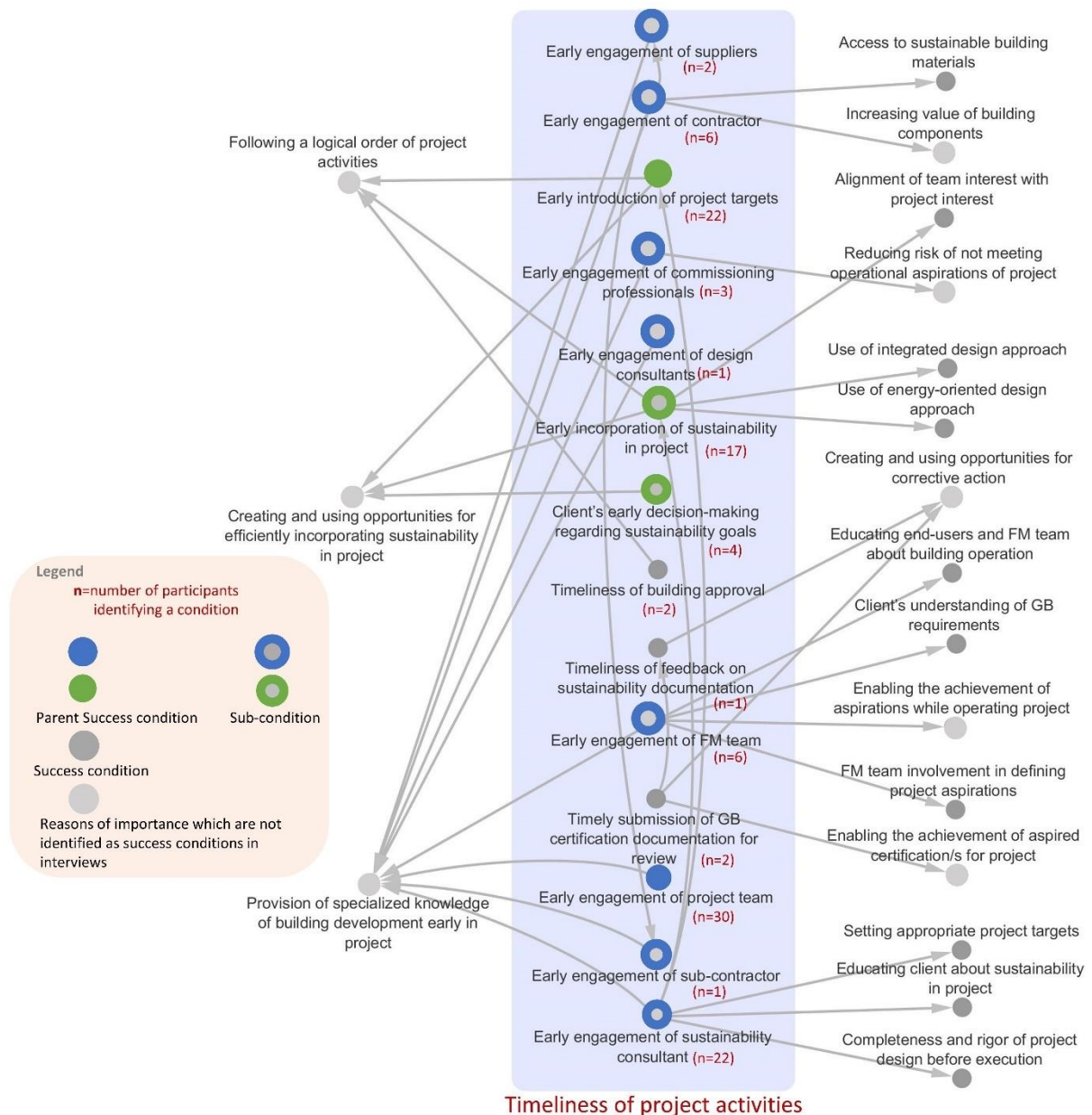


Figure 8-23: Conditions of 'Timeliness of project activities'

The conditions within this *theme*, as shown in Figure 8-23, are about the time-sensitivity of different aspects of GB project development. The two highly identified conditions within this *theme* are 'Early engagement of project team' (n=30) and 'Early introduction of project targets' (n=22). Conditions within this *theme* are specifically related to the project client, contractor, design team, facility management team, sub-contractors, suppliers, sustainability consultant, commissioning team, building control authorities and GB certification organisations. These conditions are generally related to the overall project team (Table 8-1 and Figure 8-25).

According to the conditions represented by this theme, the likelihood of GB project success increases in case: there is early involvement of team members in the project lifecycle; the project targets are introduced at the project outset; building planning approvals are processed in due time; and the GB certification documentation is timely submitted for review and receives a timely feedback from GB certification organisation. The early involvement of team members implies early involvement of design consultants, sustainability consultants, commissioning professionals, suppliers and sub-contractors; contractor's engagement in the design development stage; and the engagement of FM team during the project design development. The introduction of project targets at the project outset implies the client's early decision-making regarding sustainability goals; consideration of sustainability from project start; involvement of GB concepts in the early design decisions; and the clear articulation of the idea of GB development in the site selection stage.

These conditions are important for project success as they, help set appropriate project goals; enable the involvement of FM team in defining project aspirations; ease the access to sustainable materials; increase the value of building components; align team interests with project goals; and help educate the project client, end-users, and FM team about sustainable building development and operation. These conditions contribute towards design development by ensuring the completeness of design before execution and ensuring the use of integrated and energy-oriented design approach. These conditions are also important for GB project success since they create the opportunities for corrective actions; reduce the risk of not meeting operational aspirations and in fact, enable the achievement of aspired certifications and operational goals. Many of these conditions help follow a logical order of project activities; create opportunities for efficient incorporation of sustainability; and enable the provision of specialised knowledge of building development early in the project.

Conditions within this theme, as shown in Figure 8-23, can reduce the non-value adding activities in a GB project by, enabling the access to sustainable building materials, enabling the alignment of team interest with project interest, contributing towards the client's understanding of GB requirements, ensuring completeness and rigour of project design before execution, following a logical order of project activities, enabling the availability of specialised knowledge of building development early in the project, and by creating and using opportunities for corrective action and opportunities for efficiently incorporating sustainability in the project. These conditions can also help create value for the client by educating end-users and FM team about building operation, enabling the achievement of aspired certification/s for the project, enabling the achievement of aspirations while operating project, increasing the value of building components, reducing the risk of not meeting operational aspirations of project, and setting appropriate project targets.

8.3. Project stakeholders responsible for and affected by Success conditions

A word frequency analysis was conducted on interview data regarding Success conditions and the most used words (as shown in Figure 8-24) include: green, building, project, sustainability, team, client, consultant, contractor, development, energy, performance, people, requirements, management, stage, certification, targets, construction, cost, developer, and successful. It shows that a sizable

number of participants refer to project stakeholders while discussing GB Success conditions. It is important for theoretical and practical reasons to know the stakeholders responsible for and affected by Success conditions. In practice, by knowing the important stakeholders for a Success condition, that condition can be assigned to stakeholders who control the process of project development. In theory, by knowing the stakeholders affecting and affected by a condition, it is possible to determine the level of significance and complexity associated with a Success condition.



Figure 8-24: Word cloud summarising the responses to the interview theme of Success conditions

In the semi-structured interviews, the term ‘client’ refers to the party for whom the project procurement takes place, and for whom services of the project team are provided. A project client can be the owner of a GB project, a developer, an investor, and in some cases also the end-user. While a client can be an end-user, the FM team can also be the end-user. While a considerable number of Success conditions are associated with the overall project team, many conditions are also associated with the specialist groups of the overall team such as the sustainability team and design team. Within these specialist teams, ‘Contractor team’ includes both the head contractor team as well as the sub-contractors; and ‘Design team’ includes both the architectural design consultants and the MEP design consultants. The term ‘External Stakeholders’ refers to GB certification organisations (for example, USGBC and GBCA), neighbourhood community, and building control authorities.

The identified Success conditions are analysed to identify the project stakeholders they are related to. The associations of conditions with project stakeholders are shown in Table 8-1, while the associations of the broader *themes* of Success condition with project stakeholders are shown in Figure 8-25. Alongside Suppliers and External Stakeholders, there are three sets of stakeholders in Figure 8-25. Within the Project team set, there is 'Overall Project team' alongside specialist teams such as 'Project Management (PM) team' and 'Commissioning team'. The reason for such distribution is that some Success conditions are exclusively related to specialist teams while some other conditions are related to the overall project team. The highest number of conditions (number of conditions= 43; 28%) are associated with the overall project team. Some conditions are specifically associated with the specialist teams such as Design team (n=32; 21%), Contractor team (n=18; 12%), Sustainability consultant (n=13; 8%), PM team (n=11; 7%), and Commissioning team (n=2; 1%). Following the overall project team, the highest association of conditions is with the project client (n=36; 23%). A notable number of conditions are also associated with End-users (n=8; 5%) and FM team (n=9; 6%). The least number of conditions are associated with External Stakeholders (n=4; 3%) and Suppliers (n=2; 1%).

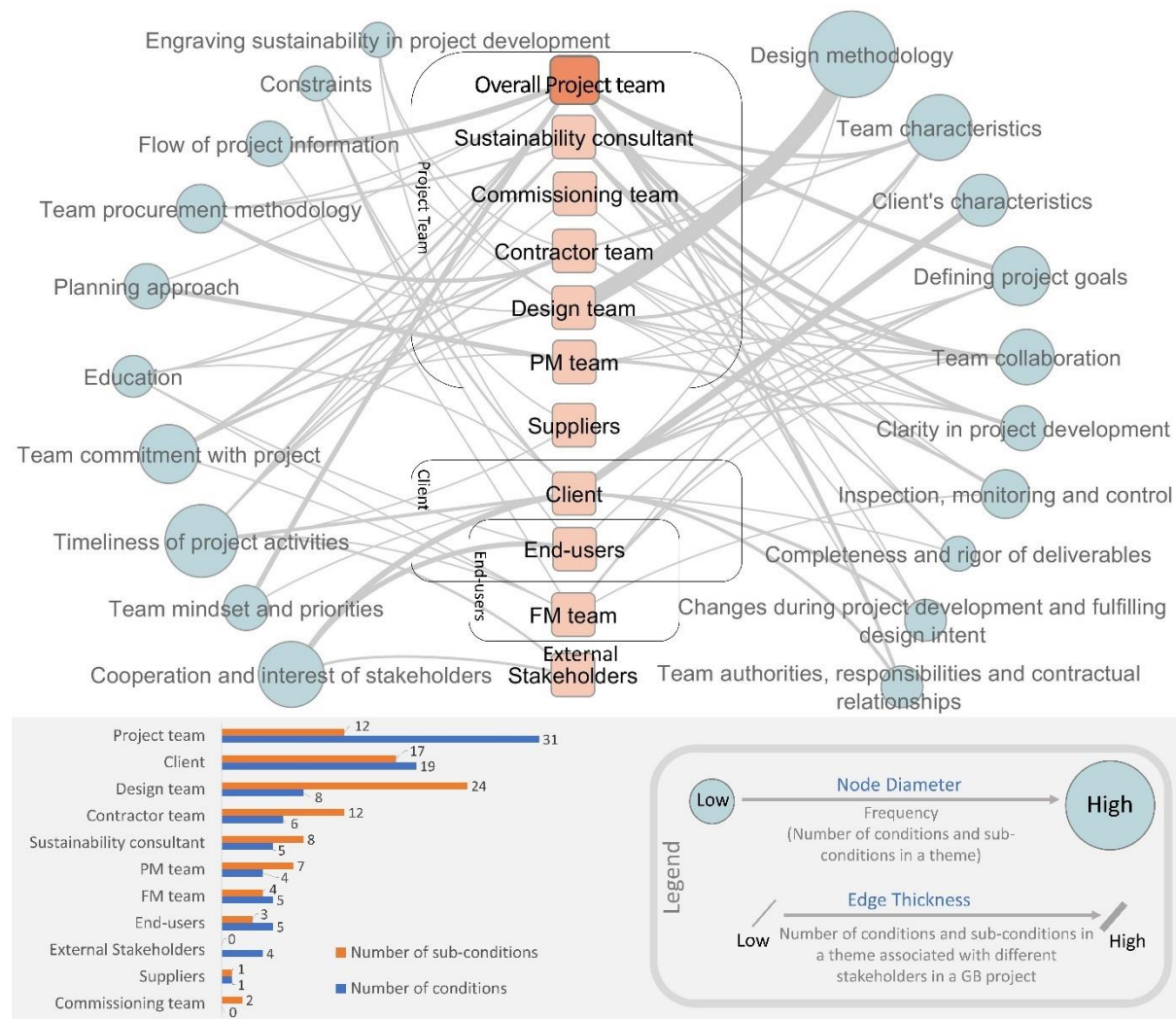


Figure 8-25: Associations of the themes of Success conditions with Green Building project stakeholders

The detailed analysis reveals that for some conditions, the stakeholders affecting a condition and the stakeholders affected by a Success condition are not the same. For instance, 'Clarity in process of developing project' is a condition which affects the project team. However, the project client has more control over this condition. This points towards an added layer of complexity in Success conditions since one condition may affect and be affected by multiple stakeholders, enabling the Success condition to affect the interests of multiple parties.

Table 8-1: Associations of Success conditions with Green Building project stakeholders

Theme	Sr.no	Identified conditions	Overall participants	Overall Project team	Design team	Contractor team	Sustainability consultant	PM team	Commissioning team	Suppliers	Client	FM team	End-users	External Stakeholders
Changes during project development and fulfilling design intent	1	Change in project team members	2	x										
	2	Execution of sustainable design during construction	5			x								
	3	Scope changes during project execution	9								x			
	3.1	Permanence in client's requirements during project delivery	2								x			
	3.2	Client's motivation to achieve original project intent	3								x			
Clarity in project development	4	Clarity in process of developing project	9	x							x			
	4.1	Use of clearly defined and standardised approaches for GB development	5	x							x			
	5	Delegating clear responsibilities to project team	6	x										
	5.1	Project team contractually required to deliver sustainable outcomes	2	x										
	5.2	Provision of sustainability specifications and other related information in tender	4			x								
Client's characteristics	5.3	Specificity of deliverables from Design Consultants	2		x									
	6	Client's leadership in project	3								x			
	7	Consensus within client organisation	2								x			
	8	Proficiency of project client	20								x			
	8.1	Client understanding the need of sustainable outcomes	5								x			
	8.2	Client's understanding of GB requirements	12								x			
	8.3	Client's understanding of sustainable building operation	2								x			
	8.4	Client's rational decision-making	1								x			
	9	Structure and nature of client organisation	5								x			
Completeness and rigour of deliverables	10	Completeness of project documentation for certification	2	x										
	11	Completeness and rigour of project design before execution	9		x	x								
	12	Setting of a detailed sustainability charter or brief	10								x			
Constraints	13	Access to sustainable building materials	2		x					x				
	14	Accessibility of project funding	6								x			
	15	Ease of logistics at project location	1								x		x	
Cooperation and interest of stakeholders	16	Client's involvement in project development	5								x			
	16.1	Client's facilitation of coordination among project team	1								x			
	17	Client's motivation to achieve sustainable outcomes	32								x			
	17.1	Client's endorsement of sustainability brief	3								x			
	17.2	Drivers for client to achieve sustainable outcomes	12								x			
	17.3	Investor's motivation to achieve sustainable outcomes	1								x			
	18	Cooperative role of building control authorities	2											x
	19	End-users' operation of building in sustainable ways	12										x	
	19.1	End-users' motivation to achieve sustainable outcomes	1										x	
	19.2	End-users' understanding of building operation	5										x	
	19.3	Tenants contractually required to consider sustainability	2										x	

An inquiry of conditions and criteria associated with Green Building project success

Theme	Sr.no	Identified conditions	Overall participants	Overall Project team	Design team	Contractor team	Sustainability consultant	PM team	Commissioning team	Suppliers	Client	FM team	End-users	External Stakeholders
Defining project goals	20	Stakeholders' approval of project	4										x	x
	21	End-users' involvement in defining project aspirations	8										x	
	21.1	FM team involvement in defining project aspirations	1									x		
	22	Project team involvement in defining project aspirations	3	x										
	23	Setting appropriate project targets	21	x							x			
	23.1	Clarity in building's operational performance targets	1									x		
	23.2	Nature of GB certification aspired for project	2								x			
	23.3	Sustainability brief aligned with project budget	3					x						
	23.4	Specificity of project requirements	12	x										
	24	Stringency level of project sustainability requirements	4	x										
Design methodology	24.1	Stringency level of GB certification requirements	2	x										
	25	Market survey to identify successful building systems	1		x						x			
	26	Rigour of project design development	41		x									
	26.01	Adding adaptability and multiple layers of use in building design	1		x									
	26.02	Use of reliable technology and solutions	2		x									
	26.03	Design consideration towards future building usage	3		x									
	26.04	Level of complexity in project design	4		x									
	26.05	Life-cycle based project development approach	4		x									
	26.06	Maintainability considered in building design	3		x									
	26.07	Speculation in building design	7		x									
	26.08	Suitability of the project design for execution	3		x									
	26.09	Use of a proactive design approach	5		x									
	26.1	Use of balanced design approach	1		x									
	26.11	Use of context-oriented design approach	3		x									
	26.12	Use of energy-oriented design approach	12		x									
	26.13	Use of holistic design approach	9		x									
	26.14	Use of innovative design approach	6		x									
	26.15	Use of integrated design approach	13		x									
Education	27	Use of performance-based specifications	1		x	x								
	28	Educating client about sustainability in project	6								x			
	29	Educating end-users and FM team about building operation	9									x	x	
	30	Educating project team about GB development	8	x										
	30.1	Educating contractors about GB development	3			x								
	30.2	Educating sub-contractors about GB development	2			x								
Engraving sustainability in project development	31	Engraving sustainability in project development	8		x									
	32	Procurement of project site based on sustainability goals	3								x			
	33	Use of environmental management systems in construction	1			x								
	34	Clarity in communication of project goals	7	x										

Theme	Sr.no	Identified conditions	Overall participants	Overall Project team	Design team	Contractor team	Sustainability consultant	PM team	Commissioning team	Suppliers	Client	FM team	End-users	External Stakeholders
Flow of project information	35	Communication among project team	11	x										
	35.1	Use of effective communication tools and strategies	5	x										
	36	Project team's access to robust information	5	x										
	36.1	Sharing of information related to project changes	1	x										
	37	Smooth transition of project from inception to operation stage	5	x								x		
Inspection, monitoring, and control	38	Inspection of project upon construction	8					x						
	38.1	Execution of commissioning and fine-tuning	7						x					
	39	Monitoring and controlling operational performance of building	5									x		
	40	Monitoring of project development	12					x						
	40.1	Project reporting	2					x						
	41	Review of project design by sustainability consultant	2				x							
	42	Thoroughness of value engineering exercise	3	x										
	43	Attention towards details	5	x										
Planning approach	44	Rigour of project planning	19					x						
	44.1	Adequate budget allocation for project development	13					x						
	44.2	Adequate time allocation for commissioning and testing	1					x						
	44.3	Adequate time allocation for project development	11					x						
	45	Rigour of risk management	4					x						
	46	Control of project design by Design and Sustainability Consultant	2		x		x							
Team authorities, responsibilities, and contractual relationships	47	Empowerment of sustainability consultant by client	3				x				x			
	48	Project team's involvement in decision-making	2	x										
	49	Using appropriate project delivery method	3	x							x			
	49.1	Contractual interrelationships between client and project team	2	x							x			
Team characteristics	50	Like-mindedness of project team members	2	x										
	51	Proficiency of FM team	3									x		
	52	Proficiency of project team	32	x										
	52.1	Leadership qualities among project team members	2	x										
	52.2	Proficiency of contractor	12			x								
	52.3	Proficiency of Design Consultant	12		x									
	52.4	Proficiency of MEP Consultant	6		x									
	52.5	Proficiency of PM team	4					x						
	52.6	Proficiency of sub-contractor	5			x								
	52.7	Proficiency of sustainability consultant	5				x							
	53	Project team's understanding of project goals and aspirations	3	x										
	54	Size of design team	2		x									
	55	Conflicts among project team	1	x										
	56	Project team collaboration	29	x										
Team collaboration	56.1	Liaison between design team and client	5		x						x			

An inquiry of conditions and criteria associated with Green Building project success

Theme	Sr.no	Identified conditions	Overall participants	Overall Project team	Design team	Contractor team	Sustainability consultant	PM team	Commissioning team	Suppliers	Client	FM team	End-users	External Stakeholders
Team commitment to the project	56.2	Liaison between FM team and project development team	2	x								x		
	56.3	Liaison between sustainability consultant and client	1				x				x			
	56.4	Liaison between sustainability consultant and contractor team	3			x	x							
	56.5	Liaison between sustainability consultant and design consultant	4		x		x							
	56.6	Liaison between sustainability consultant and project team	5	x			x							
	56.7	Willingness of project team to work together	4	x										
	57	Alignment of team interest with project interest	9	x										
	57.1	Rewards for achieving performance targets	2	x										
	58	Contractor's proactive role in project development	2			x								
	59	FM team motivation to achieve sustainable outcomes	1									x		
	60	Project team motivation to achieve sustainable outcomes	20	x										
	60.1	Contractor team motivation to achieve sustainable outcomes	8			x								
	60.2	Design Consultant's motivation to achieve sustainable outcomes	10		x									
	60.3	MEP Consultant's motivation to achieve sustainable outcomes	3		x									
	60.4	PM team motivation to achieve sustainable outcomes	3					x						
Team mindset and priorities	60.5	Sustainability Consultant's motivation to achieve sustainable outcomes	2				x							
	61	Establishing and promoting synergies	2	x										
	62	Focus of sustainability consultant on project goals	1				x							
	63	Open-mindedness and flexibility of project team	3	x										
	64	Priority of sustainability in project development	9	x							x			
	65	Team working on project with innovative mindset	1	x										
Team procurement methodology	66	Team working on project with value management mindset	5	x										
	67	Involvement of sustainability consultant in contractor's selection	1			x	x							
	68	Preferences in project team selection	12	x										
	68.1	Long-term engagement of sustainability consultant	2				x							
	68.2	Preferences in consultant's engagement	5		x									
	68.3	Preferences in contractor's engagement	5			x								
	68.4	Pre-qualification of contractors and sub-contractors	1			x								
Timeliness of project activities	68.5	Requirement for contractor to engage a sustainability advisor	1			x								
	69	Early engagement of project team	30	x										
	69.1	Early engagement of commissioning professionals	3						x					
	69.2	Early engagement of contractor	6			x								
	69.3	Early engagement of design consultants	1		x									
	69.4	Early engagement of FM team	6									x		
	69.5	Early engagement of sub-contractor	1			x								
	69.6	Early engagement of suppliers	2							x				
	69.7	Early engagement of sustainability consultant	22				x							
	70	Early introduction of project targets	22								x			

Theme	Sr.no	Identified conditions	Overall participants	Overall Project team	Design team	Contractor team	Sustainability consultant	PM team	Commissioning team	Suppliers	Client	FM team	End-users	External Stakeholders
	70.1	Client's early decision-making regarding sustainability goals	4								x			
	70.2	Early incorporation of sustainability in project	17								x			
	71	Timeliness of building approval	2											x
	72	Timeliness of feedback on sustainability documentation	1											x
	73	Timely submission of GB certification documentation for review	2	x										
		Sum of conditions		31	8	6	5	4	0	1	19	5	5	4
		Sum of sub-conditions		12	24	12	8	7	2	1	17	4	3	0
		Sum of conditions and sub-conditions		43	32	18	13	11	2	2	36	9	8	4

Note: 'Contractor team' includes both the head contractor team as well as the sub-contractors; 'Design team' includes the architectural design consultants and the MEP design consultants; 'External Stakeholders' include the GB certification organisations, neighbourhood community, and building control authorities

8.4. Robustness analysis of Success conditions network

GB projects are complex from a socio-technical perspective. The development and operation of GBs are subject to a plethora of conditions, and a sizable number of these have been discussed as Success conditions in this chapter. These conditions are interconnected to form a network where the changes in one condition may lead to changes in one or more conditions. This association of conditions in a network can result in the complex behaviour of individual conditions.

For instance, in a network, the unsuitable variable states in a condition may endanger project performance but may not directly result in project failure. This is because a project is influenced by a number of conditions and since the conditions are interlinked, the conditions may compensate each other and a linear association among the Success conditions and project performance may not be observed. For instance, according to a Pakistan-based interview participant (PK-M-1), getting a contractor on-board helps the clash avoidance exercise while another approach is to engage a construction manager early in the project who can then participate in the clash avoidance exercise. Hence, even if the contractor is not involved in this exercise, the issues of buildability and construction in a building project can be highlighted by the Construction Manager in joint meetings. This is an example of how Success conditions interrelate and compensate for each other.

The Success conditions identified in this study occur in a complex network. The fully-developed Green Building Success conditions (GBSC) network is shown in Section 8.2 (Figure 8-3). The nodes in this fully-developed network include not only the Success conditions but also the outcome conditions. The network is simplified for analysis to better understand the behaviour of Success conditions. Its simplified version (shown in Figure 8-26) exclusively comprises Success conditions and not the outcome conditions. As the simplified GBSC network (Figure 8-26) consolidates the sub-conditions (that is, A.1, A.2, B.1, and B.2) into Success conditions (A and B), the large number of edges have also been consolidated such that the associations of sub-conditions 'A.1' and 'A.2' with sub-conditions 'B.1' and 'B.2' are replaced by the association of Success condition 'A' with condition 'B'. In comparison with the fully represented GBSC network (Figure 8-3) having 174 nodes (that is, 73 Success conditions, 82 sub-conditions, 1 Underlying condition, and 18 outcome conditions), the simplified network (Figure 8-26) has 73 nodes (that is 73 Success conditions) only.

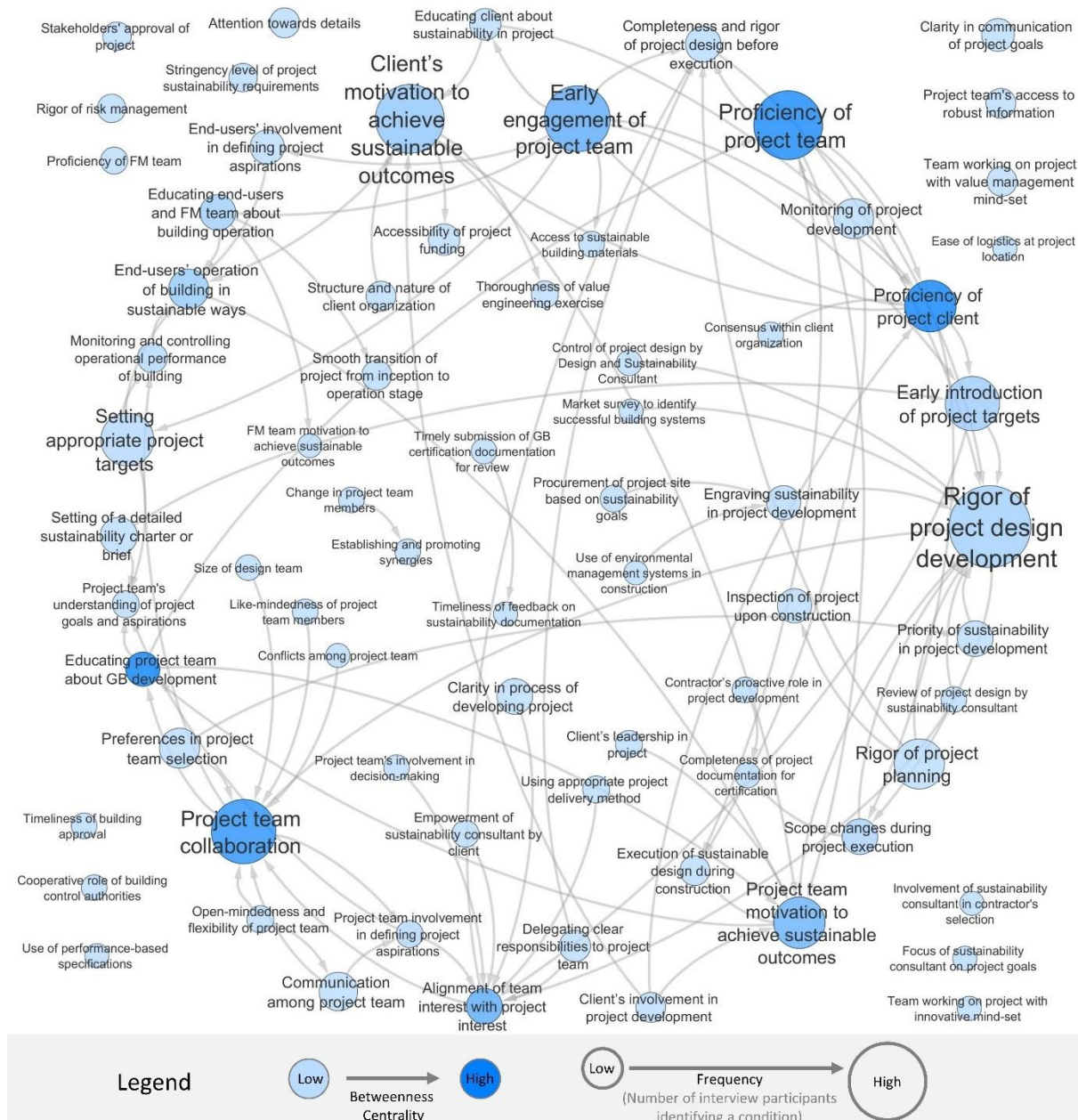


Figure 8-26: Simplified network of Green Building Success conditions

In a complex system, the associations of an element with other elements are important. Moreover, the overall interrelationships among the various elements are also important. Accordingly, the analysis of the Success conditions in the network is presented in two parts. First, the attributes of nodes in the network are explained and key findings are highlighted. Second, the attributes of the overall network are discussed.

8.4.1. Success conditions network: analysing node attributes

The attributes of nodes in this network can be defined in terms of Edge count, Stress, Betweenness centrality, Partner of multi-edged node pairs, Eccentricity, Is-single-node, Closeness centrality, Average shortest path length, Neighbourhood connectivity, and Clustering coefficient. In case a node is not isolated (that is with no associations), it has neighbouring node/s. A detailed account of the network attributes of Success conditions is provided in Appendix D (Section D.2).

A brief description of the node attributes in the context of the GBSC network is as follows:

- An **Edge** means the association of a node with another node and the edge count implies the number of associations a node has with other nodes in the network. In the GBSC network, some conditions with high edge count values are 'Rigour of project design development' (13), 'Project team collaboration' (11), and 'Alignment of team interest with project interest' (10).
- The **Clustering Coefficient** is the ratio between the number of edges between the neighbours of a node 'A', and the maximum number of edges that could possibly exist between the neighbours of 'A'. The clustering coefficient of a node is a number between 0 and 1. In the GBSC network, the highest value of clustering coefficient (0.50) is noted for four conditions which are 'Delegating clear responsibilities to project team', 'Educating client about sustainability in project', 'Monitoring of project development', and 'Open-mindedness and flexibility of project team'.
- The **Neighbourhood connectivity** of a node 'A' is defined as the average connectivity of all neighbours of 'A' (Maslov & Sneppen, 2002). In the GBSC network, the highest value of neighbourhood connectivity (12) is noted for two conditions which are 'Market survey to identify successful building systems' and 'Control of project design by Design and Sustainability Consultant'.
- The **Betweenness centrality** of a node reflects the amount of control that a node 'A' exerts over the interactions of other nodes in the network (Yoon, Blumer, & Lee, 2006). This measure favours such nodes which join communities (dense subnetworks), rather than the nodes which lie inside a community. Some conditions in the GBSC network with high values of betweenness centrality are 'Educating project team about GB development' (0.17), 'Proficiency of project client' (0.16), 'Proficiency of project team' (0.16), and 'Project team collaboration' (0.14).
- The **Shortest path** between two nodes in a network is a path with the minimum number of edges. Average Shortest Path Length is the average length value of the shortest path between node 'A' and any other node. If 'A' is an isolated node, the value of this attribute is zero. About ten Success conditions in the GBSC network have the Average Shortest Path Length value higher than 5. Some nodes with high values in this attribute are 'End-users' involvement in defining project aspirations' (5.65), 'Monitoring and controlling operational performance of building' (5.62), and 'Setting of a detailed sustainability charter or brief' (5.41). The shortest path length is an important attribute since it also defines some other attributes such as eccentricity, closeness centrality, and stress centrality.
 - **Eccentricity** is the maximum length of the shortest path between node 'A' and another node in the network. The isolated nodes have '0' value for this attribute. In the GBSC network, the highest eccentricity value (9) is noted for six conditions which are 'Educating end-users and FM team about building operation', 'Setting appropriate project targets', 'Monitoring and controlling operational performance of building', 'Setting of a detailed sustainability charter or brief', 'End-users' involvement in defining project aspirations', and 'Structure and nature of client organisation'.
 - The **Closeness centrality** of a node is defined as the reciprocal of the average shortest path length. Closeness centrality is a measure of how fast information spreads from a given node to other reachable nodes in the network (Newman, 2005). In the GBSC network, the highest value of closeness centrality (1) is noted for four conditions which are 'Scope changes during project execution', 'Contractor's proactive role in project development', 'Change in project team members', and 'Timely submission of GB certification documentation for review'.
 - The **Stress centrality** of a node 'A' is the number of shortest paths passing through 'A'. A node has high stress if it is traversed by a high number of shortest paths. In the GBSC network some conditions with high-stress values are 'Educating project team about GB development' (489),

‘Proficiency of project client’ (462), ‘Proficiency of project team’ (445), and ‘Project team collaboration’ (428).

- **Is-Single-Node** is a Boolean attribute indicating if node ‘A’ is an isolated node (has no neighbours). The GBSC network has 15 isolated nodes (that is Success conditions) and 58 non-isolated nodes.
- **Partner-of-Multi-edged-node-pairs** is an attribute indicating if node ‘A’ is a partner of node pairs with multiple edges. Only six among the 73 conditions in the GBSC network are found to be the partner of multi-edged node pairs and these are ‘Project team motivation to achieve sustainable outcomes’, ‘Educating project team about GB development’, ‘Proficiency of project client’, ‘Early engagement of project team’, ‘Rigour of project design development’, and ‘Scope changes during project execution’.

Frequency is a measure of the number of interview participants identifying a Success condition. It is a key measure in this study as it determines the importance given to a Success condition by GB experts belonging to different professional and regional backgrounds. Regression analysis is conducted to determine if the Success conditions identified by a large number of interview participants (that is with high frequency) also perform well in their network attributes (such as Edge count, Stress, and Betweenness centrality). The correlation of frequency and the number of sub-conditions associated with Success conditions is also analysed. While frequency is considered an independent variable in this analysis, the dependent variables are Edge count, Stress, Betweenness centrality, Partner of multi-edged node pairs, Eccentricity, Is-Single-Node, Closeness centrality, Average shortest path length, Neighbourhood connectivity, Clustering coefficient, and Number of sub-conditions. Since regression analysis is conducted for nodes occurring in the simplified GBSC network only, the Success conditions are included but not their sub-conditions.

The results of the correlation analysis are presented in Figure 8-27. The highest R-squared value (0.772) is observed when the dependent variable is ‘Number of sub-conditions’ implying that the conditions with a higher number of sub-conditions have a relatively higher measure of frequency. A high R-squared value (0.692) is also observed in the case of Edge count as the dependent variable, implying that up to 70% of the Edge count values are explained by Frequency values. Notable R-squared values are also observed in the case of Stress (0.367) and Betweenness centrality (0.362). From Figure 8-27, it can be noted that the variables (that is number of sub-conditions) which have a high degree of correlation with frequency are in fact positively related to it. On the contrary, two dependent variables having a negative relationship with frequency (that is, Single node property and Neighbourhood connectivity) have a considerably low degree of correlation (that is R-squared value).

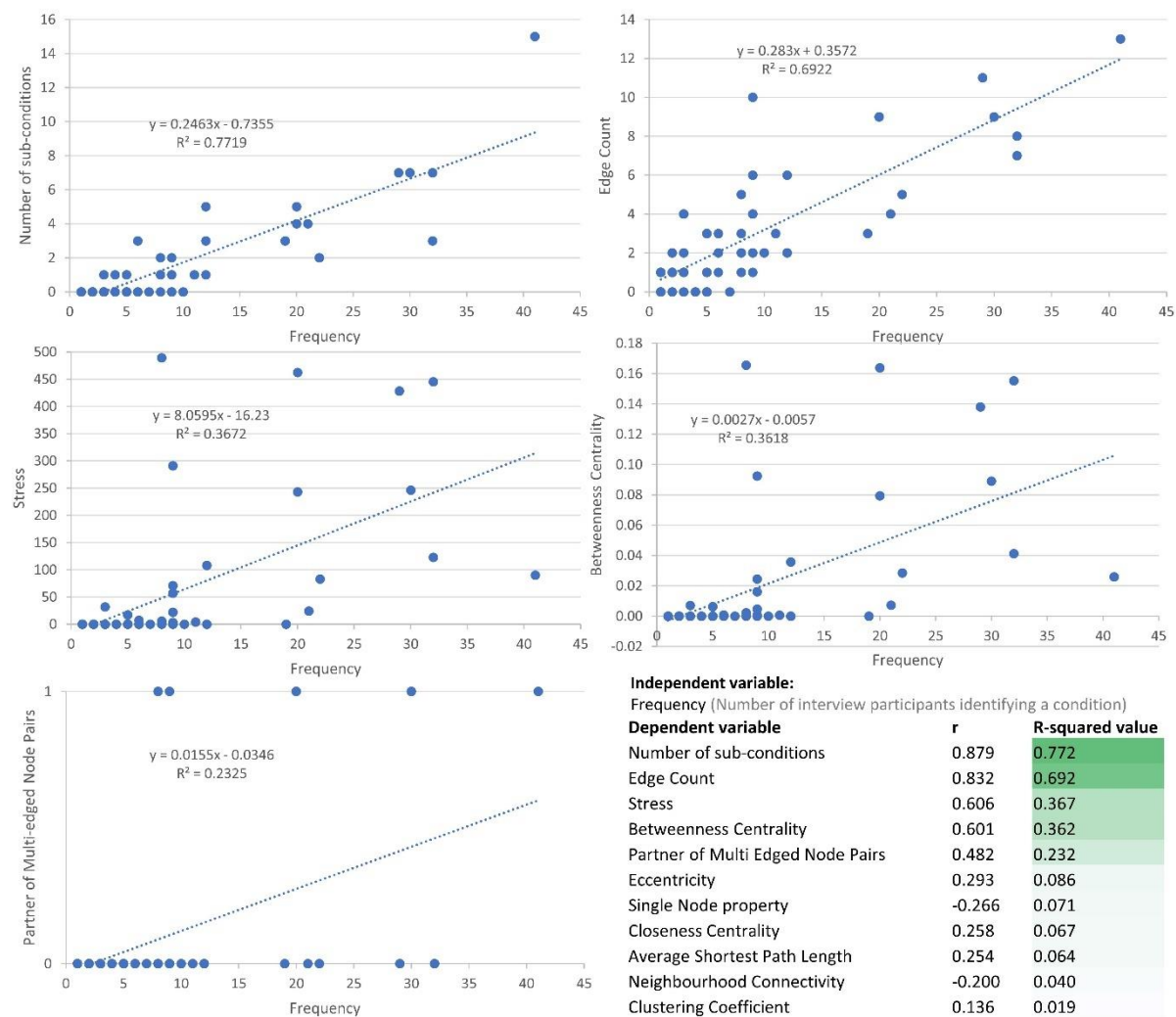


Figure 8-27: Correlation of the frequency of Success conditions with node attributes in the network

A highly positive correlation ($R\text{-square}=0.772$) between frequency and the number of sub-conditions can be explained in terms of the data collection method used. In the semi-structured interviews, the participants provided in-depth accounts of the Success conditions which led to the identification of sub-conditions related to Success conditions. High frequency of condition 'A' implies a relatively detailed discussion of it during the interview and therefore a high probability of the identification of sub-conditions related to Success condition 'A'. In short, when more people talk about a Success condition, they are more likely to talk about its sub-conditions as well.

The high correlation between frequency and Edge count value is also because of the nature of the data collection technique used in this study. The semi-structured interviews conducted in this study provided both the identification of the Success conditions as well as the explanation behind the importance of Success conditions which revealed the associations among Success conditions. For instance, an interview participant would mention that 'A' is a Success condition and the importance of condition 'A' for GB project success is that it results-in/affects/associates-with/compensates condition 'B'. In case, many participants identify condition 'A', there is a high probability that they would also indicate the association of 'A' with other conditions. Hence, a high number of associations of condition 'A' may be identified in case condition 'A' has a high frequency.

Since Edge count is the number of associations of a condition with other conditions, a highly positive correlation among frequency and the Edge count of conditions is justified. Is-Single-Node is an attribute

in contrast with the Edge count, and it is the measure of a condition appearing as an isolated node in the network or as a connected node. While the increase in frequency is associated with an increase in Edge count value, it is also associated with a reduction in Is-Single-Node value of Success conditions. This means that with the increase in the frequency of conditions, the isolation of conditions in the network reduces and their association with other conditions in the network increases.

A significant correlation ($R\text{-square} = 0.362$) is observed in the case of Betweenness centrality. This correlation can also be visualised in Figure 8-3 where some conditions with high-frequency values (such as 'Proficiency of project team' and 'Project team collaboration') also have high values of Betweenness centrality. In contrast, some conditions such as 'Rigour of project design development' and 'Educating project team about GB development' have high-frequency values but low values of Betweenness centrality and *vice versa*.

The positive association of frequency with the number of conditions and edge count highlights the role of semi-structured interviews as a data collection method in GB project success inquiry. It points out that the higher frequency count of Success conditions resulting from a high number of interviews can lead to an in-depth understanding of Success conditions in terms of the sub-conditions. Moreover, in terms of the systems-approach, a large number of condition associations provided by a large number of interview participants can lead to a comprehensive and rigorous network of conditions. Hence, with the increase in interview participants, a more detailed understanding is enabled at the level of individual conditions as well as condition network.

8.4.2. Success conditions network: analysing network attributes

While the attributes of individual nodes are important to inform how a node behaves in the overall network, the behaviour of the overall network cannot be determined at the level of individual nodes and requires the analysis of network attributes. An important property of a network is its response to external threats. Robustness in a complex network can be considered as the response of the network to the removal of nodes. While removing a single node has only a limited impact on the integrity of a network, removing several nodes can break the network into many isolated parts. As the number of nodes removed increases, the chances of damaging a network also increase. It is important to know the number of nodes which once removed can lead to the network disintegration (Barabási, 2016).

In a network, such nodes can be considered important which result in connectivity among the overall nodes. The **Betweenness centrality** of a node is an attribute determining the amount of control that node 'A' exerts over the interactions of other nodes in the network (Yoon et al., 2006). Therefore, the Betweenness centrality attribute determines the relative importance of a node by measuring the amount of traffic flowing through that node to other nodes in the network. By progressively eliminating conditions with high Betweenness centrality values, the degree of disorder created in the network is analysed. Once the clustering coefficient value of the overall network is reduced to '0', no more conditions are eliminated.



Figure 8-28: Simplified network of Green Building Success conditions after eliminating some conditions with high Betweenness Centrality

The scenarios for the analysis of Success conditions are shown in Figure 8-29. 'BC' represents the base case in which no condition is eliminated. From Scenario 'M' to 'W', the Success conditions with high Betweenness centrality values are progressively eliminated from the network and the effects of this elimination on network attributes are shown. Some network attributes used to represent the disorder and fragmentation resulting in the network upon the elimination of nodes are clustering coefficient, network diameter, and the number of isolated nodes in the network. Figure 8-29 shows the effect of the elimination of Success conditions on the clustering coefficient, network diameter, and the number of isolated nodes in the simplified network. The simplified network upon the elimination of 11 conditions (that is Scenario-W) is shown in Figure 8-28. A detailed account of the network behaviour under the influence of different elimination scenarios is provided in Appendix D (Section D.3).

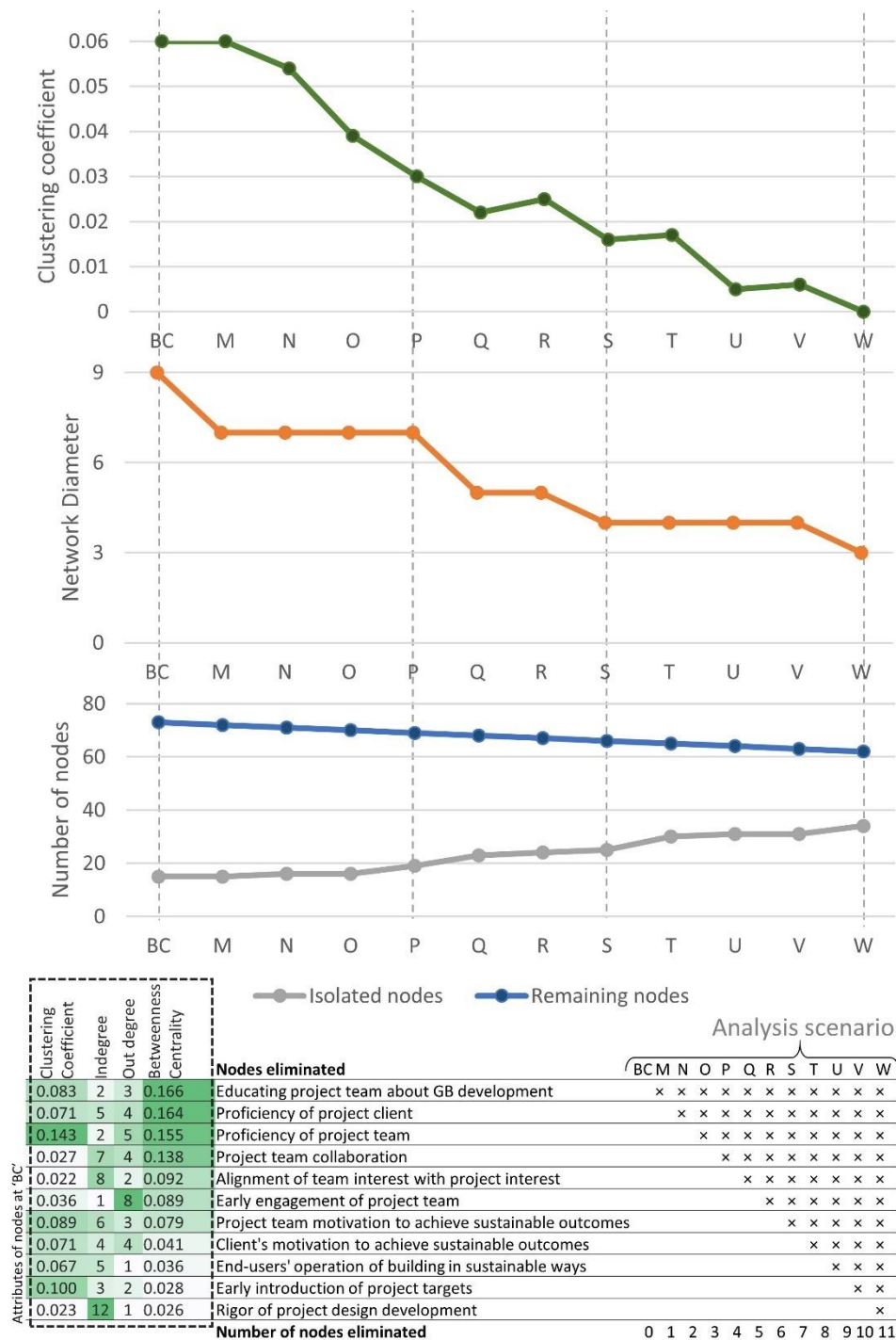


Figure 8-29: Effect of eliminating some conditions with high Betweenness Centrality on network attributes

A detailed explanation of the effect of node elimination on network attributes is as follows:

- The **clustering coefficient** is a measure of an "all-my-friends-know-each-other" property. The clustering coefficient of a node is the ratio of existing links connecting a node's neighbours to each other to the maximum possible number of such links. The clustering coefficient for the entire network is the average of the clustering coefficients of all the nodes. From scenario 'BC' to 'W', shown in Figure 8-29, as the 11 conditions are eliminated from the network, the clustering coefficient values decrease from 0.06 to 0.

- The **average shortest path length** is calculated by finding the shortest path between all pairs of nodes and taking the average overall length of the paths thereof (the length being the number of intermediate edges contained in the path). This shows, on average, the number of steps it takes to get from one member of the network to another. From scenario 'BC' to 'W' as the 11 conditions are eliminated from the network, the average shortest path length decreases from 4.181 to 1.182.
- **Diameter** is a mean of measuring network graphs. It is a measure of the longest of all the calculated shortest paths in a network. It is the shortest distance between the two most distant nodes in the network. In other words, once the shortest path length from every node to all other nodes is calculated, the diameter is the longest of all the calculated path lengths. The diameter is representative of the linear size of a network. From scenario 'BC' to 'W', as the 11 conditions are eliminated from the network, the diameter value is reduced from 9 to 3.

Before the elimination of Success conditions, the simplified GBSC network (Figure 8-26) had 15 isolated nodes. The elimination of one node (Scenario-M in Figure 8-29) reduces the overall network diameter from 9 to 7. It takes the elimination of four nodes (Scenario N to Q) to reduce the diameter to 5; it requires the removal of two more nodes (Scenario R and S) to reduce the diameter to 4; and it takes the exclusion of four more nodes (Scenario T to W) to reduce the network diameter to 3. This shows that the network resists the disorder as nodes are eliminated. Instead of a consistent reduction in the network diameter and clustering coefficient, there are scenarios (that is, R, T, and V) in which the elimination of Success conditions does not seem to affect the network structure, although they reduce the robustness of the network for further attack (that is the elimination of conditions). In case the simplified GBSC network in Figure 8-26 and Figure 8-28 is compared, the elimination of 11 conditions has resulted in a significant network disorder as the clustering coefficient values have decreased from 0.06 to 0, and the number of isolated nodes in the network have increased from 15 to 34. Although the simplified network, upon the elimination of conditions (Figure 8-28), still shows many conditions with high-frequency values, it is mainly populated with Success conditions having low values of Betweenness centrality.

The network analysis suggests that to understand the influence of Success conditions and their importance, it is necessary to consider their associations with the other conditions instead of looking at them in isolation. The elimination scenarios suggest that in a network the importance of a node (that is Success condition) can be determined by the disorder resulting in network upon elimination of that node. The higher degree of disorder means that the eliminated node (that is Success condition) played a much important role in the stability of the network and by extension, in the achievement of successful project outcomes.

8.4.3. Effect of data collection approach on Success conditions network

From the development and analysis of GBSC network, it is realised that an important contributor towards the strengths and weakness of the developed network is the data collection approach used, that is semi-structured interviews. In terms of strength, interviews are effective in the identification of previously undiscovered Success conditions and the associations among Success conditions. The weakness is that, the conditions identified and the associations among conditions depend on the sample size as well as the regional and professional diversity of interview participants. In case some Success conditions and the associations among conditions are not reported in the GBSC network, it means that within the interview sample size used, some conditions and associations are not identified. Hence, implying that a larger and a demographically more diverse sample of interview participants may identify the conditions and association not reported in this study.

The robustness analysis has shown the complex behaviour of Success conditions when associated with other conditions in a network. Success conditions are important not only because of their associations in a network but also because they create value for the project client and reduce the non-value adding activities in project development (that is Waste). The interpretation of findings in terms of the TFV theory provides an account of how Success conditions create value and reduce non-value adding activities.

8.5. Interpretation of Success conditions based on the Transformation-Flow-Value generation theory

Koskela's theory of production (that is the TFV theory) sees construction as production from three viewpoints: as a chain of transformations, as the flow of work, and as a generation of value for the customer (Lauri Koskela, 2000). A detailed account of the reasons why Success conditions associate with the TFV theory is discussed in Section 8.2. However, to provide a holistic understanding of the application of the TFV theory on GB project success in this section, the findings are interpreted at the level of broad *themes* instead of individual conditions. While a detailed account of the TFV theory of production is provided in Theoretical Framework (Chapter 3 Section 3.4), a brief overview of the underlying concepts is also provided in this section.

In the Transformation view, production is a conversion of inputs into outputs (Lauri Koskela, 2000). According to this view GB project development is a transformation of labour, information, equipment and materials into a sustainable building. Production management in this viewpoint equates to decomposing the total transformation into elementary transformations and tasks, acquiring the inputs to these tasks with minimal costs and carrying out the tasks as efficiently as possible (Lauri Koskela, 2000). Compared to the Transformation view, the Flow view provides a better understanding of how to avoid the waste of resources. In the Flow view, the basic thrust is to eliminate waste from the flow processes; hence, promoting such principles as lead-time reduction, variability reduction, and simplification (Lauri Koskela et al., 2002). In this view, the GB project development is a flow of resources (such as people, material, and information). A key principle of the Flow view is to reduce the share of non-value-adding activities (that is waste) in the project (Lauri Koskela, 2000). In comparison, the Value-generation view is focused on meeting customer requirements. The view of production as Value-generation has the basic goal of reducing the gap between achieved and best possible value, or in other words achieving the best possible value for the customer (Lauri Koskela et al., 2002). In this view, production management is to translate customer needs accurately into a design solution, and then producing products which conform to the specified design (Lauri Koskela, 2000). In the Value-generation view, the GB project development is a process of producing a sustainable building which meets the client's requirements. Overall, the TFV theory of production accounts for chains of transformations, flow of work, and Value-generation for the customer.

The TFV framework helps conceptualise the waste in the process of project development and the waste related to the end-product (such as building project). Bølviken et al. (2014) provided a taxonomy related to the waste of production in construction according to which, the wastes in the Transformation view are, material waste, non-optimal use of materials, machinery, energy or labour; wastes in the Flow view are unnecessary movement of people, unnecessary and inefficient work, waiting, space not used, materials not processed, and unnecessary transportation; and wastes in the Value view are lack of quality and intended use, harmful emissions, injuries and work-related sickness. The association of Success conditions with the TFV theory are interpreted based on the principles of the Transformation, Flow, and Value-generation views and the concepts of waste embedded in these views. The associations of the *themes* of Success conditions with the TFV theory of production are shown in Figure 8-26 and the details of these associations are provided in Table 8-2.

Table 8-2: Associations of the Success condition themes with the Transformation, Flow, and Value-generation views

Theme number	Theme title	Association of theme with the TFV theory
1	Changes during project development and fulfilling design intent	The fulfilment of design intent helps create value for the client and contributes to the transformation of resources (for example, material and labour) into end-products, in other words, GBs. Moreover, by reduced changes in the project during development, the wasteful activities (for example, project redesign) are reduced; hence, associating it with the Flow view.
2	Clarity in project development	‘Clarity in project development’ means that the project team has clearly defined roles, responsibilities, and guidelines to follow. The resulting clarity in a team’s vision contributes to the transformation process and reduces the gap between achieved and best possible value. The clarity in vision also reduces the possibility of unnecessary and in-efficient work (that is flow-related waste); hence, avoiding the non-value adding activities.
3	Client's characteristics	‘Client's characteristics’ means that the client as a person or an organisation has the necessary attributes and skill sets to effectively contribute towards successful GB project development. Considering the client’s influential role in engaging project team and driving the project development process, the client’s skill set can reduce the likelihood of non-value adding activities. Client's characteristics also affect the project decisions (that is defining project targets); hence, controlling the gap between achieved and best possible value.
4	Completeness and rigour of deliverables	‘Completeness and rigour of deliverables’ is about the level of completion and rigour of deliverables (for example, brief, design, and certification documentation) related to different project stages. Since the deliverables have a high degree of association with the project development process, their rigour and completeness have far-reaching effects on project activities. For instance, well-developed design documentation ensures better construction. Therefore, well-developed deliverables reduce the possibility of unnecessary and inefficient work (that is flow-related waste) and contribute towards aspired value for the project client.
5	Constraints	‘Constraints’ are the conditions over which project teams have limited control such as material availability, project funding, and access to the project location. As a result of constraints, the project inputs such as funding and building materials may not be available and therefore transformation into output (that is GB project) may be restrained. Constraints can also lead to non-value adding activities (for example, project redesign) and can also increase the gap between achieved and best possible value.
6	Cooperation and interest of stakeholders	‘Cooperation and interest of stakeholders’ is about the involvement of client, end-users, building control authorities, and neighbourhood community in GB development and operation. Cooperation of these stakeholders helps achieve the aspired project value by easing the pursuit of project goals. Cooperation of some stakeholders (such as the project client, building control authorities, and neighbourhood community) also contribute towards a streamlined project development process; hence, the likelihood of non-value adding activities is reduced.
7	Defining project goals	‘Defining project goals’ is about the project aspirations defined by the project team, FM team, and end-users. Since the achieved value in a project is intrinsically dependent on the aspired value, the better approaches of defining GB aspirations strongly contribute towards value for the project client. Rigorously defined project goals result in realistic aspirations, therefore, reducing the occurrence of non-value adding activities (for example, re-planning and redesigning).
8	Design methodology	‘Design methodology’ is about the rigorous development of project design to meet the project criteria of sustainability, maintainability, adaptability, reliability, buildability, and innovation. Since design development is a critical activity to transform aspirations into reality, it plays an important role in creating value for the project client. The rigour of design development also reduces the likelihood of errors in design documentation and construction; hence, reducing the non-value adding activities (for example, redesign and reconstruction).
9	Education	‘Education’ is about raising the GB development and operation-related awareness of the project client, end-users, and project team. The increased understanding of GB resulting from education can align the efforts of the project team and key stakeholders towards successful project development and operation; hence, creating value in the project. Since the project team and client are actively involved in the project development process, the increase in their awareness also reduces the Flow-related waste (that is unnecessary and inefficient work).
10	Engraving sustainability in project development	‘Engraving sustainability in project development’ is about incorporating sustainability principles and practices in different aspects of project development such as site procurement and construction. Since sustainability in GBs is one of the measures of project value, engraving sustainability in project development means generating value for the project. Moreover, as engraving sustainability also results in the efficient achievement of outcomes (that is at low cost, with less labour, and fewer resources), it positively associates with the Flow view.
11	Flow of project information	‘Flow of project information’ is about team communication and access to information. A smooth flow of information among the project team and across project stages can reduce the various non-value adding activities (for example, inefficient design and construction) associated with the lack of information. Moreover, smooth information flow also reduces the risk of not meeting project requirements hence contributing towards value for the client.

Theme number	Theme title	Association of theme with the TFC theory
12	Inspection, monitoring, and control	'Inspection, monitoring, and control' ensures that the project performs according to aspirations and value for the client is created. Monitoring of the project also helps avoid such mistakes which in the later stages of development and operation may need corrections (that is resulting in non-value adding activities).
13	Planning approach	'Planning approach' is about rigorously planning for time, cost and risk in the project. Since better planning helps achieve project aspirations, it positively associates with project value. Project planning is about decomposing the project into smaller units (that is activities) to which cost, time, and resources can be allocated. Because of this reason, planning is strongly associated with the Transformation view which has a key principle that the total transformation can be decomposed into smaller transformations. By paying attention to details, arranging activities in their logical sequence and allocating adequate time and resources for activities, the likelihood of errors and mistakes is reduced and therefore non-value adding activities (that is inefficient work) are also reduced.
14	Team authorities, responsibilities, and contractual relationships	'Team authorities, responsibilities, and contractual relationships' is about delegating responsibilities to the project team. The control and responsibilities delegated to the project team can align their interests towards project goals and therefore create value for the client. Moreover, it also helps reduce non-value adding activities since the project team has knowledgeable professionals who can efficiently develop a project in case they have the authority to control it.
15	Team characteristics	'Team characteristics' is about team proficiency and the ability of the project team to work together. Team characteristics strongly associate with the Flow view since the project team can control the project development and a proficient team can considerably reduce the non-value adding project activities (for example, project redesign because of incompetent design consultant). Proficiency of the project team also reduces the risk of not meeting project requirements; hence, the probability of achieving value for the client is increased.
16	Team collaboration	'Team collaboration' helps the team in pursuing project goals, therefore, achieving value for the client. Team collaboration also leads to more integrated and efficient project development, therefore, reducing the non-value adding activities.
17	Team commitment to the project	'Team commitment to the project' is about the commitment of development and operation team to achieve project outcomes. Owing to the important role of the project team in the development process, team commitment eases the pursuit of project goals, therefore, resulting in value for the client. Team commitment also results in the rigour of project development (that is meeting quality standards) and this reduces the non-value adding activities (that is rework because of poor quality).
18	Team mindset and priorities	'Team mindset and priorities' is about the viewpoints used by the project team while working together and in achieving project outcomes. Owing to the critical role of the project team in the development process, its priorities significantly determine the achievement of project outcomes, therefore affecting the value generated in the project. The open-mindedness and innovative mindset of project team results in efficient development approaches, therefore, reducing the non-value adding activities.
19	Team procurement methodology	'Team procurement methodology' is about selecting suitable professionals for project activities. Team procurement significantly contributes towards value for the client since the selection of suitable professionals means that the risk of not meeting project requirements is reduced. Moreover, the selection of suitable professionals also means increased opportunities for efficiently developing the project, therefore, reducing the non-value adding activities.
20	Timeliness of project activities	'Timeliness of project activities' is about early team engagement, early introduction of project targets, and timeliness of GB certification documentation. The timeliness of activities increases the possibility of meeting project requirements, therefore, easing the generation of the project value. In case project activities are timely performed, opportunities for a more efficient development (for example, reduced labour, cost, and material resources) are created, therefore reducing the non-value adding activities.

Although all the *themes* shown in Figure 8-26 and explained in Table 8-2 are associated with the Value-generation view, some *themes* such as 'Defining project goals' (Theme-7) and 'Design methodology' (Theme-8) are more strongly embedded in this view. This is because these *themes* capture project requirements and convert these requirements into a workable plan (that is design). Some *themes* which are strongly associated with the Flow view are about the rigour of deliverables (Theme-4), engraving sustainability (Theme-10), information flow (Theme-11), monitoring and control (Theme-12), team collaboration (Theme-16), team commitment (Theme-17), and timeliness of activities (Theme-20). This is because these *themes* strongly influence project development in terms of the flow of materials, resources, and labour. Unlike Flow and Value-generation, the Transformation view is associated with a low number of *themes*. The *theme* strongly associated with the Transformation view is planning approach (Theme-13), since it is embedded in the concept of breaking the overall transformation (that is project) into a number of component transformations (that is activities) which are individually optimised for cost, time, and resources.

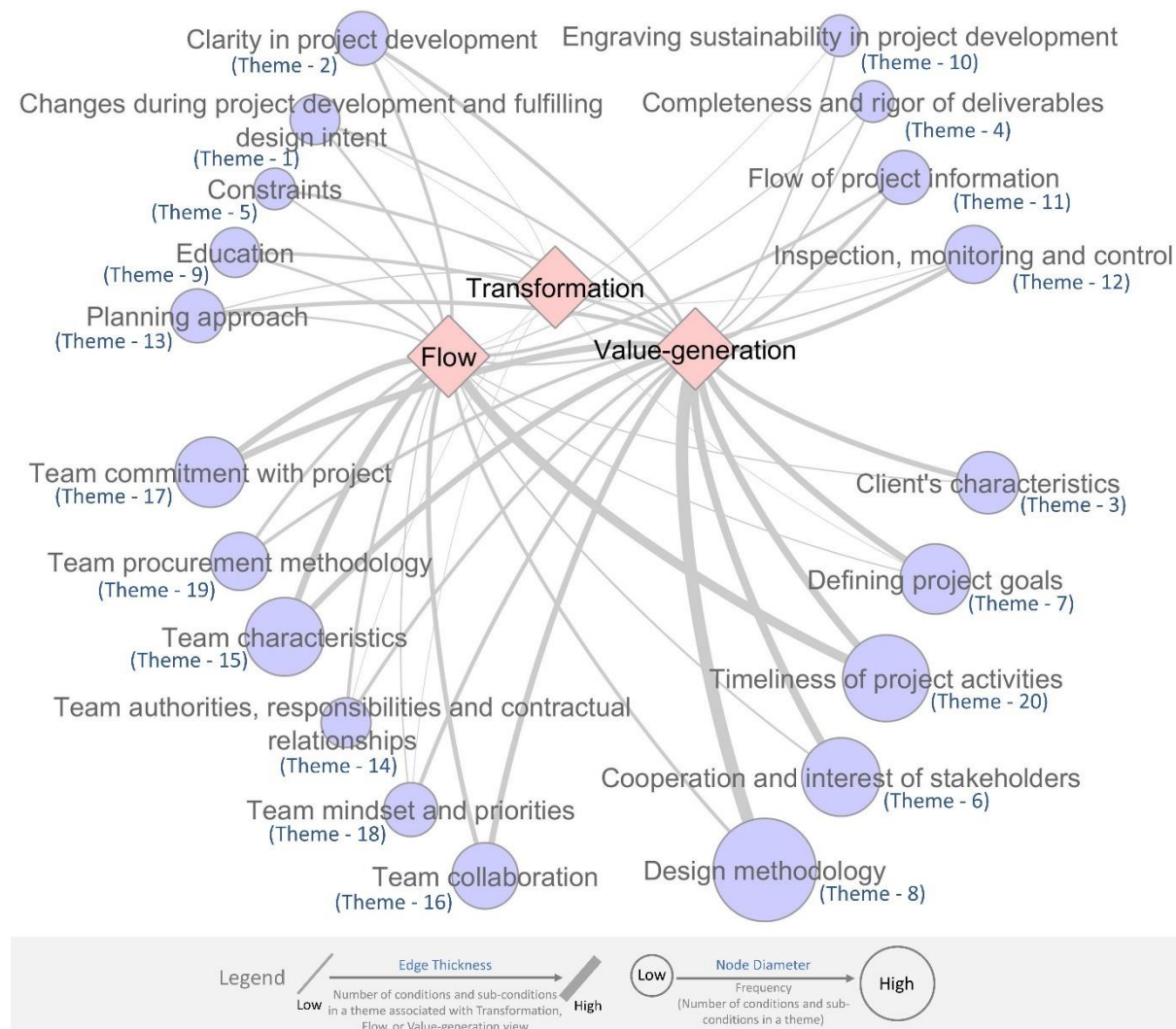


Figure 8-30: Associations of the Success condition themes with the Transformation, Flow, and Value-generation views

Regarding the association of Success conditions and sub-conditions with the TFV theory, highest number of conditions (that is 146, 94%) are associated with the Value-generation view; a sizable number of conditions (that is 94, 61%) are also associated with the Flow view; and only a few conditions (that is 11, 7%) are associated with the Transformation view.

8.6. Exploratory analysis of Success conditions

This section provides additional analysis to explore the effect of the attributes and viewpoints of interview participants on the identified Success conditions. The identified Success conditions and sub-conditions are shown in Table 8-3 which has 21 columns (A to T). The role of these columns in explaining the Success conditions is as follows:

- Column-A in Table 8-3 shows the overall number of interview participants (n=72) who identified the conditions associated with GB project success. For instance, in the case of 'Project team's access to robust information', 5 participants had an opinion that this condition is important for GB project success. The conditions and sub-conditions associated with GB project success are identified by varying number of interview participants as shown in Figure 8-31. As shown, 10 conditions and 15 sub-conditions are identified by only 1 participant in each case, while 14 conditions and 17 sub-conditions are identified by 2 participants in each case. Contrarily, 10 conditions and 4 sub-

conditions are identified by at least 13 participants in each case. In an extreme case, there is a Success condition identified by 41 participants. The Success conditions mentioned by a large number of interview participants include 'Rigour of project design development' (n=41), 'Client's motivation to achieve sustainable outcomes' (n=32), 'Proficiency of project team' (n=32), 'Early engagement of project team' (n=30), 'Project team collaboration' (n=29), and 'Early introduction of project targets' (n=22).

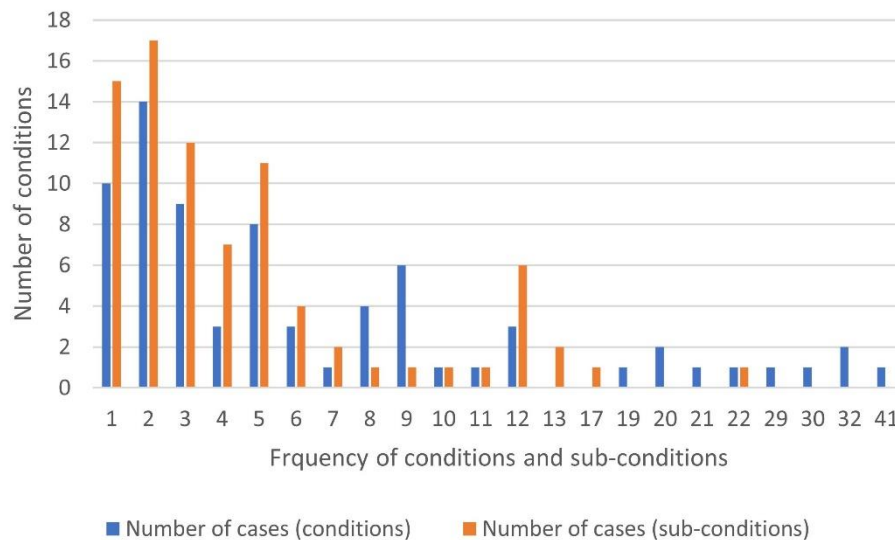


Figure 8-31: Frequency-based distribution of Success conditions and sub-conditions

- Interview participants have discussed the conditions by explaining their role for project success from three viewpoints.
 - **Findings from successful/failed projects:** The interview participants recalled some successful/failed GB projects they have been involved in and highlighted the conditions resulting in challenges (Column-B), failure (Column-C), and success (Column-G) in those projects. For instance, 2 interview participants associated 'Project team's access to robust information' with project challenges (Column-B), 3 participants associated 'Scope changes during project execution' with GB project failure (Column-C), and one interview participant associated 'Client's motivation to achieve original project intent' with GB project success (Column-G).
 - **Findings from participants' overall experience:** Based on their overall experience of sustainable project development, the interview participants highlighted the conditions associated with success (Column-H and Column-U) and failure (Column-D) of GB project development as well as the operational success (Column-F) and operational failure (Column-E) of GB projects. The difference between Success conditions (Column-H) and best practices (Column-U) is that the Success conditions according to participants are necessary for achieving desired outcomes while the best practices represent the conditions which positively influence the project performance, but the project success does not necessarily depend on these conditions.
 - **Suggestions for clients:** As experts of GB projects, some interviewees provided 'Suggestions for clients' to successfully develop GB projects (Column-I). For instance, as shown in Column-I, 2 interview participants suggested 'Client's involvement in project development'.
- Although the GB professionals interviewed in this study have many different roles in GB projects (Figure 4-5 in Chapter 4), Design consultant and Sustainability Consultant are the two major roles of interview participants. Accordingly, Column-J and Column-K in Table 8-3 respond to the Success

conditions identified by Design consultants (n=19) and Sustainability Consultants (n=21) respectively. It needs to be highlighted that the professionals represented in Column-J and Column-K only, had one key role in GB projects.

- GB professionals interviewed in this study had a varying experience of GBs in terms of the number of years. In Table 8-3, the interview participants are divided into three groups, that is participants with less than 10 years' experience of GB projects (Column-R, n=22), participants with 10 or more years but less than 15 years' experience of GB projects (Column-S, n=32), and participants with 15 or more years' experience of GB projects (Column-T, n=18).
- GB professionals interviewed in this study have worked on GB projects in six geographical regions. Column-L, M, N, O, P, and Q respond to the conditions identified by interview participants belonging to the UAE (n=5), Australia (n=30), the UK (n=13), Hong Kong (n=8), Pakistan (n=2), and Singapore (n=14) respectively.

Table 8-4 shows the results of analysing the success conditions identified by participants belonging to only a particular region, professional role, and professional experience. Table 8-4 highlights the conditions which are only associated with project success or project failure only, but not both. The explicit association of conditions with one of the three viewpoints (that is, '*Findings from successful/failed projects*', '*Findings from participants' overall experience*', and '*Suggestions for clients*') is also shown in Table 8-4. This analysis provides the foundations for an in-depth discussion of identified conditions.

Table 8-3: Identification of Success conditions in different viewpoints by professionals belonging to six regions and having different experience of Green Building projects

			Overall participants	Relation with failure in GBs					Relation with success in GBs					Role in GBs		The region where participants' GB experience is based						Experience in GBs		
				Conditions leading to challenges (Case Projects)	Failure conditions (Case Projects)	Failure conditions	Reasons for operational failures	Conditions behind the operational success	Success conditions (Case Projects)	Success conditions	Best practices in GB development	Suggestions for client	Design Consultant	Sustainability Consultant	UAE	Australia	UK	Hong Kong	Pakistan	Singapore	Low to medium (less than 10 years)	High (10 or more years but less than 15 years)	Very High (15 years or more)	
Theme	Sr.no	Identified conditions and sub-conditions	A	B	C	D	E	F	G	H	U	I	J	K	L	M	N	O	P	Q	R	S	T	
Changes during project development and fulfilling design intent (n=14)	1	Change in project team members	2						1			1				1	1					1	1	
	2	Execution of sustainable design during construction	5			1		1		3			1	2		3		1		1	1	2	2	
	3	Scope changes during project execution	9		3	3			1	2		1	3	3		3	2	2	1	1	3	2	4	
	3.1	Permanence in client's requirements during project delivery	2		1	1								2			1	1			2			
	3.2	Client's motivation to achieve original project intent	3			2				1	1			2			1		2			1	1	1
Clarity in project development (n=13)	4	Clarity in process of developing project	9			1			1	6		1	4	3	1	4	3		1		2	6	1	
	4.1	Use of clearly defined and standardised approaches for GB development	5						1	4			3	2		1					2	2	1	
	5	Delegating clear responsibilities to project team	6			1			2	3		3	2	1		1	2	2		1	2	4		
	5.1	Project team contractually required to deliver sustainable outcomes	2						1			2	1				1	1			1	1		
	5.2	Provision of sustainability specifications and other related information in tender	4							3	2		1	1		1		2		1	1	3		
	5.3	Specificity of deliverables from Design Consultants	2			1				1							1	1				2		
Client's characteristics (n=24)	6	Client's leadership in project	3						1	1		1	2	1		1		1		1	1	1	1	
	7	Consensus within client organisation	2	1	1									1		2					1		1	
	8	Proficiency of project client	20		2	3	1			3	8	2	4	5	6	2	8	6	1	3	8	7	5	
	8.1	Client understanding the need of sustainable outcomes	5						1	4			2	2		1	2	1	1		2	2	1	
	8.2	Client's understanding of GB requirements	12		1	3			1	4			2	4		1	5	4		2	5	4	3	
	8.3	Client's understanding of sustainable building operation	2				1					1	1				1			1	1	1		
	8.4	Client's rational decision-making	1		1												1						1	
	9	Structure and nature of client organisation	5	1						4				4			2	2		1	3	1		
Completeness and rigour of deliverables (n=20)	10	Completeness of project documentation for certification	2		1	1								1		1	1			1		1		
	11	Completeness and rigour of project design before execution	9			3		1	2	4	1		1	2		3	2	2	1	1	2	5	2	
	12	Setting of a detailed sustainability charter or brief	10			1			1	7		2	4	5	1	5	3			1	2	3	5	
Constraints (n=9)	13	Access to sustainable building materials	2	2												1			1		1		1	
	14	Accessibility of project funding	6	2	1				1	3			3	1		4	2				1	4	1	
	15	Ease of logistics at project location	1						1				1				1					1		
Cooperation and interest of stakeholders (n=42)	16	Client's involvement in project development	5		1				1	1		2	1	2		2	1	1		1	2	1	2	
	16.1	Client's facilitation of coordination among project team	1										1					1			1			
	17	Client's motivation to achieve sustainable outcomes	32			5			20	12		3	11	9	3	11	9	4	2	3	10	14	7	
	17.1	Client's endorsement of sustainability brief	3								1	2	2	1		1	1	1			1	2		
	17.2	Drivers for client to achieve sustainable outcomes	12			3			9				2	4		2	5	2	2	1	5	6		
	17.3	Investor's motivation to achieve sustainable outcomes	1						1				1				1						1	
	18	Cooperative role of building control authorities	2						2				1				1		1		1	1		
	19	End-users' operation of building in sustainable ways	12	1			2	2	3	3		1	6	1		5	2	2		3	3	5	4	
	19.1	End-users' motivation to achieve sustainable outcomes	1						1				1				1						1	
	19.2	End-users' understanding of building operation	5					2	1	1		1	3			1	1	1		2	1	2	2	
	19.3	Tenants contractually required to consider sustainability	2						1	1			1	1		2					1	1		
	20	Stakeholders' approval of project	4	1	1				1			2	1			2	1			1	2	1	1	
	Defining project goals (n=31)	21	End-users' involvement in defining project aspirations	8					1	2	5	1	2	5				4	3		1	1	5	2
21.1		FM team involvement in defining project aspirations	1									1	1				1					1		
22		Project team involvement in defining project aspirations	3						2			1	1	2	1		1	1			1	2		
23		Setting appropriate project targets	21	1	2	4	1		6	10		3	7	5	2	6	5	2		6	6	11	4	
23.1		Clarity in building's operational performance targets	1				1									1					1			
23.2		Nature of GB certification aspired for project	2	1	1								1	1			2				1	1		
23.3		Sustainability brief aligned with project budget	3			1						2	1	1	1		1			1	1	1	1	
23.4		Specificity of project requirements	12		1	3			1	8		1	3	4	1	3	3	1		4	4	7	1	
24		Stringency level of project sustainability requirements	4	3							1			2			2	1	1		1	2	1	
24.1		Stringency level of GB certification requirements	2	1							1						2						1	
Design methodology (n=41)		25	Market survey to identify successful building systems	1							1										1			
	26	Rigour of project design development	41	2		11	6	1	11	21	4	3	12	11	3	16	7	5		10	10	19	12	
	26.01	Adding adaptability and multiple layers of use in building design	1								1		1							1			1	

Theme	Sr.no	Identified conditions and sub-conditions	Overall participants	Relation with failure in GBs					Relation with success in GBs					Role in GBs		The region where participants' GB experience is based						Experience in GBs		
				Conditions leading to challenges (Case Projects)	Failure conditions (Case Projects)	Failure conditions	Reasons for operational failures	Conditions behind the operational success	Success conditions (Case Projects)	Success conditions	Best practices in GB development	Suggestions for client	Design Consultant	Sustainability Consultant	UAE	Australia	UK	Hong Kong	Pakistan	Singapore	Low to medium (less than 10 years)	High (10 or more years but less than 15 years)	Very High (15 years or more)	
A	B	C	D	E	F	G	H	U	I	J	K	L	M	N	O	P	Q	R	S	T				
	26.02	Use of reliable technology and solutions	2				1			1		1						1		1	1			
	26.03	Design consideration towards future building usage	3				1		1						1				2		1			
	26.04	Level of complexity in project design	4	1			1			1	2		2	1				4		1	2	1		
	26.05	Life-cycle based project development approach	4			1				3			1					3	2	1	1			
	26.06	Maintainability considered in building design	3				1			2				2				3	1	2				
	26.07	Speculation in building design	7			4	3																	
	26.08	Suitability of the project design for execution	3			2						1	2	3				2	3	3	1			
	26.09	Use of a proactive design approach	5						1	4			2					2		3	2			
	26.1	Use of balanced design approach	1							1			1							1				
	26.11	Use of context-oriented design approach	3							3			2					1		1	2			
	26.12	Use of energy-oriented design approach	12							4	8		1	4	2			3	2	6	4			
	26.13	Use of holistic design approach	9			1				2	5	1		4	2	1		1	2	4	3			
	26.14	Use of innovative design approach	6	1		1				4	1			3		1	1			3	3			
	26.15	Use of integrated design approach	13			3	1			5	4	1	1	5	3	2	3		3	7	3			
	27	Use of performance-based specifications	1							1								1	1					
Education (n=18)	28	Educating client about sustainability in project	6							5	1		2	1			3		1	2	4			
	29	Educating end-users and FM team about building operation	9				2	5		3	1		2	1			5	1	3	1	4	4		
	30	Educating project team about GB development	8						1	8			3	3			5		2	3	2	3		
	30.1	Educating contractors about GB development	3							3			1	1			1		2		1	2		
	30.2	Educating sub-contractors about GB development	2							2			1	1			2			1	1			
Engraving sustainability in project development (n=9)	31	Engraving sustainability in project development	8			4				4		3	2	2			4	3		1	2	3	3	
	32	Procurement of project site based on sustainability goals	3							1		2	1	1			1	2			2	1		
	33	Use of environmental management systems in construction	1							1			1				1					1		
Flow of project information (n=25)	34	Clarity in communication of project goals	7	1		1				1	3		1	4		1	2	1	1		2		6	1
	35	Communication among project team	11							1	9	3		6	1	1	3	4	1		2	1	7	3
	35.1	Use of effective communication tools and strategies	5								3	3		4		1	2	1		1		2	3	
	36	Project team's access to robust information	5	2		2					1				3			4	1			1	3	1
	36.1	Sharing of information related to project changes	1			1									1			1				1		
	37	Smooth transition of project from inception to operation stage	5				2	2			1	1		2	1	1	2	2				4	1	
Inspection, monitoring, and control (n=25)	38	Inspection of project upon construction	8			1	1	2		4		1	1	3			4	1	1		2	1	4	3
	38.1	Execution of commissioning and fine-tuning	7			1	1	2		3		1	1	3			4	1	1		1	1	3	3
	39	Monitoring and controlling operational performance of building	5				2	1		3			2	1			4			1	2	1	2	
	40	Monitoring of project development	12			2				10	1		5	2	1	5	1	3		2	1	9	2	
	40.1	Project reporting	2							1	1		1				2						1	1
	41	Review of project design by sustainability consultant	2							1	1						1			1				2
	42	Thoroughness of value engineering exercise	3	1		2							1				1	2			1	2		
Planning approach (n=24)	43	Attention towards details	5			1		1	2	2			2	2			1	2	1		1	1	3	1
	44	Rigour of project planning	19	4	1	6				3	8		1	3	7	2	8	5	1		3	5	9	4
	44.1	Adequate budget allocation for project development	13	3		4				1	6			3	3	1	6	2	1		3	3	6	3
	44.2	Adequate time allocation for commissioning and testing	1								1				1		1							1
	44.3	Adequate time allocation for project development	11	1	1	2				1	5		1	1	4	1	3	4	1		2	2	6	3
	45	Rigour of risk management	4								2	2	1	3	1	1	2	1				2	2	
Team authorities, responsibilities, and contractual relationships (n=9)	46	Control of project design by Design and Sustainability Consultant	2						2				1						1		1	1		
	47	Empowerment of sustainability consultant by client	3						2			1		1			1	2			1	1	1	
	48	Project team's involvement in decision-making	2		1				1					1			1				1		1	
	49	Using appropriate project delivery method	3						2	1			1	1	2				1		2	1		
	49.1	Contractual interrelationships between client and project team	2						1	1			1	1	2						1	1		
Team characteristics (n=36)	50	Like-mindedness of project team members	2							1							2					1	1	
	51	Proficiency of FM team	3				2	1						1			3					2	1	
	52	Proficiency of project team	32	1	1	7	1		6	21	2	3	7	11	1	13	8	3	2	5	11	12	9	
	52.1	Leadership qualities among project team members	2							2			1	1			1			1	1		1	
	52.2	Proficiency of contractor	12			4	1			8	1	1	3	3		6	3	1	1	1	4	3	5	
	52.3	Proficiency of Design Consultant	12			2			2	6		2	3	3		3	5	1		3	1	6	5	
	52.4	Proficiency of MEP Consultant	6			1	1		2	2				2			4			2	1	5		
	52.5	Proficiency of PM team	4						2		1	1		2			3		1		2	2		

			Overall participants	Relation with failure in GBs					Relation with success in GBs					Role in GBs		The region where participants' GB experience is based						Experience in GBs		
				Conditions leading to challenges (Case Projects)	Failure conditions (Case Projects)	Failure conditions	Reasons for operational failures	Conditions behind the operational success	Success conditions (Case Projects)	Success conditions	Best practices in GB development	Suggestions for client	Design Consultant	Sustainability Consultant	UAE	Australia	UK	Hong Kong	Pakistan	Singapore	Low to medium (less than 10 years)	High (10 or more years but less than 15 years)	Very High (15 years or more)	
Theme	Sr.no	Identified conditions and sub-conditions	A	B	C	D	E	F	G	H	U	I	J	K	L	M	N	O	P	Q	R	S	T	
	52.6	Proficiency of sub-contractor	5			2				3				1		3			1	1	1	1	3	
	52.7	Proficiency of sustainability consultant	5			1				4				2		2	2			1	1	4		
	53	Project team's understanding of project goals and aspirations	3							3				3		1	1	1				3		
	54	Size of design team	2							2					1	1			1		2			
Team collaboration (n=30)	55	Conflicts among project team	1	1												1						1		
	56	Project team collaboration	29		1				13	15	4		6	10	3	7	9	3	2	5	14	12	5	
	56.1	Liaison between design team and client	5						2	2	1			1	1	1	2			1	2	2	1	
	56.2	Liaison between FM team and project development team	2							2				1				1		1	2			
	56.3	Liaison between sustainability consultant and client	1							1				1				1			1			
	56.4	Liaison between sustainability consultant and contractor team	3							2		1		1			2		1		2	1		
	56.5	Liaison between sustainability consultant and design consultant	4		1					3	1			2	1		1	2	1		2	1	1	
	56.6	Liaison between sustainability consultant and project team	5								4	1			3		1			1	4		1	
	56.7	Willingness of project team to work together	4							1	1				1		1			2	2	3	1	
Team commitment to the project (n=27)	57	Alignment of team interest with project interest	9			1		1		7	1		3	2		4	3	1		1	2	5	2	
	57.1	Rewards for achieving performance targets	2					1				1		1			1	1			1	1		
	58	Contractor's proactive role in project development	2			1				1		1		1			1	1				1	1	
	59	FM team motivation to achieve sustainable outcomes	1								1			1			1						1	
	60	Project team motivation to achieve sustainable outcomes	20	2	1	1			8	11			6	7	1	10	5	1	1	2	6	10	4	
	60.1	Contractor team motivation to achieve sustainable outcomes	8			1			3	4			3	2		6	1		1		3	2	3	
	60.2	Design Consultant's motivation to achieve sustainable outcomes	10	1		1			3	5			3	4	1	6	3				1	7	2	
	60.3	MEP Consultant's motivation to achieve sustainable outcomes	3	1		1					1		1	1		2	1				2		1	
	60.4	PM team motivation to achieve sustainable outcomes	3	1	1					1			1	1			3				2	1		
60.5	Sustainability Consultant's motivation to achieve sustainable outcomes	2							1				1			1	1				1	1		
Team mindset and priorities (n=18)	61	Establishing and promoting synergies	2						2				1			1	1					1	1	
	62	Focus of sustainability consultant on project goals	1						1					1				1				1		
	63	Open-mindedness and flexibility of project team	3								3		1	1		1	1	1			1	1	1	
	64	Priority of sustainability in project development	9	2	2	2				1	3		2	2		3	3	2		1	2	5	2	
	65	Team working on project with innovative mindset	1								1			1			1						1	
	66	Team working on project with value management mindset	5							1	3		2	2		1	3			1	1	1	3	
Team procurement methodology (n=13)	67	Involvement of sustainability consultant in contractor's selection	1		1								1				1					1		
	68	Preferences in project team selection	12			1				3	7		2	4	2	1	3	4	1	1	2	4	6	2
	68.1	Long-term engagement of sustainability consultant	2			1					2			1	1		2				1	1		
	68.2	Preferences in consultant's engagement	5							2	2		1		1		3		1	1	3	2		
	68.3	Preferences in contractor's engagement	5			1					3		1				1	1	1	1	1	2	2	
	68.4	Pre-qualification of contractors and sub-contractors	1							1				2			1	1	1	1	1			
	68.5	Requirement for contractor to engage a sustainability advisor	1								1			1		1						1		
Timeliness of project activities (n=39)	69	Early engagement of project team	30	1		2		2	3	14	7	9	4	12	3	9	6	5	1	6	10	14	6	
	69.1	Early engagement of commissioning professionals	3							1	1	1					1			2		3		
	69.2	Early engagement of contractor	6	1								3		3		2	3		1		2	2	2	
	69.3	Early engagement of design consultants	1			1							1	1			1					1		
	69.4	Early engagement of FM team	6					2			4		1			2		1		3	1	4	1	
	69.5	Early engagement of sub-contractor	1									1					1					1		
	69.6	Early engagement of suppliers	2									2					1	1				1	1	
	69.7	Early engagement of sustainability consultant	22			2				2	11	2	9	3	12	3	7	5	3		4	8	10	4
	70	Early introduction of project targets	22	1	1	6				3	7	4	5	7	10	1	10	5	3	1	2	9	8	5
	70.1	Client's early decision-making regarding sustainability goals	4								1		3	2	1		2	1	1			1	2	1
	70.2	Early incorporation of sustainability in project	17	1		6				1	6	4	2	6	7	1	8	3	2	1	2	7	6	4
	71	Timeliness of building approval	2							1	1			1			1		1			1		1
	72	Timeliness of feedback on sustainability documentation	1		1						1				1							1		
	73	Timely submission of GB certification documentation for review	2		1						1			1	1	1	1					1	1	
Number of interview participants			72	15	9	30	10	8	32	55	21	19	19	21	5	30	13	8	2	14	24	32	18	
Number of conditions identified			73	19	18	27	10	13	44	52	19	23	53	53	25	62	50	32	14	39	54	61	55	
Number of sub-conditions identified			82	11	8	29	11	5	38	54	20	24	52	56	17	56	54	29	11	36	58	67	49	
Number of unique conditions identified													5	3	0	8	3	0	0	2	3	6	4	
Number of unique sub-conditions identified													6	7	2	11	8	2	1	1	6	9	5	

Table 8-4: Explicitness of Success conditions and sub-conditions with respect to the viewpoints and demographic attributes of interview participants

		Overall participants							Role in GBs		The region where participants' GB experience mainly based						Experience in GB projects		
Sr.no	Identified conditions and sub-conditions		Findings from successful/failed	Findings from participants' overall	Suggestions for clients	Condition leading to failure	Condition leading to success		Design Consultant	Sustainability Consultant	UAE	Australia	UK	Hong Kong	Pakistan	Singapore	Low to medium (less than 10 years)	High (10 or more years but less than 15 years)	Very High (15 years or more)
1	Change in project team members	2					x												
2	Execution of sustainable design during construction	5		x															
3	Scope changes during project execution	9																	
3.1	Permanence in client's requirements during project delivery	2				x			x								x		
3.2	Client's motivation to achieve original project intent	3																	
4	Clarity in process of developing project	9																	
4.1	Use of clearly defined and standardised approaches for GB development	5					x												
5	Delegating clear responsibilities to project team	6																	
5.1	Project team contractually required to deliver sustainable outcomes	2					x												
5.2	Provision of sustainability specifications and other related information in tender	4		x			x												
5.3	Specificity of deliverables from Design Consultants	2																x	
6	Client's leadership in project	3					x												
7	Consensus within client organisation	2	x			x						x							
8	Proficiency of project client	20																	
8.1	Client understanding the need of sustainable outcomes	5					x												
8.2	Client's understanding of GB requirements	12																	
8.3	Client's understanding of sustainable building operation	2																	
8.4	Client's rational decision-making	1	x			x						x							x
9	Structure and nature of client organisation	5	x																
10	Completeness of project documentation for certification	2				x													
11	Completeness and rigour of project design before execution	9																	
12	Setting of a detailed sustainability charter or brief	10																	
13	Access to sustainable building materials	2	x			x													
14	Accessibility of project funding	6																	
15	Ease of logistics at project location	1	x				x		x				x					x	
16	Client's involvement in project development	5																	
16.1	Client's facilitation of coordination among project team	1			x		x		x					x			x		
17	Client's motivation to achieve sustainable outcomes	32																	
17.1	Client's endorsement of sustainability brief	3					x												
17.2	Drivers for client to achieve sustainable outcomes	12																	
17.3	Investor's motivation to achieve sustainable outcomes	1	x				x		x				x						x
18	Cooperative role of building control authorities	2	x				x												
19	End-users' operation of building in sustainable ways	12																	
19.1	End-users' motivation to achieve sustainable outcomes	1	x				x		x				x						x
19.2	End-users' understanding of building operation	5					x												
19.3	Tenants contractually required to consider sustainability	2					x					x							
20	Stakeholders' approval of project	4																	
21	End-users' involvement in defining project aspirations	8					x												
21.1	FM team involvement in defining project aspirations	1			x		x		x				x					x	
22	Project team involvement in defining project aspirations	3					x												
23	Setting appropriate project targets	21																	
23.1	Clarity in building's operational performance targets	1		x		x			x			x					x		
23.2	Nature of GB certification aspired for project	2	x			x							x						
23.3	Sustainability brief aligned with project budget	3																	
23.4	Specificity of project requirements	12																	
24	Stringency level of project sustainability requirements	4																	
24.1	Stringency level of GB certification requirements	2										x							
25	Market survey to identify successful building systems	1		x			x									x		x	
26	Rigour of project design development	41																	
26.01	Adding adaptability and multiple layers of use in building design	1		x			x		x							x			x
26.02	Use of reliable technology and solutions	2		x															
26.03	Design consideration towards future building usage	3		x															
26.04	Level of complexity in project design	4										x							
26.05	Life-cycle based project development approach	4																	
26.06	Maintainability considered in building design	3		x								x							
26.07	Speculation in building design	7																	
26.08	Suitability of the project design for execution	3		x														x	
26.09	Use of a proactive design approach	5					x												
26.1	Use of balanced design approach	1		x			x		x			x						x	
26.11	Use of context-oriented design approach	3		x			x												
26.12	Use of energy-oriented design approach	12					x												
26.13	Use of holistic design approach	9																	
26.14	Use of innovative design approach	6																	
26.15	Use of integrated design approach	13																	
27	Use of performance-based specifications	1	x				x									x	x		
28	Educating client about sustainability in project	6		x			x												
29	Educating end-users and FM team about building operation	9		x															
30	Educating project team about GB development	8					x												
30.1	Educating contractors about GB development	3		x			x												
30.2	Educating sub-contractors about GB development	2		x			x					x							
31	Engraving sustainability in project development	8																	
32	Procurement of project site based on sustainability goals	3					x												
33	Use of environmental management systems in construction	1		x			x		x			x							x
34	Clarity in communication of project goals	7																	
35	Communication among project team	11					x												
35.1	Use of effective communication tools and strategies	5		x			x												
36	Project team's access to robust information	5																	
36.1	Sharing of information related to project changes	1		x		x			x				x					x	
37	Smooth transition of project from inception to operation stage	5		x															
38	Inspection of project upon construction	8																	
38.1	Execution of commissioning and fine-tuning	7																	
39	Monitoring and controlling operational performance of building	5		x															
40	Monitoring of project development	12		x															
40.1	Project reporting	2		x			x					x							
41	Review of project design by sustainability consultant	2					x												x

Sr.no	Identified conditions and sub-conditions	Overall participants	Findings from successful/failed	Findings from participants' overall	Suggestions for clients	Condition leading to failure	Condition leading to success	Role in GBs		The region where participants' GB experience mainly based						Experience in GB projects		
								Design Consultant	Sustainability Consultant	UAE	Australia	UK	Hong Kong	Pakistan	Singapore	Low to medium (less than 10 years)	High (10 or more years but less than 15 years)	Very High (15 years or more)
42	Thoroughness of value engineering exercise	3				x												
43	Attention towards details	5																
44	Rigour of project planning	19																
44.1	Adequate budget allocation for project development	13																
44.2	Adequate time allocation for commissioning and testing	1		x			x		x		x							x
44.3	Adequate time allocation for project development	11																
45	Rigour of risk management	4					x											
46	Control of project design by Design and Sustainability Consultant	2	x				x											
47	Empowerment of sustainability consultant by client	3					x											
48	Project team's involvement in decision-making	2	x															
49	Using appropriate project delivery method	3					x											
49.1	Contractual interrelationships between client and project team	2					x			x								
50	Like-mindedness of project team members	2		x			x				x							
51	Proficiency of FM team	3		x							x							
52	Proficiency of project team	32																
52.1	Leadership qualities among project team members	2		x			x											
52.2	Proficiency of contractor	12																
52.3	Proficiency of Design Consultant	12																
52.4	Proficiency of MEP Consultant	6																
52.5	Proficiency of PM team	4					x											
52.6	Proficiency of sub-contractor	5		x														
52.7	Proficiency of sustainability consultant	5		x														
53	Project team's understanding of project goals and aspirations	3		x			x	x									x	
54	Size of design team	2	x				x									x		
55	Conflicts among project team	1	x			x					x						x	
56	Project team collaboration	29																
56.1	Liaison between design team and client	5					x											
56.2	Liaison between FM team and project development team	2		x			x									x		
56.3	Liaison between sustainability consultant and client	1	x				x		x				x			x		
56.4	Liaison between sustainability consultant and contractor team	3					x											
56.5	Liaison between sustainability consultant and design consultant	4																
56.6	Liaison between sustainability consultant and project team	5		x			x											
56.7	Willingness of project team to work together	4					x											
57	Alignment of team interest with project interest	9		x														
57.1	Rewards for achieving performance targets	2		x			x											
58	Contractor's proactive role in project development	2																
59	FM team motivation to achieve sustainable outcomes	1		x			x	x			x							x
60	Project team motivation to achieve sustainable outcomes	20																
60.1	Contractor team motivation to achieve sustainable outcomes	8																
60.2	Design Consultant's motivation to achieve sustainable outcomes	10																
60.3	MEP Consultant's motivation to achieve sustainable outcomes	3																
60.4	PM team motivation to achieve sustainable outcomes	3	x									x						
60.5	Sustainability Consultant's motivation to achieve sustainable outcomes	2	x				x											
61	Establishing and promoting synergies	2	x				x											
62	Focus of sustainability consultant on project goals	1	x				x		x			x					x	
63	Open-mindedness and flexibility of project team	3		x			x											
64	Priority of sustainability in project development	9																
65	Team working on project with innovative mindset	1		x			x		x		x							x
66	Team working on project with value management mindset	5					x											
67	Involvement of sustainability consultant in contractor's selection	1	x			x		x				x					x	
68	Preferences in project team selection	12																
68.1	Long-term engagement of sustainability consultant	2		x			x					x						
68.2	Preferences in consultant's engagement	5					x											
68.3	Preferences in contractor's engagement	5																
68.4	Pre-qualification of contractors and sub-contractors	1	x				x							x		x		
68.5	Requirement for contractor to engage a sustainability advisor	1		x			x	x		x							x	
69	Early engagement of project team	30																
69.1	Early engagement of commissioning professionals	3					x										x	
69.2	Early engagement of contractor	6																
69.3	Early engagement of design consultants	1							x			x					x	
69.4	Early engagement of FM team	6		x			x											
69.5	Early engagement of sub-contractor	1		x			x					x					x	
69.6	Early engagement of suppliers	2		x			x											
69.7	Early engagement of sustainability consultant	22																
70	Early introduction of project targets	22																
70.1	Client's early decision-making regarding sustainability goals	4					x											
70.2	Early incorporation of sustainability in project	17																
71	Timeliness of building approval	2					x											
72	Timeliness of feedback on sustainability documentation	1							x		x					x		
73	Timely submission of GB certification documentation for review	2																
Sum of conditions			13	15	0	6	28	5	3	0	8	3	0	0	2	3	6	4
Sum of sub-conditions			8	26	2	5	41	6	7	2	11	8	2	1	1	6	9	5
Sum of conditions and sub-conditions			21	41	2	11	69	11	10	2	19	11	2	1	3	9	15	9

8.6.1. Analysis of Success conditions based on the viewpoints of interview participants

Three viewpoints are used by interview participants to discuss the conditions associated with GB project success which are, '*Findings from successful/failed projects*', '*Findings from participants' overall experience*', and '*Suggestions for clients*'. As shown in Figure 8-32, the same condition can occur within all three viewpoints. Figure 8-32 presents the case of a condition, 'Setting appropriate project targets', identified by 21 interview participants overall. From the viewpoint of '*Findings from successful/failed projects*', this condition was associated with challenges (n=1), failure (n=2), and success (n=6). From the viewpoint of the '*Findings from participants' overall experience*', this condition was associated with operational failure (n=1) as well as GB development success (n=10) and failure (n=4). This condition was also identified from the viewpoint of '*Suggestions for clients*' as 3 participants suggested this condition for the GB project clients. The reason that a condition is associated with both the success and failure of GB projects is that some states of the condition contribute towards success while some other states contribute towards failure as shown in Figure 8-32. While 69 (44%) of the overall conditions are only associated with project success, 11 (7%) of the overall conditions are only associated with project failure (as shown in Table 8-4). Hence, 75 (48%) conditions are associated with both the project success as well as failure and this implies that for a sizable number of conditions the variable states of conditions can lead to different performance outcomes (that is, success and failure).

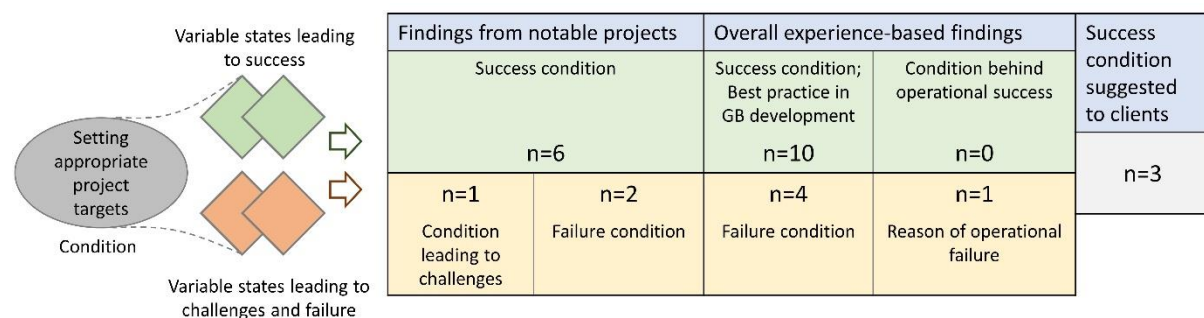


Figure 8-32: Example of a Success condition responding to the viewpoint of 'Successful/failed projects', 'Overall experience', and 'Suggestions for clients'

As many as 64 (41%) of all conditions are identified by only one out of the three viewpoints. Following is a brief overview of these conditions:

- Up to 41 (26%) of the overall 155 conditions are only identified when using the viewpoint of the '*Findings from participants' overall experience*' and are not identified through the other two viewpoints (Table 8-4). Some of these conditions identified by more than 8 participants include 'Educating end-users and FM team about building operation' (n=9), 'Alignment of team interest with project interest' (n=9), and 'Monitoring of project development' (n=12).
- Up to 13 conditions and 8 sub-conditions are only identified when using the viewpoint of successful/failed projects and are not identified through the other two viewpoints (Table 8-4). A highly identified condition in this regard is 'Structure and nature of client organisation' (n=5). A highly identified sub-condition in this regard is 'PM team motivation to achieve sustainable outcomes' (n=3).
- Two sub-conditions are only identified when using the viewpoint of '*Suggestions for clients*' and are not identified through the other two viewpoints (Table 8-4). These are 'Client's facilitation of coordination among project team' (n=1) and 'FM team involvement in defining project aspirations' (n=1).

This indicates that a sizable number of conditions (that is 41%) are easily recalled by interview participants when employing multiple viewpoints in interviews. This implies that the use of multiple viewpoints for a topic of interest (such as GB Success conditions) during interviews can ensure a richer data collection. While the use of multiple viewpoints in interviews contributed towards a comprehensive list of Success conditions, it also resulted in data triangulation. A majority (that is 59%) of conditions is identified by multiple viewpoints and this indicates that the majority of conditions is triangulated by multiple perspectives. A detailed analysis regarding the overlap of Success conditions among three viewpoints is provided in Appendix D (Section D.5).

Overall, the use of multiple viewpoints helped identify a relatively large number of Success conditions per participant. By asking the interview participants to use multiple viewpoints during interviews a better acquisition of required information was enabled since multiple viewpoints helped avoid the availability heuristic and Bandwagon effect. The use of multiple viewpoints has also resulted in the triangulation of findings and a detailed understanding of Success conditions.

8.6.2. Analysis of Success conditions based on the attributes of interview participants

The identified Success conditions are analysed based on multiple contexts, that is participants' role in GBs, region of belonging, and experience of working on GBs. The key highlights of the analysis are provided in this section. Further details regarding this analysis are provided in Appendix D (Section D.6).

The analysis of identified conditions with respect to participants' role in GBs shows that 11 (7%) of the overall conditions are identified by Design Consultants only (shown in Table 8-4). While two of these conditions are about design methodology, the remaining 9 conditions are about defining project goals, team characteristics, team commitment to the project, team procurement methodology, project constraints, cooperation and interest of stakeholders, and engraving sustainability in project development. As many as 10 (7%) of the overall conditions are exclusively identified by sustainability consultants. These conditions are about changes during project development and fulfilment of design intent, defining project goals, planning approach, team mindset and priorities, team collaboration, the flow of project information, cooperation and interest of stakeholders, and timeliness of project activities.

The analysis of Success conditions with respect to the regional context of interview participants reveals that participants from each region have identified some conditions which are not mentioned by participants from other regions. Table 8-4 shows the Success conditions which are unique in case of each regional group of participants. The majority of Success conditions (that is 76%) prevail in multiple regions. Overall, 13 conditions and 25 sub-conditions (25% of the overall conditions) are unique in terms of the regional context, in other words, they are identified by participants belonging to only one out of the six regions. This validates that the identification of Success conditions is a region-specific inquiry. The highest number of unique conditions and sub-conditions are identified in the case of Australia and the UK.

A significant correlation (R^2 value=0.80) is found among the number of interview participants belonging to different regions and the number of conditions and sub-conditions identified by these interviewees as shown in Figure 8-33. The correlation has a steep slope value of 3.22 which implies that as the number of interview participant belonging to a particular region increases, the number of identified conditions also increases. For instance, 14 participants from Singapore identified 75 Success conditions. With a notably larger number of participants from Australia ($n=30$), a relatively larger number of Success conditions (that is 118) were identified. This indicates that the more number of interviews are conducted in a region, the more comprehensive list of success conditions is developed. This, however, does not mean that saturation is not possible in this case, that is the notion that with an

increased number of participants there will always be new factors identified. The bar chart as shown in Figure 8-33 addresses the issue of saturation. As an example, in case of the UAE, 42 conditions were identified by 5 participants. This means that on average 8.4 conditions were identified by each participant. Contrary to this in case of Australia, 118 conditions were identified by 30 participants. This means an average of 4 conditions per participant. This shows a significant reduction in the average number of Success conditions per participant with the increase in the number of participants. Moreover, 118 conditions in case of Australia does not imply that all those conditions were exclusively identified by Australian participants. Only 19 of those conditions were exclusively identified by Australian participants and not by participants from other regions. This highlights that even though the number of identified conditions is a function of sample size, saturation occurs in the identified conditions.

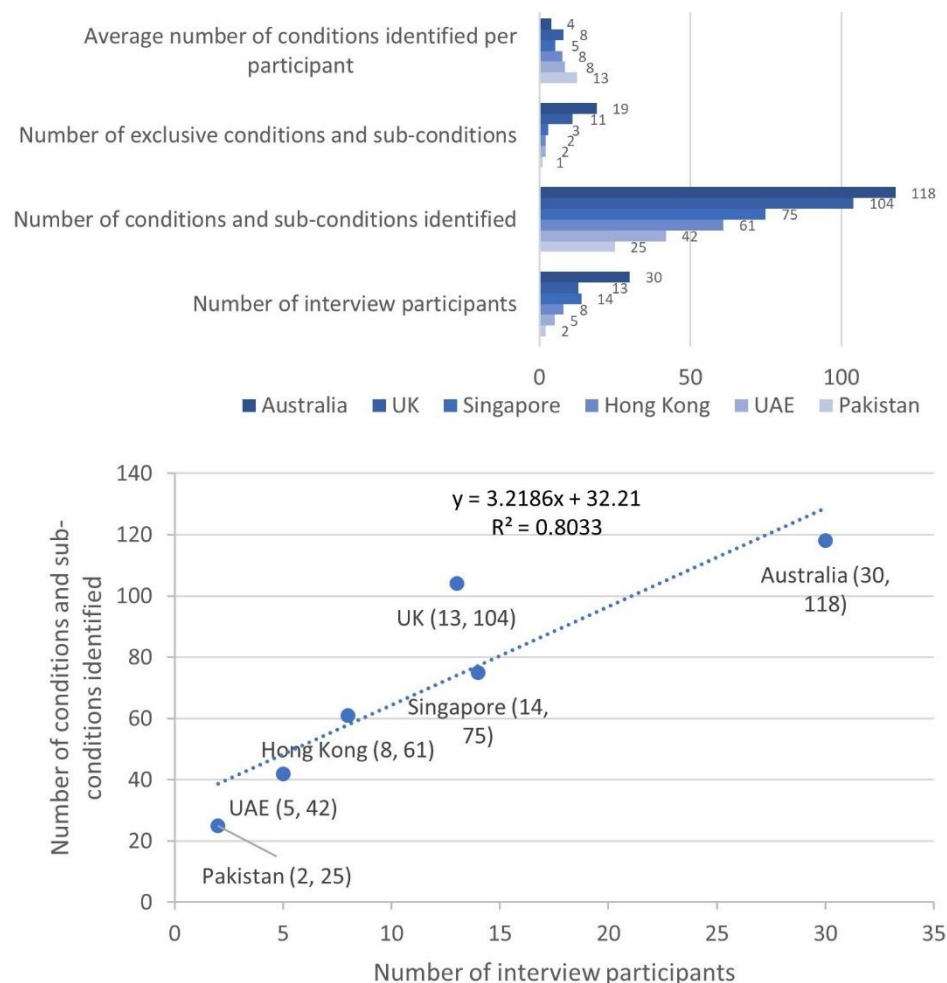


Figure 8-33: Correlation of the number of interview participants belonging to six regions with the number of identified conditions

Analysis of Success conditions with respect to the experience of participants in GBs reveals that each group of participants has identified some conditions and sub-conditions which are not mentioned by the other two groups. Table 8-4 shows the Success conditions which are unique in the case of each group of participants. Some Success conditions identified only by participants with Low to medium-level experience include: 'Use of performance-based specifications', 'Size of design team', and 'Timeliness of feedback on sustainability documentation'. Success conditions identified only by participants with high-level experience include: 'Ease of logistics at project location', 'Market survey to identify successful building systems', 'Project team's understanding of project goals and aspirations',

‘Conflicts among project team’, ‘Focus of sustainability consultant on project goals’, and ‘Involvement of sustainability consultant in contractor's selection’. Success conditions identified only by participants with very high-level experience include: ‘Use of environmental management systems in construction’, ‘Review of project design by sustainability consultant’, ‘FM team motivation to achieve sustainable outcomes’, and ‘Team working on project with innovative mindset’.

Overall, 16 conditions and 30 sub-conditions are identified by participants belonging to single instead of multiple contexts (that is, the region, professional role, and experience in GB projects as shown in Table 8-4). This highlights that although 70% of conditions are identified as Success conditions in multiple contexts, the remaining 30% of conditions (which is considerable) are exclusive to a single context, that is identified by design consultants or identified by the UK-based participants only. The identification of conditions within multiple contexts results in an internal validation of Success conditions and implies that at least 70% of the identified conditions could be generalisable.

To visualise how the experience of interview participants and the viewpoint used by participants affect their perception of Success conditions, the top ten Success conditions with highest frequency values are plotted on radars. Following are the key highlights of the analysis presented in Figure 8-34:

- In Part-1, the radar is plotted with respect to participants’ region of belonging. The participants accountable for the highest and lowest frequency of Success conditions belong to Australia and Pakistan respectively. This is because of the large number of participants from Australia (n=30) and the scarce number of participants from Pakistan (n=2). While Australia-based participants are not strongly convinced of ‘Project team collaboration’ as a Success condition, the UK and the UAE-based participants have strongly highlighted this condition. Moreover, unlike Australia-based participants, the Singapore-based interviewees have strongly highlighted ‘Setting appropriate project targets’ as a Success condition.
- In Part-2, the radar is plotted with respect to participants’ experience of GB projects. Some dissimilarities in trends are worth mentioning. For instance, as compared to participants with high to very high experience, the interviewees with low to medium-level experience have strongly highlighted ‘project team collaboration’, ‘early introduction of project targets’ and ‘proficiency of project client’ as Success conditions.
- In Part-3, the radar is plotted with respect to participants’ role in GB projects. It can be observed that a similar number of Design consultants and Sustainability consultants interviewed have a significantly different focus on Success conditions. Unlike design consultants, the sustainability consultants have strongly highlighted some conditions, including ‘proficiency of project team’, ‘early engagement of project team’, and ‘project team collaboration’. On the contrary ‘Rigour of project planning’ is strongly highlighted by design consultants and not by sustainability consultants.
- In Part-4, the radar is plotted in terms of the three viewpoints used in interviews for the inquiry of Success conditions. Within the viewpoint of ‘*Findings from participants’ overall experience*’, some of the highly focused Success conditions are ‘rigour of project design development’ and ‘proficiency of project team’. Within the viewpoint of successful/failed project-based findings, a highly focused condition is ‘client’s motivation to achieve sustainable outcomes’. Within the viewpoint of ‘*Suggestions for clients*’, a highly focused condition is ‘early engagement of project team’.

Overall Part-1, 2, and 3 of Figure 8-34 show that the identification of Success conditions by interview participants is considerably determined by the context in which participants are based. Part-4 shows that the identification of Success conditions by interview participants also depends on the viewpoint used in interviews for the inquiry of Success conditions.



Figure 8-34: Effect of interview participants' demographic attributes and viewpoints on the identification of Success conditions

Section 8.6.1 and 8.6.2 have provided analysis at the level of Success conditions. Analysis at the level of broader *themes* of Success conditions is provided in Section 8.6.3.

8.6.3. Thematic analysis of Success conditions

The overall 155 conditions and sub-conditions are classified within 20 broader *themes*. To see how the attributes of interview participants and their viewpoints affect the identification of Success conditions within their broader *themes*, the analysis of the frequency distribution of broader *themes* is conducted in this section (shown in Table 8-5).

- **Viewpoints used in interviews:** Regarding the three viewpoints used in interviews for the inquiry of Success conditions, it can be observed that varying consideration is given to different *themes* while using the three viewpoints. Success conditions regarding 'Education', 'Completeness and rigour of deliverables', 'Flow of project information', and 'Inspection, monitoring, and control' are mostly identified by participants while using the viewpoint of '*Findings from participants' overall experience*', and not by the other two viewpoints. Success conditions regarding 'Constraints' and 'Team authorities, responsibilities, and contractual relationships' are mainly identified by participants while using the viewpoint of '*Findings from successful/failed projects*', and not by the other two viewpoints.
- **Regional belonging of interview participants:** Upon analysing Success conditions identified by participants with GB experience based in different regions it can be observed that conditions regarding 'team authorities, responsibilities, and contractual relationships' have received a major focus from the UAE-based participants. Conditions regarding 'changes during project development and fulfilling design intent', 'education', and 'team mindset and priorities' have received no attention from the UAE-based participants. Conditions regarding 'Inspection, monitoring, and control' and 'education' have received insignificant attention from the UK-based participants. Conditions regarding 'planning approach' have received insignificant attention from the Hong Kong-based participants. Conditions regarding 'team commitment to the project' have received insignificant attention from Hong Kong, Singapore, and the UAE-based participants. Conditions related to 'team authorities, responsibilities, and contractual relationships' have received insignificant attention from Hong Kong and Australia-based participants.
- **Experience of participants in GB projects:** Upon analysing Success conditions identified by participants with medium, high and very high experience of working on GBs, it is observed that conditions regarding 'client's characteristics' have received the most attention from participants with medium-level experience of GBs. On the contrary, this group of participants has paid the least attention to conditions regarding 'flow of project information' and 'engraving sustainability in project development'. Participants with high-level experience have given much attention to conditions regarding 'flow of project information'. This group of participants has, however, given little attention to 'engraving sustainability in project development'. Compared to participants with medium-level and high-level experience, participants with very high-level experience have given much attention to conditions regarding 'education'. This group of participants has, however, given little attention to 'team collaboration' and 'clarity in project development'.
- **Role of participants in GB projects:** Upon analysing Success conditions identified by participants having different professional roles in GBs, it is observed that conditions regarding 'constraints', 'team procurement methodology', and 'flow of project information' have received insignificant attention from sustainability consultants. Conditions regarding 'design methodology', 'flow of project information', and 'cooperation and interest of stakeholders' have received much attention from design consultants. However, these professionals have paid little attention to conditions

regarding 'changes during project development and fulfilling design intent' and 'team authorities, responsibilities, and contractual relationships'.

Overall, it can be stated that the identification of Success conditions by interview participants is considerably determined by the viewpoints of participants as well as their experience, professional role, and regional belonging.

Table 8-5: Distribution of Success condition themes in terms of the experience, regional belonging, and viewpoints of participants

Themes of Success conditions	Viewpoints			Participant's primary role in GB projects (%)		Experience of participants in GB projects			Country where GB experience of participants mainly based					
	Findings from successful/failed projects	Findings from participants' overall experience	Suggestions for clients	Design Consultant	Sustainability Consultant	Low to Medium experience (less than 10 years)	High experience (10 or more years but less than 15 years)	Very high experience (15 years or more)	Pakistan	UAE	Hong Kong	UK	Singapore	Australia
Constraints	7	3	0	16%	5%	13%	13%	11%	50%	0%	0%	15%	7%	17%
Engraving sustainability in project development	0	7	4	16%	10%	8%	9%	22%	0%	0%	0%	23%	7%	17%
Team authorities, responsibilities, and contractual relationships	7	1	1	11%	14%	21%	9%	6%	50%	80%	0%	15%	7%	3%
Clarity in project development	3	12	0	26%	14%	17%	25%	6%	0%	20%	13%	31%	7%	20%
Team procurement methodology	4	8	2	26%	10%	17%	22%	11%	50%	20%	13%	38%	14%	10%
Changes during project development and fulfilling design intent	4	10	1	16%	24%	17%	13%	33%	50%	0%	25%	23%	14%	20%
Education	1	18	0	26%	24%	13%	22%	44%	0%	0%	25%	8%	36%	33%
Team mindset and priorities	7	10	0	32%	19%	17%	22%	39%	0%	0%	38%	54%	14%	20%
Completeness and rigour of deliverables	4	17	2	26%	33%	21%	25%	39%	50%	20%	25%	46%	14%	27%
Client's characteristics	8	13	5	32%	38%	46%	25%	28%	0%	40%	25%	46%	29%	33%
Planning approach	8	17	1	37%	38%	33%	34%	28%	0%	60%	13%	46%	29%	33%
Flow of project information	5	21	1	53%	19%	8%	53%	33%	0%	20%	25%	54%	29%	37%
Inspection, monitoring, and control	2	22	1	37%	24%	25%	38%	39%	0%	20%	50%	23%	36%	40%
Team commitment to the project	9	20	0	42%	43%	29%	41%	39%	50%	20%	13%	54%	21%	47%
Team collaboration	14	18	0	32%	48%	58%	41%	28%	100%	60%	38%	69%	36%	27%
Defining project goals	14	21	5	53%	38%	38%	47%	39%	0%	60%	63%	62%	50%	27%
Team characteristics	9	29	3	47%	62%	50%	47%	50%	100%	40%	50%	62%	36%	50%
Timeliness of project activities	11	31	10	53%	67%	58%	50%	50%	100%	60%	75%	54%	50%	47%
Design methodology	11	35	3	63%	52%	42%	59%	67%	0%	60%	63%	54%	71%	53%
Cooperation and interest of stakeholders	24	22	6	74%	43%	54%	53%	67%	100%	60%	75%	77%	43%	50%
Number of participants	35	66	19	19	21	24	32	18	2	5	8	13	14	30

8.7. Review of Success conditions in terms of theory and practice

The findings presented in this study are reviewed in terms of the theory and practice of GB development. To review in terms of theory, the identified Success conditions are compared with research studies published in the area of GB project development. To review in terms of practice, the identified Success conditions are compared with credits of GB certification systems.

8.7.1. Comparing Success conditions with previous research on Green Buildings

The Success conditions and sub-conditions identified in this study have been reviewed in terms of the findings of previously published studies on GB project development and the synthesis of review findings is provided in Figure 8-35. A detailed account of review findings is provided in Appendix D (Section D.4),

Most of the Success conditions (46) and sub-conditions (51) identified in this study are partially or completely associated with findings from previous studies on GBs. Many Success conditions (44) and sub-conditions (48) identified in this study have also been discussed as Success conditions in previous studies. Previous studies have considered GB Success conditions within the CSF and PDA paradigms which are discussed in detail in Literature Review (Chapter 2 - Section 2.2).

Some Success conditions and sub-conditions have also been discussed as challenges (28), risks (25), drivers (5), and performance criteria (2) in previous studies. The set of challenges shown in Figure 8-35 is a mix of Barriers and Failure conditions. As shown in Figure 8-35, up to 35 conditions and sub-conditions belong to multiple paradigms (such as drivers, risks, and success factors). While a majority of Success conditions (46) and sub-conditions (51) are discussed within different paradigms of GB research, a sizable number of conditions (27) and sub-conditions (31) have not been discussed previously in the research on GB projects.

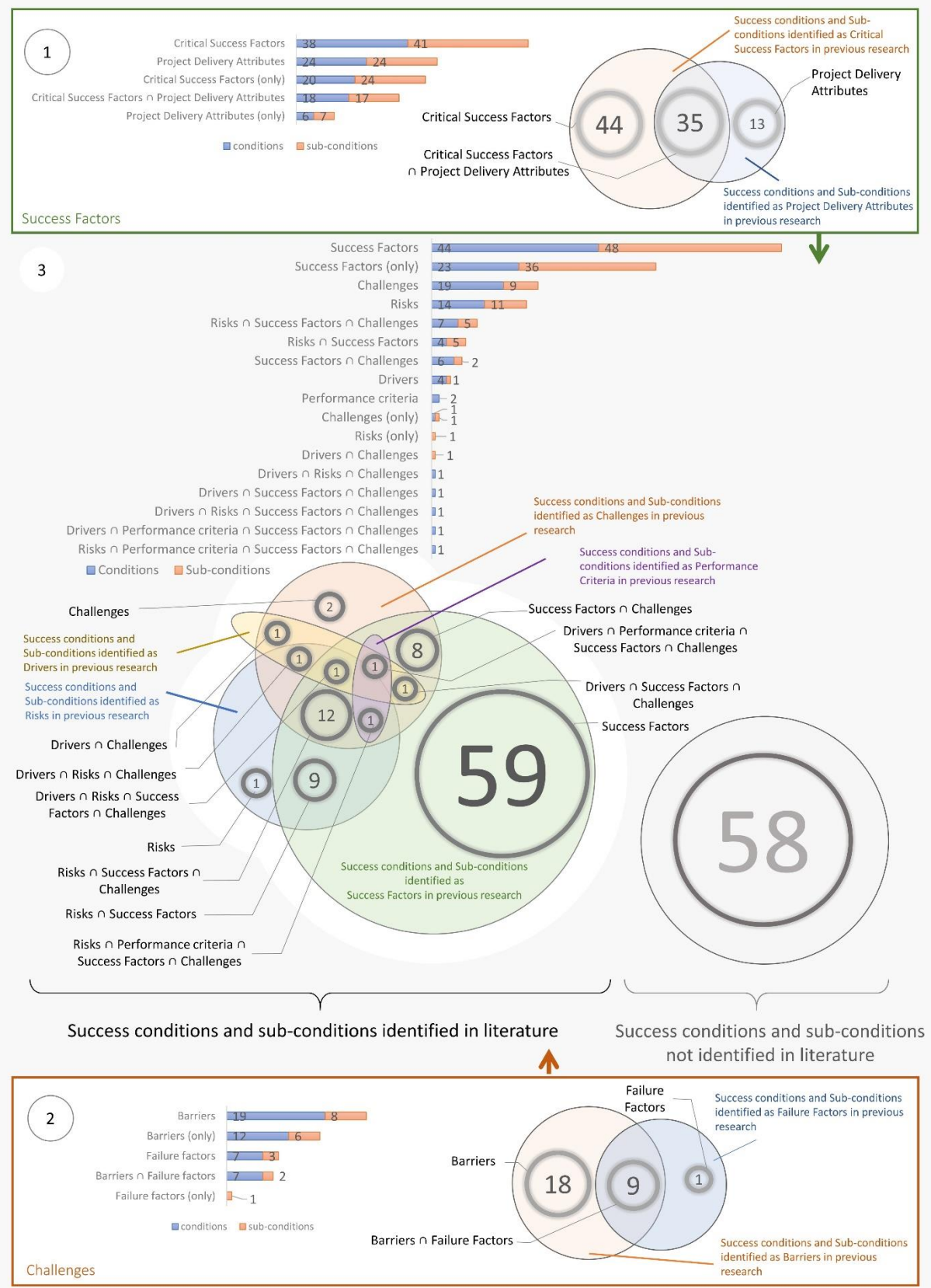


Figure 8-35: Association of identified Success conditions with previous research on Green Building projects

A comparison of the emphasis on Success conditions in this study as compared to previous studies is necessary to highlight the significance of research outcomes. Key findings of this comparison are presented below.

Success conditions which are focused on in previous studies, and which have also been highly emphasised by interview participants include, 'Client's motivation to achieve sustainable outcomes' (number of interview participants discussing the Success condition= 32), 'Proficiency of project team' (n=32), 'Project team collaboration' (n=29), 'Early engagement of sustainability consultant' (n=22), and 'Setting appropriate project targets' (n=21). Other Success conditions which are also focused on in previous studies but which have received a medium-level of attention by interview participants include, 'Early incorporation of sustainability in project' (n=17), 'Use of integrated design approach' (n=13), 'Proficiency of Design Consultant' (n=12), 'Monitoring of project development' (n=12), 'Preferences in project team selection' (n=12), 'Communication among project team' (n=11), 'Completeness and rigour of project design before execution' (n=9), and 'End-users' involvement in defining project aspirations' (n=8).

Success conditions which are focused on in previous studies, however, have received little emphasis by interview participants, include, 'Accessibility of project funding' (n=6), 'Early engagement of contractor' (n=6), 'Provision of sustainability specifications and other related information in tender' (n=4), 'Proficiency of PM team' (n=4), 'Rigour of risk management' (n=4), 'Using appropriate project delivery method' (n=3), and 'Project team contractually required to deliver sustainable outcomes' (n=2). On the contrary, some Success conditions which are highly emphasised by interview participants but which have not received significant attention in previous research in terms of the number of studies, are, 'Rigour of project design development' (n=41), 'Proficiency of project client' (n=20), 'Project team motivation to achieve sustainable outcomes' (n=20), and 'Rigour of project planning' (n=19).

As discussed, few Success conditions are highly emphasised both in this study as well as in previous ones. On the contrary, many Success conditions which are highly emphasised in previous research in terms of the number of studies have received less emphasis in this study and *vice versa*. The difference in emphasis towards Success conditions may be a result of research design and the socio-cultural and historic context of research studies, as discussed below.

An important reason for the difference in emphasis towards Success conditions can be due to research design. As indicated in Chapter 2 (Section 2.5), the previous research on GB project success has mainly favoured the explanatory research design compared to exploratory design. While explanatory design can help explain the associations among factors (that is the effect of Success conditions on Success criteria), it does not have much emphasis on identifying the unknown factors necessary to explain a phenomenon (such as GB project success) (*The SAGE Encyclopedia of Qualitative Research Methods*, 2008, pp. 323-325). As a result, the explanatory design mainly used by previous research on GB project success has relied on a limited pool of Success conditions and criteria already identified in the literature. Since the Success conditions identified in this study are purely an outcome of exploratory research design and the previous studies are mainly explanatory, this may be a reason for the difference in emphasis towards Success conditions across these studies.

Another potential reason behind the difference in emphasis towards Success conditions can be due to the regional and historical context of research. In epistemological terms, the study is based on the belief that knowledge about reality is always socially, culturally, and historically situated. The Success conditions in this study have been identified by GB experts belonging to Australia, the UK, the UAE, Singapore, Pakistan, and Hong Kong, and these interviews were conducted from September 2017 to February 2019 (explained in detail in Chapter 4 - Section 4.4.2). Success conditions in previous studies have been mainly investigated within the context of the US, the UK, Malaysia, Singapore, and Australia.

As many as 79% (n=38) of the previous studies are published before the year 2017 (explained in detail in Chapter 2 - Section 2.5). While some regions of inquiry are the same, both in this study and previous studies (that is, the UK, Singapore, and Australia), some regions are different in these studies (that is, the UAE, Hong Kong, and Pakistan). The difference in the regional context and the timeframe of previous studies as compared to this study may be responsible for the difference in emphasis towards Success conditions.

8.7.2. Comparing Success conditions with credits of Green Building certification systems

Credits of GB certification systems are the criteria against which the sustainability of GB projects is assessed, and a certificate is awarded. In the case of GBs, project teams and clients are highly driven towards sustainability certification. In case a Success condition occurs as a credit in a certification system, it implies a recognition of its importance in the practice of GB development. Considering the importance of credits, the Success conditions and sub-conditions identified in this study are compared with the credits of four GB certification systems namely, Leadership in Energy and Environmental Design (LEED) system by the U.S. Green Building Council, Building Research Establishment Environmental Assessment Method (BREEAM) by the U.K. Building Research Establishment, Green Star system by Green Building Council of Australia, and Living Building Challenge system by International Living Future Institute. The Australia-based Green Star system is used since the majority of GB professionals who participated in this study through the online survey (n=42, 41%) and semi-structured interviews (n=32, 42%) are based in Australia. LEED system originating in the US in 1998, and BREEAM established in 1990 in the UK are used for analysis as these are two most popular certification systems worldwide. Another reason behind the reason for using BREEAM is that a significant number of interview participants (n=13, 17%) are based in the UK. While the popular certification systems such as LEED, BREEAM and Green Star have a focus towards reducing environmental footprint and improving the indoor environment, they lack emphasis towards a regenerative built environment. To complement this aspect, the Living Building Challenge system is used in analysis since it has a goal of creating a regenerative built environment (Thomas, 2016).

The certification systems are comprised of multiple frameworks focused on different project types and life-cycle stages. To compare with the findings in this study, the LEED frameworks used are 'Building Design and Construction' and 'Building Operations and Maintenance'; BREEAM framework used is 'UK New Construction'; Living Building Challenge framework used is 'Buildings'; and Green Star frameworks used are 'Design & As Built' and 'Performance'. The association of Success conditions with credits of certification systems is shown in Figure 8-36 with the detail provided in Appendix E (Section E.2).

Among the overall 155 Success conditions and sub-conditions identified in this study, 16 conditions and 23 sub-conditions are associated with 11 credits of Green Star, 2 credits of Living Building Challenge, 24 credits of LEED, and 20 credits of BREEAM. Hence, there is the highest association of identified conditions with the LEED and BREEAM GB accreditations. By association, it means that the credits of certification systems provide a complete or partial representation of particular Success conditions. For instance, 'Use of innovative design approach' is a Success condition associated with 'innovation' credit of the LEED system. Some Success conditions highly associated with the certification systems are 'Use of energy-oriented design approach', 'Monitoring and controlling operational performance of building', 'Execution of commissioning and fine-tuning', 'Procurement of project site based on sustainability goals', and 'Life-cycle based project development approach'. The credits in the four certification systems fail to represent 62 (79%) conditions and 70 (75%) sub-conditions. This lack of representation indicates that the certification systems need to account for more number of Success conditions. A detailed discussion regarding the potential role of certification systems in the uptake of Success conditions is provided in Chapter 9 (Section 9.3.1).

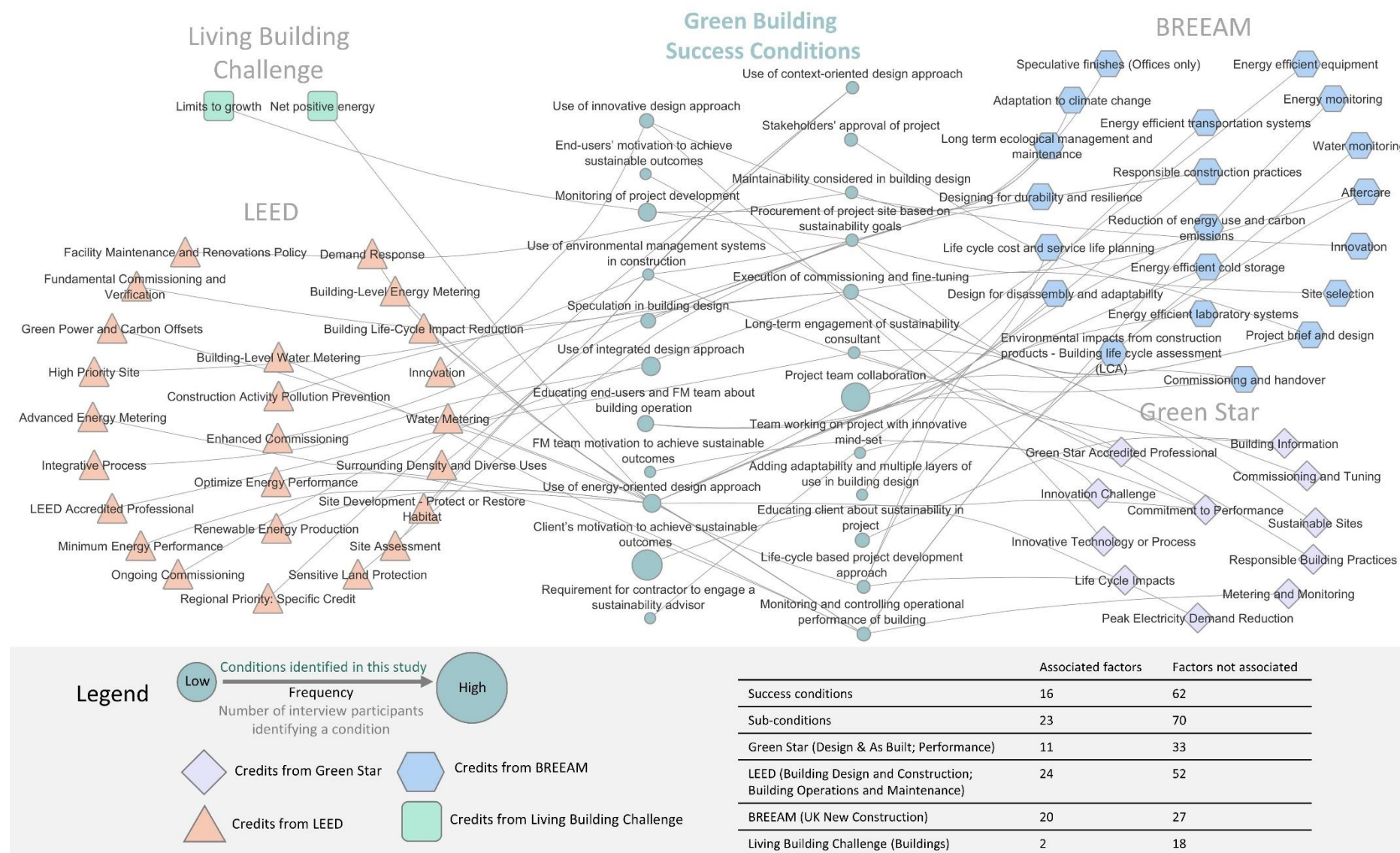


Figure 8-36: Association of Success conditions design with credits of Green Building certification systems

8.8. Chapter Summary

The research findings reported in this chapter address a key research question of this study which is to identify the conditions associated with the likelihood of achieving GB project outcomes, and in that regard examine the significance and associations of these conditions. The findings in this chapter are based on thematic analysis of interview findings.

In the semi-structured interviews conducted with GB professionals, Success conditions are inquired using three different viewpoints (that is, '*Findings from successful/failed projects*', '*Findings from participants' overall experience*', and '*Suggestions for clients*') to effectively capture the success perception of 72 GB professionals. A considerable overlap among the conditions responding to the three viewpoints is realised.

Using interview data, 73 conditions and 82 sub-conditions are identified and the conditions with common attributes have been allocated within 20 broad *themes* which emerged from the analysis. A detailed description of the meaning of Success conditions is provided. The associations of conditions resulting in their importance have also been explained.

The identified conditions are also analysed with respect to the TFV theory. As a result of this analysis, the conditions within all the 20 *themes* are found to reduce the non-value adding activities in project development, create value for the client, and in some cases also result in transformation. Up to 7%, 61%, and 94% of Success conditions and sub-conditions are associated with the Transformation, Flow, and Value-generation views respectively.

The analysis of Success conditions in terms of the attributes of participants revealed that 5 conditions and 6 sub-conditions are only identified by Design Consultants, while 3 conditions and 7 sub-conditions are only identified by sustainability consultants. Moreover, 13 conditions and 25 sub-conditions are only identified by participants belonging to one of the six regions. This analysis of findings has shown that the varying emphasis on Success conditions is subject to the regional belonging of participants, professional roles of participants in GBs, and the experience participants have of working on GBs. The analysis has also revealed that about 70% of the Success conditions are identified by participants belonging to multiple regions, professional roles, and experience in GBs, suggesting generalisability of the identified Success conditions.

The use of qualitative research methodology in this study has helped explain the reasons behind the importance of Success conditions. This explanation has provided a detailed account of associations among Success conditions and has helped develop a Success conditions network. Based on the understanding of Complexity theory, the attributes of Success conditions within the network are analysed to determine the importance of conditions in the network. Moreover, the robustness of the network is also analysed by the progressive elimination of 11 Success conditions from the network. While the network analysis has shown the role and importance of Success conditions in a network, it has also highlighted the importance of semi-structured interviews approach for this inquiry.

The study findings are reviewed in terms of theory and practice of GB projects by comparing the identified Success conditions and sub-conditions with previously published research on GB projects and credits occurring in GB certification systems.

This chapter identified the Success conditions in GB projects and determined the associations among these conditions. But how do the Success conditions, Underlying conditions, and Differentiating conditions overlap? What are the theoretical interpretations and implications of overall research findings? What are the practical implications of the research findings? What are the limitations of this

study? What are the suggestions for future research on GB development? Chapter 9 will answer these remaining questions by discussing the research findings of this study as a whole.

9. Discussion and Implications of findings

A detailed account of the research findings in terms of their interpretations and implications is provided in this chapter. The previous chapters (5, 6, 7, and 8) have provided a detailed analysis of research findings and also a detailed discussion and interpretation of those findings. Chapter 5 provided a detailed account of the conditions differentiating GBs from non-GB projects. The interrelationships among project management Success criteria (that is, *schedule*, *cost*, and *quality*) and sustainability performance criteria are investigated in Chapter 6. Chapter 7 provides the account of an in-depth inquiry of GB Success criteria and in Chapter 8, the Success conditions for GBs and their interrelationships are discussed. Unlike Chapter 5, 6, 7, and 8 providing detailed implications and interpretations of research findings, the aim of this chapter is to provide a holistic overview of research findings and in doing so the interpretations, implications, and limitations are discussed.

The structure of this chapter is such that first Section 9.1 explains the overlap of Success conditions, Underlying conditions, and Differentiating conditions. By converging findings of this study, this section provides an in-depth understanding of Success conditions. This is followed by theoretical interpretations and implications of research findings (Section 9.2). The subsequent section (Section 9.3) is about the practical implications of research findings. Finally, in Section 9.4, the limitations of this study and suggestions for future research are discussed, including the role of data collection approaches (that is, online surveys and semi-structured interviews), sequence of *themes* in interviews, need of a longitudinal study on GB project success, and the need of developing appropriate research scope for studies on GB project success.

9.1. Overlap among Success conditions, Underlying conditions, and Differentiating conditions

Referring to the definition of the three types of conditions, the conditions associated with the achievement of project outcomes in GBs are Success conditions (see Chapter 8); conditions setting GBs apart from the non-GB projects because of their sustainability requirements are Differentiating conditions (see Chapter 5); and the conditions which influence the associations among performance criteria in GB projects are Underlying conditions (see Chapter 6). The definitions of these three condition types suggest their importance for GB projects and also highlight the possibility of overlap between them. For instance, GBs compared to non-GB projects have a high requirement of design integration owing to their sustainability requirements. While being a Differentiating condition, high design integration is also an Underlying condition as it results in mutually positive associations among performance criteria. Moreover, the high level of design integration is also a Success condition as it contributes to project success. The three types of conditions are compared and the analysis approach for this is explained in Chapter 4 (Section 4.5.1.4). As expected, the comparative analysis has revealed a high degree of overlap across the three sets of conditions as shown in a Venn Diagram (Figure 9-1). There is a considerable overlap of Underlying and Differentiating conditions with Success conditions. Around 40 (26%) Success conditions overlap with 22 (65%) Differentiating conditions and 27 (73%) Underlying conditions. A detailed account of the overlapping conditions is provided in Appendix E (Section E.1).

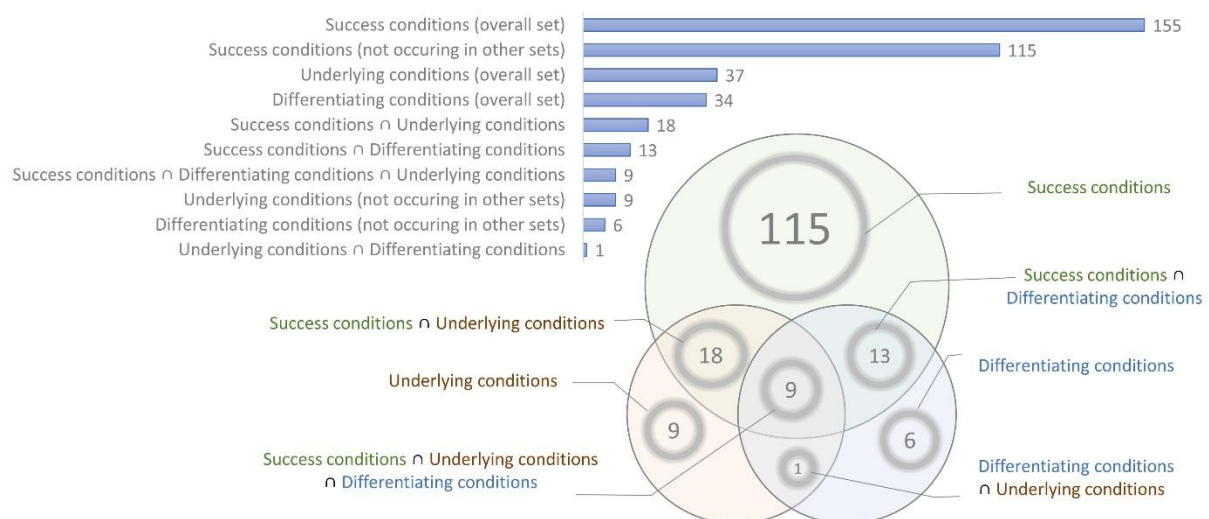


Figure 9-1: Overlap between Differentiating, Underlying, and Success conditions identified in this study

Following are the implications of overlap among the three types of conditions:

- As many as 22 (65%) Differentiating conditions also occur as Success conditions for GBs implying that the conditions setting GBs apart from traditional projects are mainly the aspects necessary for their success;
- As many as 27 (73%) Underlying conditions overlap with Success conditions of GB projects implying that the majority of conditions influencing the associations among performance criteria contribute towards GB project success; and
- The overlap of 9 Underlying, Differentiating, and Success conditions means that some conditions which set GBs apart from non-GBs also influence the associations among performance criteria and also contribute towards GB project success.

The comparative analysis highlights that instead of being disjoint and separate, the three types of conditions considerably overlap, and this helps converge the research findings. However, the comparative analysis also highlights the importance of separate inquiries for the three types of factors as conducted in this study. The non-overlapping 115 (74%) Success conditions, 6 (18%) Differentiating conditions, and 9 (24%) Underlying conditions indicate that even if substantial overlaps exist among the three types of conditions, it does not mean that the three constructs are one and the same.

The overlap of Differentiating conditions with Success and Underlying conditions shows the importance of using the contingent approach to project success research. The contingent approach to project success has a situational view of project success with particular emphasis on 'project context' (Ika, 2009). The investigation of Differentiating conditions in this study has provided a detailed account of the GB project context. For instance, high design integration is a condition differentiating GBs from their traditional counterparts. This means that high design integration is an aspect defining the context of GB projects. Resultantly, the overlap of Differentiating conditions with Success conditions elaborates that the concept of GB project success is strongly embedded in the context of GB projects. This can also be considered a validation of the contingent approach to project success in GB projects.

9.2. Theoretical implications and interpretations of research findings

This section provides some of the key highlights regarding the interpretation of research findings in terms of complex systems and the TFM theory. The theoretical implications of research findings are also explored by explaining the overlap of project success paradigm with other paradigms (that is, risks, drivers, and barriers).

9.2.1. Comparison of Green Building Success conditions with success factors of other socio-technically complex projects

Socio-technical complexity occurs in projects which are about designing, managing or transforming complex systems. This is particularly relevant to large, innovative and complex projects, involving many individuals and heterogeneous disciplines. Owing to the sustainability requirements of GBs, these projects, in comparison with traditional building projects, have additional Success criteria, more heterogeneous project teams, and a high requirement for technological innovations. This indicates that the development of GB projects has increased socio-technical complexity resulting from the combination of social and technical aspects.

To evaluate if the Success conditions of GB projects identified in Chapter 8 also occur in case of other socio-technically complex projects, a review of research on the success of complex systems in other disciplines was conducted. While one of the reviewed studies is about construction projects (Duy Nguyen, Ogunlana, & Thi Xuan Lan, 2004), the other reviewed studies were focused on: large scale complex projects (Pisarski et al., 2011), complex multinational projects (Thamhain, 2013), international development capacity building projects (Ika & Donnelly, 2017), pest management projects (Schmidt, Stiefel, & Hürlimann, 1997), global information systems (Biehl, 2007), and aerospace and defence projects (Rodriguez-Segura, Ortiz-Marcos, Romero, & Tafur-Segura, 2016). In contrast to the term 'Success conditions' used for findings of this study, the success enablers in reviewed studies are referred to as 'success factors' for distinguishing purpose.

The comparison shows a considerable representation of GB Success conditions in the success factors of other complex systems. Some success factors occurring in reviewed studies represent very specific aspects of a project type and hence do not represent Success conditions identified in this study. The representation of Success conditions by success factors of complex systems is shown in Table 9-1. The GB Success conditions represented by success factors of other complex systems are: stakeholder interest; client's characteristics; communication; team characteristics, responsibilities, and commitment; team collaboration; team and client's education; client's funding; project planning, monitoring and control; team selection criteria; defining project; and clarity in the project development process. These Success conditions are either about the stakeholder attributes in projects or approaches contributing to successful project development through the efficient use of human skills, knowledge, and commitment. The representation of these GB Success conditions by the success factors of other complex systems indicates that the existence of similar Success conditions across different complex systems can be due to the socio-technical complexity in all these systems.

Table 9-1: Comparison of Green Building Success conditions with success factors of other complex projects

Success factors identified in reviewed studies	Complex projects							Sum	Success conditions of Green Building projects	Success condition identified as Differentiating condition
	Global information systems (Biehl, 2007)	Large scale complex projects (Pisarski et al., 2011)	Large construction projects (Duy Nguyen et al., 2004)	Integrated pest management (Schmidt et al., 1997)	Complex multinational projects (Thamhain, 2013)	International development capacity-building projects (Ika & Donnelly, 2017)	Large projects in aerospace and defence sectors (Rodriguez-Segura et al., 2016)			
Commitment of stakeholders			x		x	x		3	Stakeholders' approval of project	
Communication (cross-functional communication, clear communication)	x		x				x	3	Communication among project team	x
Understanding and approval by top management	x		x				x	3	Client's motivation to achieve sustainable outcomes PM team motivation to achieve sustainable outcomes	
Adequate funding throughout the project			x				x	2	Accessibility of project funding	
Competent project managers			x				x	2	Proficiency of PM team	
Involving cross-functional teams	x		x					2	Preferences in project team selection	x
Project monitoring and control						x	x	2	Monitoring and controlling the operational performance of building Monitoring of project development Control of project design by Design and Sustainability Consultant	x
Motivation of project team							x	1	Project team motivation to achieve sustainable outcomes	
Adequacy of project team							x	1	Proficiency of project team	
Alignment of personal and organisational interests with project outcomes						x		1	Alignment of team interest with project interest	
Availability of resources			x					1	Access to sustainable building materials	
Awarding bids to the right designer/contractor			x					1	Preferences in project team selection	x
Bringing end-users on board early during the project	x							1	End-users' involvement in defining project aspirations	x
Budget management							x	1	Adequate budget allocation for project development	
Clear objectives and scope			x					1	Clarity in communication of project goals	
Community involvement			x					1	Stakeholders' approval of project	

Success factors identified in reviewed studies	Complex projects							Sum	Success conditions of Green Building projects	Success condition identified as Differentiating condition
	Global information systems (Biehl, 2007)	Large scale complex projects (Pisarski et al., 2011)	Large construction projects (Duy Nguyen et al., 2004)	Integrated pest management (Schmidt et al., 1997)	Complex multinational projects (Thamhain, 2013)	International development capacity-building projects (Ika & Donnelly, 2017)	Large projects in aerospace and defence sectors (Rodriguez-Segura et al., 2016)			
Comprehensive contract documentation			×					1	Provision of sustainability specifications and other related information in tender	
Leadership attributes		×						1	Client's leadership in project Leadership qualities among project team members	
Planning							×	1	Rigour of project planning	
Practical and continuous training of team				×				1	Educating project team about GB development	
Preparation of client's team							×	1	Educating client about sustainability in project Educating end-users and FM team about building operation	
Project definition							×	1	Setting of a detailed sustainability charter or brief	×
Promoting ownership				×				1	Delegating clear responsibilities to project team	
Proper emphasis on the past experience			×					1	Proficiency of project team Proficiency of project client	
Decision-making abilities of clients				×				1	Client's rational decision-making	
Risk management							×	1	Rigour of risk management	
Team collaboration						×		1	Project team collaboration	×
Verification and testing							×	1	Inspection of project upon construction Execution of commissioning and fine-tuning	×

Some GB Success conditions represented by success factors of other complex systems are also the conditions differentiating GBs from non-GBs. The GB Success conditions which are also the Differentiating conditions are related to communication, preferences in project team selection, end-users' involvement in defining aspirations, team collaboration, commissioning and fine-tuning, sustainability brief, and project monitoring and control. This implies that a number of Success conditions (n=8) represented by success factors of other complex systems are in fact the conditions setting GBs apart from traditional non-GB projects. This also implies that the complexity of GB projects tends to set them apart from non-GB projects.

9.2.2. Interpretation of findings based on the Transformation-Flow-Value generation theory

Koskela's theory of production in construction (that is the TFV theory) sees production from three viewpoints: as a chain of transformations, as the flow of work, and as a generation of value for the customer. A detailed account of the associations of Success criteria and Success conditions with the TFV theory has been discussed in Chapters 7 and 8 respectively. The associations of Success conditions and criteria with the TFV theory are based on the researcher's assessment of the interview findings with respect to the principles of Transformation, Flow, and Value-generation. A detailed overview of the assessment process used by the researcher is provided in Chapter 4 (Section 4.5.1). In this section, a holistic overview of the associations of Success conditions and criteria with the TFV theory is provided and the limitations regarding the use of this theoretical framework are also discussed.

9.2.2.1. Interpreting Success conditions using the Transformation, Flow, and Value-generation views

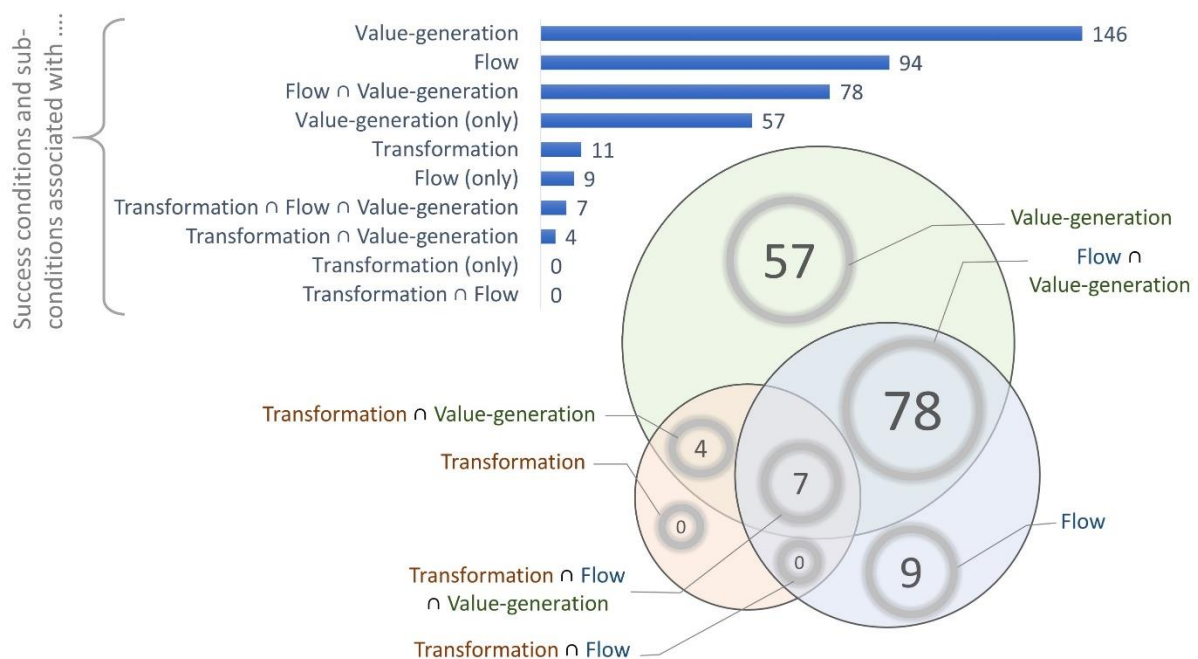


Figure 9-2: Association of Success conditions with the Transformation, Flow, and Value-generation views of the TFV theory

The inquiry regarding GB Success conditions in Chapter 8 has addressed the research sub-question, that is 'What are Success conditions in Green Building projects and how do they interrelate?' For theoretical interpretation of findings, an overview of the associations of Success conditions with the Transformation, Flow, and Value-generation views in the TFV theory is provided (Figure 9-2). Following are some key highlights of the associations observed:

- About 94% (146) of Success conditions and sub-conditions are associated with the Value-generation view which means that they directly affect the value for the project client. This is unsurprising since Success conditions are about achieving project outcomes and by doing so value for the project is created;
- About 61% (94) of Success conditions and sub-conditions are directly associated with the Flow view. This means that most Success conditions are about creating efficiency in work and reducing non-value adding activities;
- High overlap of 78 Success conditions associated with both the Flow and Value-generation indicates that half of the overall Success conditions simultaneously add value in the project and contribute towards efficient project development; and
- About 7% (11) of Success conditions and sub-conditions are associated with the Transformation view. Even these few conditions are not explicitly associated with the Transformation view as they are also associated with Flow and Value-generation views. This shows that even though transformation is an important underlying concept, it does not necessarily have a direct association with many Success conditions.

The high association of Success conditions with the Value-generation and Flow view means that these two views in the TFM theory are most relevant in explaining the Success conditions. This, therefore, indicates that the conditions which critically determine project success are mainly those which add value in project for the client or reduce the non-value adding activities.

Although some Success conditions are not directly associated with the Transformation, Flow, and Value-generation views, they may, however, have indirect associations with these views. This is because as discussed in Chapter 8 (Section 8.4), the Success conditions are associated with each other in a complex network. Hence, even if condition 'A' does not directly associate with project value, it interrelates with condition 'B' which is directly associated with project value.

Even though Success conditions seem to have scarce associations with the Transformation view in the TFM theory, it does not mean that the Transformation view is unimportant for project success. It is possible that aspects related to transformation are so embedded in the project development process that industry professionals do not consider these as Success conditions anymore. As Lauri Koskela (2000) highlighted, over the years, the role of the transformation model as the foundational theory is forgotten. In practice as well as in research settings, the transformation concept is most often implicit, and when made explicit, it is rarely treated as a testable and discussible theory. This indicates that although the transformation is an important underlying view of production in the TFM theory, it has limited use in interpreting Success conditions of GB projects.

9.2.2.2. *Interpreting Success criteria using the Value-generation view*

In case Koskela's definition of value-generation and waste is considered (explained in detail in Chapter 3 - Section 3.4), the Success criteria resulting in values for the environment will also result in Value-generation for the project clients and occupants. This is because Value-generation for a client involves the concept of avoiding potential waste related to unwanted by-products (that is environmental degradation). Although the popular Value-generation view provides an explanation for Success criteria resulting in value for client and environment, it does not explain the criteria resulting in value for society and the construction industry. In short, a Success criterion resulting in value for the project clients, occupants, and environment is associated with the Value-generation view in the TFM theory and in case a Success criterion only creates value for society or the construction industry it will not associate with the Value-generation view in the TFM theory.

The inquiry regarding GB Success criteria in Chapter 7 has addressed the research sub-question, that is *'What are Success criteria in Green Building projects and how do they interrelate?'* An overview of the association of Success criteria with the Value-generation view in the TFM theory is provided in Figure 9-3.

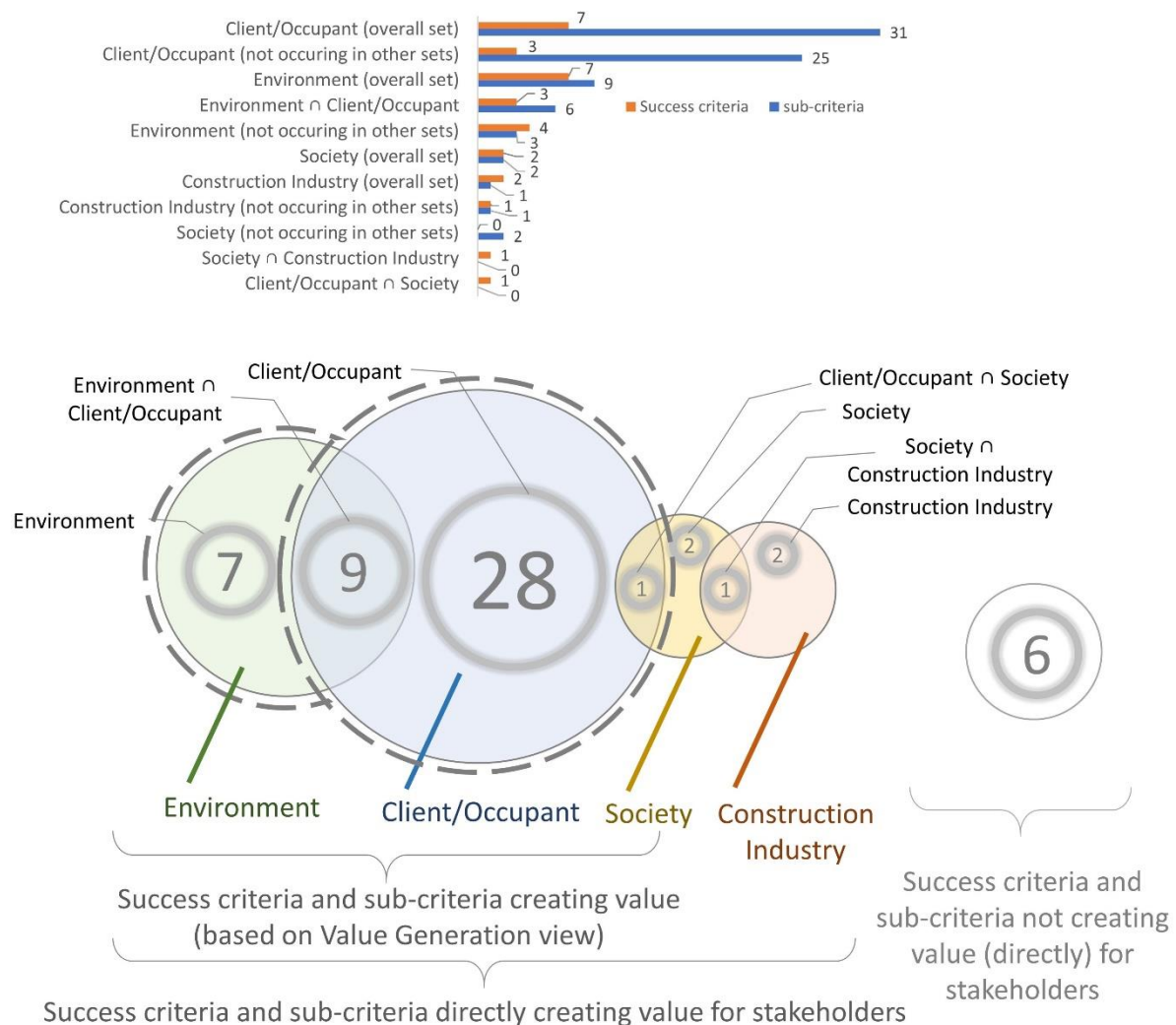


Figure 9-3: Association of Success criteria with the Value-generation view

Following are some key highlights of the associations observed:

- 13 criteria and 37 sub-criteria create value for not only the project client and occupants but also for the environment, society, and the construction industry;
- 4 criteria and 2 sub-criteria do not seem to create value for any stakeholder;
- 11 criteria and 34 sub-criteria create value for clients/end-users and environment; hence, these criteria and sub-criteria can be considered as associated with the Value-generation view proposed by Koskela; and
- 2 criteria and 3 sub-criteria create value for the construction industry and society only and are therefore not represented by Koskela's Value-generation view.

A majority of the identified Success criteria are about creating value for stakeholders and therefore can be interpreted by the Value-generation view. This indicates that the Value-generation view is an important theoretical lens to interpret Success criteria in GB projects.

9.2.2.3. *Relevance and limitations of using the TFM theory for research on Green Building project success*

The high degree of association of identified Success conditions and criteria with the Flow, and Value-generation views shows that the TFM theory is a relevant theoretical lens to interpret GB project success. This theory may also be used for interpreting the success of other construction projects.

Overall, in this study, the concept of GB project success is found to be much more associated with the Value-generation and Flow view than the Transformation view. As highlighted by research findings, success in GB projects creates value for not only the environment and the client but also for the construction industry and society. The definition of ‘customer’ in the Value-generation view of the TFM theory only includes the project clients, occupants, and to a limited extent the environment. To accurately assess value and waste, the value must be assigned to natural resources (living systems) and human resources (social and cultural systems) that are the basis of human existence (Hawken et al., 2013). If all resource types are not considered, delivery factors that may affect the environmental, or “green” values to the customer (for example, environmental burdens in operation, service life, risk of deterioration, convertibility, and flexibility) are overlooked (Klotz et al., 2007). For GB projects, it is particularly important to consider society and the environment as additional customers. Johansson and Sundin (2014) also emphasised the need for broadening the definition of the ‘customer’ to include society in general. Future research needs to rearticulate the definition of ‘customer’ in the Value-generation view to represent the variety of stakeholders benefitting from sustainable project development. As society is intrinsically part of a global system, Value-generation must be considered in relation to the external environment and social problems (Salvatierra-Garrido et al., 2010). Understanding and making this collective value tangible in the briefing and design phases can be pivotal in delivering value and defining waste (Novak, 2012).

Although the TFM theory has a focus on reducing waste, the elimination of waste may not always be desirable when it comes to complex projects such as GBs. Waste is mostly defined in terms of short term, operational issues. In comparison, projects may involve higher-level purposes which may be more important than waste minimisation, such as learning, maintaining the production system in working order, and avoiding catastrophic consequences for the wider world (Bertelsen & Koskela, 2005). For instance, GB projects involve innovation and while this results in learning opportunities and the likelihood of improved project development practices, it may also result in the waste of resources. As Smart et al. (2003) have argued, waste minimisation cannot be the only or not even the most important pursuit in all situations. The apparent wasteful features of a complex system such as a GB project can be important for the survival and existence of the system and can be associated with long-term benefits. Bak (1999) specifically studied the errors, faults and accidents as sources for evolution in the form of learning in complex systems. Faults in a system result in a learning process and this reduces the likelihood of big problems. For instance, a significant crisis in Toyota’s Aisin brake valve plant resulting from fire damage was controlled because of the emergent system properties of Toyota’s supply chain (Bertelsen & Koskela, 2005). Considering GBs as complex projects, the waste concept originating from the TFM theory may not provide a complete interpretation for Success conditions and criteria.

While the association of the TFM views with successful GB project development has direct theoretical implications, it also has practical implications. For instance, looking at GB project development from the viewpoint of TFM, Project Managers would be aware that their decisions on a certain project aspect are more driven towards the Value-generation as compared to the Flow or Transformation. Knowing this can have much value as it creates the opportunity of balancing the project development between Transformation, Flow, and Value-generation. As Lauri Koskela (2000) also emphasised, it is not enough to carry out task, flow and value management as separate functions. Instead, they must be balanced, and their interactions must be controlled to avoid anomalies. The TFM theory predicts that a production

system where the operational principles of all three domains are implemented at all levels of managerial action (design, control, and improvement) should have a better performance than one where principles are implemented less comprehensively.

9.2.3. Overlap of Success conditions with Risks, Challenges, Drivers, and Success criteria

Alongside the project success paradigm, research on GB project development has also been conducted using other paradigms such as risks, drivers, benefits, and challenges. A large overlap between the factors investigated within these research paradigms exists and is demonstrated by the review study conducted by the researcher (Ahmad et al., 2019). Also, the comparison of Success conditions identified in this study in the backdrop of previous research on GB development has shown that many of these conditions have not only been discussed as success factors but also as risks, challenges, Success criteria and drivers.

The overlap of factors between different research paradigms indicates that the same factors can have different meanings depending on the paradigm. This is because of the variable nature of these factors. For instance, 'Scope changes during project execution', identified as a Success condition in this work has been identified as a success factor (Bon Gang Hwang et al., 2015; Bon Gang Hwang et al., 2016; Kiani Mavi & Standing, 2018), a risk (Qin et al., 2016), a challenge (Bon Gang Hwang & Ng, 2013), as well as a performance criterion (El Asmar et al., 2013; Enache-Pommer & Horman, 2009) in previous studies on GBs. This variability can be explained by different attributes this condition can have. For example, a high frequency of design alterations and variations during construction can turn this factor into a challenge. Changes in GB evaluation standards can turn it into a risk. 'Avoiding design changes', 'minimal scope changes', and 'minimising change orders during construction' can turn this factor into a success factor. The occurrence of a factor in multiple paradigms, therefore, affirms the importance of investigating and reporting the factors as variables instead of constants. These findings are in accordance with the approach adopted in this study, which has analysed and interpreted Success conditions as variables.

The overlap of factors across multiple paradigms also highlights the importance of these factors for project development. This overlap can also be considered as a triangulation as the consideration of the same factors across multiple paradigms demonstrates their importance.

The overlap of factors in this study indicates that factors identified as Success conditions may also be used to inform or confirm research on GB barriers, risks, drivers, and benefits. Hence, the theoretical implications of this study may stretch beyond the research on GB project success as the other paradigms of GB development may interpret findings of this study in terms of barriers, risks, drivers, and benefits. For a detailed discussion regarding this, readers are referred to the review paper by the researcher¹.

9.3. Practical implications of research findings

The study has several implications for practice. In this section, practical implications of the research are discussed in detail, including the use of GB certification systems and the allocation of Success conditions and criteria to project stakeholders.

¹ Ahmad, T., A.A. Aibinu, and A. Stephan, Managing green building development – A review of current state of research and future directions. *Building and Environment*, 2019. 155: p. 83-104.

9.3.1. Role of certification systems in the implementation of research findings

GB projects can perform better in case the project management aspects (such as good team communication) occur in GB certification systems (He, Kvan, Liu, & Li, 2018). The Success conditions and criteria of GB projects as identified in this study can occur as credits in GB certification systems promoting effective GB development practices. Typically, the prime focus of GB certification systems is to evaluate the sustainability performance of a GB project. Therefore, the certification systems are more related to Success criteria (see Section 7.5 in Chapter 7) than Success conditions (see Section 8.7.2 in Chapter 8). The representation of Success conditions by credits of certification systems, although scarce, suggests that certification systems do acknowledge the importance of Success conditions to some extent. Based on the purpose and operational nature of certification systems, it can be argued that the critical Success conditions should be included in certification systems as credits. World over, the trend of certifying green building development prevails (Petrullo et al., 2018). Hence, in case the certification systems encapsulate Success conditions, the likelihood of successful GB development will increase.

Providing a quantitative measure of the criticality of Success conditions requires a data-intensive investigation and can be enabled by GB certification systems. The importance of Success conditions has been analysed through their frequency of occurrence in interviews (Chapter 8). Similarly, the network attributes of Success conditions also provide a measure of their importance. Previous studies on GB project success have used regression analysis on multi-case studies to determine the criticality of success factors. Instead of being a strictly explanatory inquiry of associations among conditions and criteria, this study is an exploratory inquiry of Success conditions and Success criteria. Unlike exploratory design, the explanatory approaches can provide a quantitative measure of the associations, and therefore can be used to evaluate the criticality of conditions based on their associations with Success criteria. Owing to a large number of Success conditions, the data collection for such explanatory research can be a highly laborious and resource-intensive exercise. This is where GB certification systems can be helpful not only in implementing best practices (such as Success conditions) but also in investigating Success conditions.

Although a direct adoption of study findings in GB certification systems is possible, such incorporation can also benefit from additional research to determine the criticality of factors identified in this study (for example, Success conditions and criteria). For the potential uptake of Success conditions by GB certification systems, two scenarios are proposed as shown in Figure 9-4. In Scenario-1, a certification system adopts the Success conditions identified in this study and other studies conducted on GB project success. In this scenario, the certification system considers those conditions as critical. Based on the criticality of conditions, they may be assigned different weights in the certification system. While Scenario-1 is simple and readily applicable, it faces the challenge of determining the criticality of Success conditions. This is because the research on GB project success including this study, does not rigorously account for the relative importance of a large number of Success conditions. To complement this limitation, Scenario-2 is proposed where the certification system can introduce additional steps, that is a research pathway. As a first step, a list of Success conditions from this study and similar studies on GBs is prepared. The values of these conditions are recorded for new projects certified with the GB system and once enough data from multiple case studies is available for quantitative analysis, the criticality of conditions for project success is determined. The critical conditions can then be considered as credits within the certification system. Hence, in Scenario-2, a GB certification system can help conduct a rigorous inquiry regarding the criticality of Success conditions. An important aspect of both these scenarios is that the Success conditions need to be converted into measurable parameters (for

example, ‘collaboration’, a Success condition can be measured in terms of the number of formal and informal project team meetings).

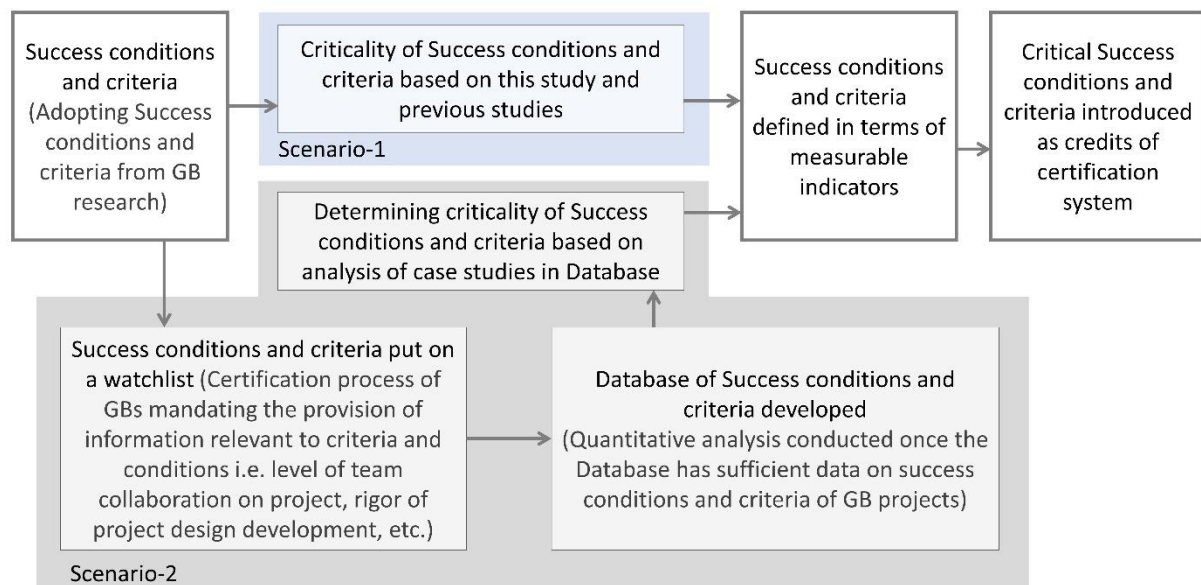


Figure 9-4: Scenarios for the adoption of Success conditions and criteria by Green Building certification systems

As discussed in Chapter 7 (Section 7.5), some Success criteria are represented by credits in certification systems, while others are not. Similar to the adoption of Success conditions as credits in certification systems, some Success criteria may also need to be represented in certification systems. Scenario-1 and 2 (shown in Figure 9-4) are applicable not only for the adoption of Success conditions in certification systems but also for Success criteria.

9.3.2. Assigning ownership of Success conditions to project stakeholders

For the implementation of effective GB development practices, the Success conditions and criteria identified in this study may need to be allocated to project stakeholders. The influence of different stakeholders in a GB project can vary depending on the type of project (for example, public/private, office, and residential projects). Considering the client as the party which engages a project team for GB procurement, the client usually has the most influence over the project. The influence of the project team in project development depends on the authority that the client delegates to project team members. Both for the theoretical and practical reasons it is important to know which stakeholders are effective in implementing which Success conditions and criteria in GBs.

Pathways for the implementation of Success conditions and criteria in GB projects are shown in Figure 9-5. The list of Success conditions and Success criteria resulting from this study are readily applicable to GB projects in the form of checklists and the project client and/or PM team can monitor their implementation. However, to effectively enable Success conditions, it may be necessary to hold several project stakeholders accountable. To delegate responsibilities in this regard, the tradition of using risk owner/s in risk management can be visited. In risk management, a risk owner is an accountable point of contact for a risk, who coordinates efforts to mitigate and manage the risk with various individuals owning parts of the risk (Lavanya & Malarvizhi, 2008). The practice of successful GB project development and operation can also benefit from introducing ‘success owners’, an analogy of ‘risk owners’. Like the role of risk owners, there can be several success owners in a project (such as clients, design consultants, and contractor) who coordinate efforts with the rest of the team to enable the Success conditions assigned to them.

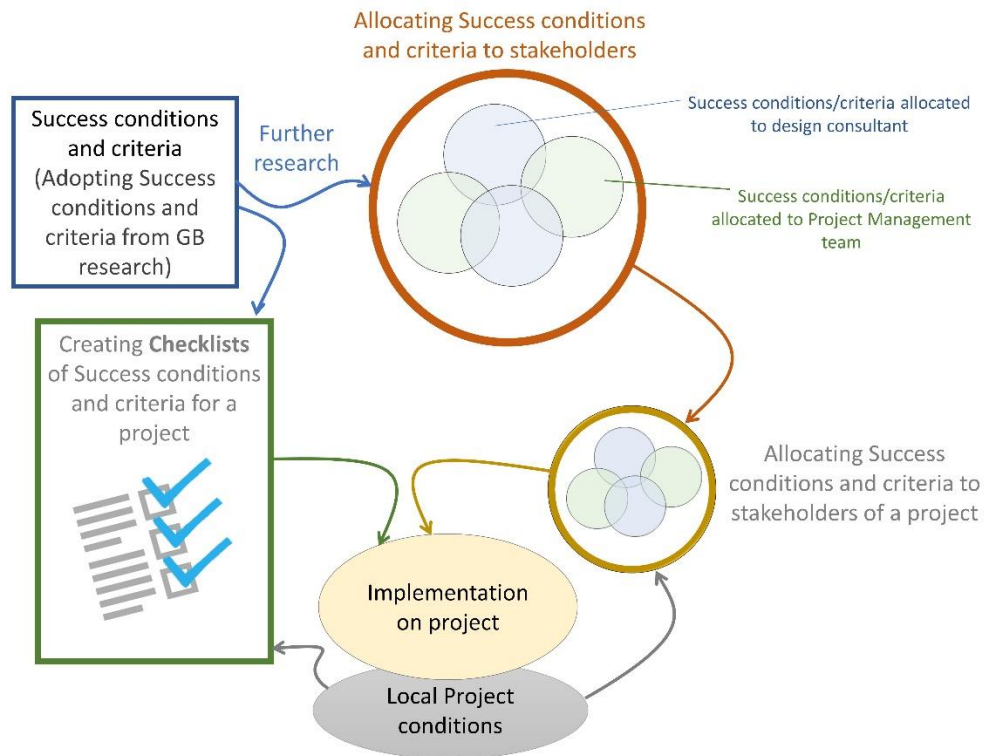


Figure 9-5: Implementation of Green Building Success conditions and criteria by project stakeholders

The assignment of Success conditions and criteria to project stakeholders can be achieved through further research on this area. Future studies can indicate the project stakeholders which are most effective in controlling project development for specific Success conditions and criteria. In practice, a limitation regarding the allocation of Success conditions and criteria to the project stakeholders is that they need to be adopted to the unique environment of each project. In future studies, allocating Success conditions for success owners can be an important research inquiry for theoretical reasons. However, such allocations may need to be revisited before implementation and revised according to local project conditions, as indicated in Figure 9-5.

9.4. Research scope and data collection methods: limitations and suggestions for future studies

A detailed inquiry regarding the successful development of GB projects is conducted in this study. Owing to the limitations in resources and time availability, some limitations exist in terms of the research paradigm, data collection, and the interpretation of findings. These limitations include the limited sample size, limitations in generalisability, time-bound relevance of findings, and comparability with other research on this topic. A detailed account of these limitations is provided in this section, as well as the suggestions to address them. The future research areas are also applicable to other types of projects beyond GB projects.

Since the GB market is still in the early stages of its evolution, the number of GB projects and the experience of building professionals regarding GB development is limited. As this study is based on knowledge and experience of industry professionals regarding GBs, the early stages of GB market evolution limit the research findings. Due to the limited number of GBs, the expert sampling of industry professionals is also limited. To provide specificity, this study has only involved GB professionals having the experience of being involved in green office projects and this further limits the sample set.

During interviews, some participants have also mentioned Success conditions for projects other than office buildings, however, the majority of research findings are related to office buildings. Hence, the overall research findings are related to green office projects and may not be generalised to other building types.

While this study provides a detailed account of the Success conditions and Success criteria, it is acknowledged that the study is not exhaustive in terms of the factors and their interrelationships identified. While the study provides a detailed inquiry of the associations within Success criteria and within Success conditions, it is limited in terms of the associations between Success conditions and Success criteria. These associations are beyond the scope of this study. Future studies conducted with the approaches proposed in this section can help identify the Success criteria and conditions which remained undiscovered in this study and this can further enrich the definitions and associations identified in this study.

9.4.1. Limitations related to research paradigm and epistemology

Since this study embraces the critical realism paradigm, it adopts a realist ontology and epistemic relativism. Epistemic relativism is based on the understanding that knowledge is articulated from various standpoints according to various influences and interests and is transformed by human activity. While knowledge is context-dependent, the representations of the world are historical, perspectival, and fallible (Archer et al., 2016). The study has the stance that reality exists independent of the human conception, however, we need human perception to know about reality. While the perception of GB professionals informing this study is justified using the critical realism paradigm, the study may lack comparability with research on similar topics conducted using other paradigms, such as constructivism and interpretivism. Studies conducted on the same topic while using positivist, constructivist, and interpretivist paradigms may provide findings different from the results reported in this study.

As this study is based on epistemic relativism, it acknowledges that the research findings have a historic context. The study is based on cross-sectional data. While the online survey for this study was conducted from April to September 2017, interviews were conducted from September 2017 to February 2019.

Since the GB market is rapidly evolving, the innovations in this sector may limit the applicability of some research findings in future. While acknowledging time as an important function for the research findings, the study presents the findings such that they are comparable with similar studies in past and future. Some of the findings may have limited application in the future when significant changes occur in the context of GB project development. According to epistemic relativism, knowledge is articulated from various standpoints and the representations of the world are not only historical, but also perspectival. This study is basically developed on the knowledge acquired from GB service-providers and therefore employs their perspective of the GB project success. The interview participants had different roles in the development of GB projects, with the two most common roles among the participants being 'design consultant' (n=19) and 'sustainability consultant' (n=22). From a total of 75 interview participants, only 2 were representative of end-users and project client. Similarly, in the case of online survey, from the overall 104 survey participants, 78 belonged to design and sustainability consultancy roles, while only 2 participants represented GB project clients. This indicates that findings of this study are almost entirely limited to the knowledge acquired from GB service-providers, such as design consultants and sustainability consultants. Even though, project clients, end-users, and regulatory organisations do not have such active contribution in GB project development as in case of service-providers, a study focussed on project clients and end-users for data collection may uncover some aspects of project success left unidentified in this study.

9.4.2. Survey-based data collection for research on Green Building project success

While the online survey involved a large number of GB professionals ($n=104$), the researcher's lack of control over the response of participants stands out as a limitation. In this study, an online survey was used to investigate associations between 6 performance criteria (see Section 4.4.1 in Chapter 4). Survey questions were developed while assuming the associations between performance criteria as bi-directional, that is the effect of 'A' on 'B' and the effect of 'B' on 'A'. Hence, for the 6 performance criteria, 30 interrelationships were inquired resulting in 30 closed-ended questions in the online survey. Even though a detailed description of the performance criteria was provided in the questionnaire, it can be expected that some participants still lacked clarity in their understanding of criteria and in deciding the interrelationships among criteria. Some participants might have lacked clarity in understanding because of the bi-directional associations among criteria and might have found the questions repetitive even if they were not so in reality. Moreover, some participants might have misinterpreted the detailed descriptions of the criteria. Although utmost caution and care were practised in the design of the questionnaire and the administration of the survey to eliminate the participants' confusion, some survey responses still might lack accuracy because of the unintended consequences. The prime reason behind this is the mode of data collection - use of the online survey in which the researcher cannot actively brief the participants. Since the researcher was not actively involved in data collection as in an interview, it meant that the participants could not actively communicate with the researcher for clarification of questions. A key learning from this experience is that for the purpose of inquiring factor associations, semi-structured interviews can be preferred to online surveys.

To develop the knowledge of GB project development based on the perceptions of industry professionals, future studies will continue to use online surveys and interviews, however, they may need to cater for the following challenges:

- For two factors, two associations are to be identified and for 6 factors these associations rise to 30, indicating an exponential increase in the number of associations with the increase in the number of inquired factors. This highlights the impracticality of investigating associations for a large number of factors in online surveys or interviews; and
- The list of Success conditions and criteria created in this study is based on the collective knowledge of 75 interview participants belonging to 6 countries. This highlights that a person participating in such a study through survey or interviews is unlikely to possess the knowledge and experience to reflect on the associations among all the factors being inquired.

To some extent, the second challenge can be addressed using the modularisation approach to knowledge acquisition as was used in this study. While using this approach, the researcher actively adapted the interview questions to the experience and professional role of interview participants. This way, the participants answered for only those aspects of GB development regarding which they had most knowledge and experience. Details regarding this approach are provided in Chapter 4 (Section 4.4.2.2).

9.4.3. Interview-based data collection for research on Green Building project success

This study is significantly informed by data collection from semi-structured interviews (see Section 4.4.2 in Chapter 4). Most of the interviews were conducted in-person and for this reason, the researcher had to travel extensively. Owing to the logistical constraints, some interviews were also conducted over the telephone. Face-to-face interviewees were engaged better with the researcher and provided more in-depth discussion related to interview themes compared to those in telephone interviews. Owing to the

effort-intensive data collection process, the sample size for this study was limited to 75 interview participants.

A limitation of this study is in terms of the participants interviewed. Most of the interviewed stakeholders are Design Consultants, Sustainability Consultants, and Engineering Consultants. This results in an asymmetrical distribution of stakeholders in the sample set which implies that there is a higher number of Success conditions and Success criteria identified by service-providers than those identified by service-seekers. Future studies can address these limitations by employing a symmetrical data collection across service-providers and service-seekers. Moreover, future studies can consider the regions not covered in this inquiry because of its limited scope. Future studies also need to investigate Success conditions and criteria for GBs belonging to residential, industrial, retail, educational, hospitality, and health sector.

The need for conducting semi-structured interviews for a qualitative inquiry in the area of GB project success research cannot be overstated. However, to ensure a feasible data collection approach employing a larger sample size, the researchers may need to consider advanced electronic media as a replacement of face-to-face interviews. The automated tools for transcription and coding of interviews are still in the process of development. For future research, these tools may have significant value since a large amount of researcher's time is spent in transcription and coding processes.

For research on GB projects, the associations between conditions and criteria are also important along with the identification of Success conditions and criteria. The identification of conditions, criteria, as well as their associations, depends on the number of interview participants in case a research inquiry is exploratory and employs a fieldwork approach, as used in this study. With the higher number of participants, a greater number of conditions are identified, and a more in-depth understanding of associations is provided. The identification of these conditions is also subject to the context in which interview participants are based (such as the region of belonging or professional role) as explained in Chapter 8 (Section 8.6). Hence, for such a research inquiry, it is suitable to have not only a larger number of participants but also more participants from diverse contexts. Although this study has engaged 75 interview participants belonging to 6 countries (as explained in Chapter 4 - Section 4.4.2.4), there are still limitations in data collection owing to the limited research resources and the PhD candidature time.

For future research on GB project success conducted with the same or similar aim, it is suggested to complement the limitations of this study by:

- Interviewing a greater number of project clients, Facility Management professionals and end-users;
- Interviewing a greater number of third-party stakeholders, such as local government, GB certification authorities, building inspectors, and neighbourhood community;
- Interviewing GB professionals in developing economies (for example, India, Pakistan, and Nigeria) and developed economies (for example, the US, and Germany); and
- Interviewing GB professionals from regions where the GB development faces special climatic constraints, for example, heat, water scarcity, or cultural constraints.

9.4.4. The sequence of general and specific themes in semi-structured interviews

The in-depth interviews in this study had a general *theme* in which the participants were asked to reflect on the conditions which make GBs successful. Interviews also had a specific theme, in which the participants discussed the conditions which contributed to the performance of successful and failed projects in their portfolios, as discussed in Chapter 8 (Section 8.6). Both the general and specific themes had their usefulness in data collection, and they enabled the interviewer to actively engage the participants. For instance, in case a participant was unable to differentiate between Success conditions and Success criteria, it was a useful approach to first discuss the specific theme followed by the general

theme. Upon recalling the details of a project, a participant could talk about conditions and criteria with more clarity. While this approach of ‘Specific to General’ had its advantages, its limitation is that a participant may end-up giving the same answer for a general *theme* as s/he previously provided for a specific theme. This may occur as the specific themes can trigger an availability heuristic which is a mental shortcut relying on immediate examples that a person recalls when evaluating a specific topic, concept, method or decision. The availability heuristic operates on the notion that if something can be recalled, it must be important to them, or at least be more important than alternative solutions, which are not as readily recalled (Folkes, 1988).

The ‘General to Specific’ approach can help avoid the availability heuristic while the ‘Specific to General’ approach can result in more clarity of concepts for an interview participant. While understanding the potential benefits and pitfalls of these approaches, the researcher in this study referred to both these approaches under different interview circumstances for effective data collection. Hence, both the approaches had their usefulness and limitations and their appropriate use was subject to the researcher’s judgment, time available for conducting an interview, and the cognitive abilities of participants.

9.4.5. Longitudinal study of Green Building project success

Based on the philosophical paradigm of critical realism, it is believed that the research findings are time-dependent, and therefore have a historic context. The findings of this study may change with time and in this regard, the thoughts of an interview participant (AU-M-14) are worth mentioning,

“Initially, we used to think of success in the way that how we can change the design industry and bring innovation into the design of Green Buildings. This was around 10 years ago. These days, it is a given Now, the expectation is that, how we can operate the buildings efficiently and there needs some work to be done in this regard.”

This observation implies that the perceptions of GB Success conditions and criteria are subject to time and this is an additional validation that critical realism is a well-suited paradigm for this study. Recognising time as an important attribute of this research, adopting a longitudinal research approach can yield important findings. One way of enabling a longitudinal study is by interviewing the same GB professionals as previously interviewed or in case they are inaccessible, interviewing the professionals from the same contexts to which the participants of this study belonged. Such an approach can help understand how the perception of project success is affected by time. Such an inquiry of GB project success is missing from the literature and by conducting it, a significant contribution to the theory of GB project success can be made (Ahmad et al., 2019; Sinem Korkmaz et al., 2009). Such a longitudinal study of GB project success can also contribute towards the inquiry of GBs in terms of innovation diffusion. By considering GBs as innovation in the construction industry, the longitudinal study of GB project success can inform how the diffusion of innovation impacts the perceptions of project success.

9.4.6. Developing appropriate scope for research on Green Building project success

Since this study reports a large number of factors, the individual factors are reported as succinctly as possible. In this study many factors have been identified in terms of Success conditions (conditions=73; sub-conditions=82), Success criteria (criteria=17; sub-criteria=39), Underlying conditions (36), and Differentiating conditions (28). The factors identified in this study involve a description of their importance and their interrelationships. The explanation regarding the identified factors is an important aspect of this study. Even though each factor merits a detailed analysis and reporting, it is challenging to concisely report a large number of factors. Furthermore, the detailed analysis of

individual factors may result in a much broader scope of research as compared to the scope of PhD-level research. Under these constraints, the factors in this study are presented as concisely as possible.

For future studies in the area of GB project success, it is suggested to give due consideration to project scope while developing research design. In terms of deciding research scope, there are two extreme approaches - scaled-down and detailed - and a balanced approach as shown in Figure 9-6. The research conducted in this study lies between balanced research approach and detailed research approach.

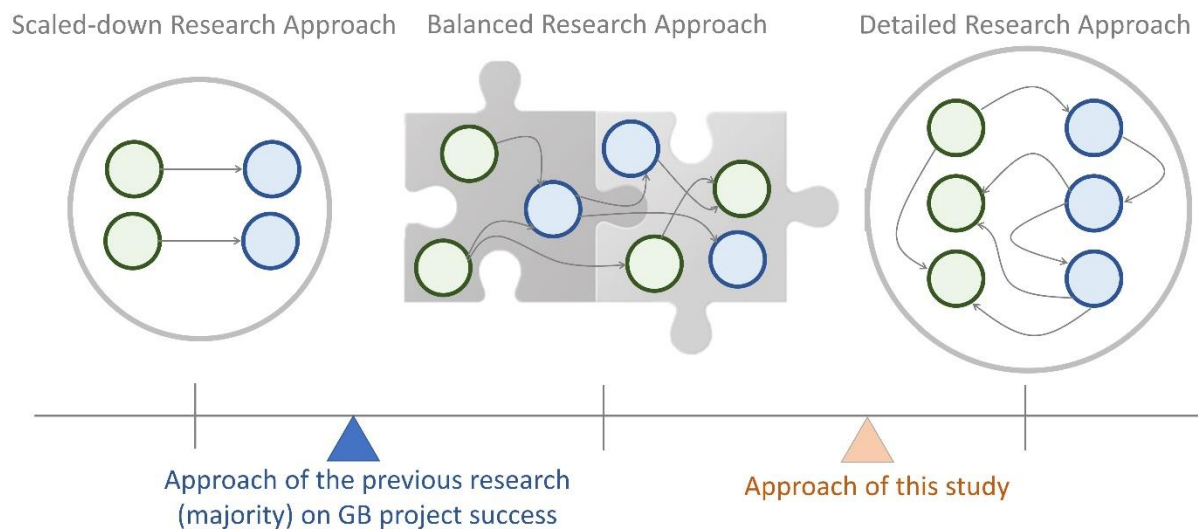


Figure 9-6: Approaches for research on Green Building project success

On one end, there is an approach of scaling down the research scope in terms of things like building type, stage of the project (for example, development or operation), focused stakeholders (for instance, success factors for the project manager, or client), and region. The benefits of scaled-down studies are that the data collection and analysis is reasonably easier to conduct; more rigorous analyses of factors (such as Success conditions and criteria) and their associations are possible within limited resources; and the analysis findings are easier to report. On the downside, this approach is reductionist and ignores the complex nature of GB project development and operation. Upon scaling the research scope down to one stage of a project or a particular stakeholder, either many factors are consolidated, or their sheer number is reduced resulting in a blindside towards the factor associations.

At the other end, is the approach of developing detailed research on GB project success. Such an approach thrives on the discovery of a greater number of factors and factor associations. Therefore, such research can benefit from a broader scope in terms of project stages, stakeholder opinions, regional diversity, and the like. Since this approach focuses on unfolding complex systems, it is suitable for inquiring GB project success, given that these projects have socio-technical complexity (Rohracher, 2001). Considering complex systems, the more factors and associations are discovered, the more in-depth understanding of a system's working is developed. The broader scope because of the detailed research approach means an opportunity of knowing more about factors and their associations, therefore, not only broadening but also deepening the insight of a complex system, like GB project success. A major limitation of this research approach is in terms of its unprecedented scope, requiring an excessively large amount of resources.

Between the two extremes of scaled-down approach and detailed research approach lies a balanced research approach. In such an approach, studies are conducted with a limited scope such that they are consistent with previous studies and are reported in a way that studies on similar patterns can be conducted in the future. To understand factor associations, the balanced approach limits reductionism.

Such studies need to be reported so that the subsequent studies can start where they end. In practice, previous research on GB project success is conducted somewhere between scaled-down highly reductionist approach and a balanced approach. Studies conducted on balanced approach can be considered as parts of a jigsaw puzzle: while the individual studies do not account for a large number of factors and associations, in combination with other studies they can provide a holistic as well as an in-depth understanding of GB project success. Studies conducted in the future could adopt a balanced research approach. By limiting these studies to the scope of individual project stages (for example, design, construction, and operation), different building types, regions, and stakeholders, the studies will have a manageable number of factors which can be analysed in detail and reported adequately at the level of individual factors. For future studies to successfully follow the balanced approach, it is necessary to disseminate not only the interpretation of the findings, but also the raw data so that a better integration among the findings of these studies can be achieved.

9.5. Chapter Summary

An overview of the research findings is provided in this chapter alongside a holistic discussion regarding the interpretations, implications and limitations of this study.

The comparison of Success conditions, Underlying conditions, and Differentiating conditions is provided and it is realised that many conditions contributing towards project success also control the associations between performance criteria and differentiate GBs from non-GBs.

The literature on project success of complex systems is reviewed to compare the findings of GB project success with success factors of complex projects belonging to different industries. A considerable match of Success conditions across GB projects and other complex projects is realised indicating that because of the socio-technical complexity of these projects, there are some common Success conditions across these systems.

Findings of this study - Success conditions and Success criteria - are discussed with respect to the TFV theory of production. The Flow and Value-generation views are found to explain Success conditions much more than the Transformation view. The Value-generation view is also found to explain Success criteria for GB projects. The Value-generation view has some limitations in explaining Success criteria because the concept of client/customer in this view does not account for stakeholders such as the construction industry and society. The concept of waste based on the TFV theory is found to limit the use of this theory in interpreting some conditions and criteria.

The overlap of Success conditions with factors from other paradigms (such as risks and challenges) is discussed. The overlap of factors across multiple paradigms highlights the need for considering factors (such as Success conditions and risks) as variables in research. It also indicates the opportunities of paradigms to benefit from each other's findings, for example, studies on GB risks advancing from findings of GB project success research.

For the practical application of research findings, the potential role of GB certification systems is explored in two scenarios. It is realised that the certification systems may not only help the implementation of Success conditions in GBs, they may also be instrumental in further investigation of GB project success because of their ability to collect data from a large number of GB projects.

For the practical application of research findings, the idea of ownership for Success conditions and criteria of GB projects is discussed. It is realised that the allocation of such ownership may require further research on the subject area.

While providing an account of research limitations and suggestions for future research, the role of data collection approaches - online surveys and semi-structured interviews - are discussed. It is suggested

to avoid the use of online surveys for inquiring associations among a large number of factors such as Success conditions and Success criteria. It is highlighted that future research conducted on the same or similar topics can benefit from conducting interviews with GB professionals having diverse regional belonging and having different roles in GB development. While discussing the structure of interviews conducted for this study, it is highlighted that the future studies on similar topics need to consider both the approach of general-to-specific themes and specific-to-general themes since both can be useful in effective data collection. The effect of time on research findings is explained and accordingly, the need for longitudinal studies on GB project success is highlighted. While explaining the possible approaches of defining the scope for research on GB project success, it is indicated that the most suitable approaches are those which are scaled-down to some aspects of GB projects, yet meanwhile promote non-reductionism, build on similar studies previously conducted, and have good connectivity with both the previous and future studies.

10. Summary and Conclusion

With an increased understanding of environmental degradation, society is starting to show an increased acceptance towards GBs. The construction industry is rapidly approaching a stage where the ability to plan and execute a sustainable project would be a core competency for any top builder. This signifies the need for effective development practices of GBs to further increase their rate of construction.

The special requirements in the development of GBs should be managed to achieve the desired outcomes in these projects. To sustain an increased development of GBs, attention should be given to the aspects of their management and delivery. Underperformance in GB project development should be avoided by controlling conditions related to the success of these projects.

The aim of this research was *'to promote the development of better Green Building projects'*, with the focus on office buildings. This aim has been addressed by identifying the special requirements of GBs, investigating the criteria against which the GB performance can be evaluated, and investigating the conditions which enable success in GBs.

This research has used the theoretical lenses of project success, sustainability, complexity perspective and the Transformation-Flow-Value-generation theory. This theoretical framework has informed data collection, analysis, and interpretation in this study. The research design relies on a 'Critical realism' paradigm, which considers that GB projects and their development practices exist independently of our knowledge, that is their existence is not socially constructed. Using the foundations of epistemic relativism, this study has considered project success as context-specific and develops the concept of GB project success based on the viewpoint of GB professionals. To address the research questions, the study has used exploratory and explanatory mixed-methods research design. It used a multi-regional survey of 104 Green Building professionals and 75 semi-structured interviews in Australia, Hong Kong, Pakistan, Singapore, the UAE, and the UK. To interpret the data and test the reliability of findings, qualitative and quantitative analyses are conducted on interview and survey findings.

While the main findings and conclusions have been presented in Chapters 5-8, their highlights are as follows:

Question 1: How do sustainability requirements set Green Buildings apart from non-Green Buildings?

In this study, 34 conditions differentiating GBs from non-GBs were identified based on the opinion of 25 interview participants and 3 survey participants (Chapter 5). Results show that GBs are different because of project complexity and project goals. They are also different because of the requirements related to: *budget and time; design methodology; documentation; flow of project information; inspection, monitoring, and control; team collaboration; team procurement methodology, and timeliness of project activities*. The analysis of associations among the Differentiating conditions suggests that the conditions related to the *procurement methodology, timeliness of activities, and defining goals* are the core aspects differentiating GBs from non-GBs. The overall analysis suggests that GBs are primarily different from non-GBs because of the effective project development approaches they require. These findings are important as they indicate that the project development practices of traditional buildings may not lead to success in GB projects, therefore, emphasising the need for research focused on GB project success.

Question 2: What are the associations between sustainability performance criteria and project management performance criteria in Green Building projects and which conditions control these associations?

The interrelationships between sustainability performance criteria (*Environmental, Economic, and Social sustainability*) and project management performance (*Schedule, Cost, and Quality*) criteria are identified based on the opinions of 104 survey participants and 30 interview participants (Chapter 6). Results show positive associations implying that all three sustainability dimensions have mutually positive associations with each other, that is a good performance in one criterion leads to a good performance in another. Sustainability performance has a positive influence on quality performance and *vice versa*. Cost and schedule performance are also positively associated. Cost performance also has a positive effect on economic sustainability. No associations were found between schedule and sustainability performance criteria.

Underlying conditions, which drive associations among performance criteria, have been identified. Results show that the variations in these conditions lead to different associations among performance criteria. Hence, desirable performance criteria associations could be achieved upon optimising these Underlying conditions. For instance, if a Value Engineering exercise is conducted in a project with a disregard of sustainability considerations, then in an attempt to reduce cost, sustainability performance and quality performance may get negatively affected. Key Underlying conditions include: *project planning, quality of project development process, life-cycle perspective, project management, project delivery method, client's vision and motivation, regional constraints, regional climate, compliance requirements, and innovation in building industry*. Sustainability performance in a GB project may not influence schedule and cost performance in case the identified Underlying conditions can be appropriately controlled during project development.

These findings are important for the practice of GB development because by understanding the pivotal role of Underlying conditions, decision-makers would be able to consider these conditions in their project development plans. The control of these conditions by project clients or a project team can help achieve optimal results for a project across different performance criteria. In theoretical terms, holistic decision-making and project management-related frameworks can be developed from the findings. The identified conditions can lead to more comprehensive multi-objective optimisation models specifically designed for GB projects.

Question 3: What are Success conditions and Success criteria in Green Building project development; and how are the Success criteria interrelated as well as the Success conditions?

Sub-question 3.A: What are Success criteria in Green Building projects and how do they interrelate?

An inquiry of GB Success criteria is conducted based on the opinions of 40 interview participants (Chapter 7). From among the 17 Success criteria and 39 sub-criteria identified, the key Success criteria include: *human-oriented and occupant-centric development; meeting project aspirations and client's requirements; realising sustainable and efficient building operations; achieving GB development-related certifications; reducing environmental impact and improving the environment; achieving tangible benefits of sustainability; and project acting as a source of learning*. These Success criteria are associated with the environment, the project clients, end-users, society, and the construction industry. While most of the criteria have positive associations with each other, some criteria also have negative interrelationships. The priorities of Success criteria depend on the project life-cycle stage, project stakeholders, as well as the regional context of the project.

The findings of the Success criteria inquiry have both theoretical and practical value. Theoretically, the identification of GB Success criteria informs future research on the dependent variables to measure the success of GB projects. This adds depth to the understanding of building project success and particularly GB project success. The identification of Success criteria can benefit practice as project teams may consider a more holistic range of criteria when making decisions related to project development. The

criteria list can also be used for the purpose of performance evaluation and for controlling project performance. Moreover, GB certification systems can include the identified criteria in their credit lists to ensure a higher correlation between certification and success.

Sub-question 3.B: What are Success conditions in Green Building projects and how do they interrelate?

An inquiry of GB Success conditions is conducted based on the data from 72 interview participants (Chapter 8). A list of socio-technical Success conditions was developed comprising 73 conditions and 82 sub-conditions. The identified conditions related to project stakeholders are about: *team characteristics; collaboration; commitment; mind-set; authorities; responsibilities; procurement methodology; client's characteristics; education of project team, client, and end-users; and the cooperation and interest of external stakeholders*. Identified technical conditions are mainly about using effective and rigorous methodologies at different project stages, for instance, project goal definition, planning, design development, inspection, monitoring, and control. Some of the conditions are not specific to a project stage and instead apply to the entire process of project development, for instance: *clarity in development process, flow of project information, completeness and rigour of deliverables, and managing project changes*. Some of the technical conditions are also the project constraints which are beyond the control of the project team and can also be beyond the control of the client.

Associations among Success conditions are identified, from which a Success conditions network is developed. Using the Complexity theory, the attributes of Success conditions within the network are analysed to determine the importance of conditions in the network. The robustness of the network is also analysed. The network analysis has shown the role and importance of Success conditions in a network.

The interpretation of findings with respect to the Transformation-Flow-Value-generation theory has shown that up to 7%, 61%, and 94% of Success conditions and sub-conditions are associated with the Transformation, Flow, and Value-generation views respectively. This implies that the identified conditions are mainly about reducing the non-value adding activities in project development and creating value for the client.

The comparison of Success conditions, Underlying conditions, and Differentiating conditions has shown that many conditions contributing to project success also control the associations among performance criteria and differentiate GBs from non-GBs.

The findings of the Success conditions inquiry have both practical and theoretical value. Theoretically, the findings can inform future research focused on: the priorities of GB Success conditions at different project stages, in different building types, for example, commercial, hospitality, or educational; associations between Success conditions; and associations between Success conditions and Success criteria. The identification of Success conditions can benefit practice, as project teams and project clients may consider a wide range of conditions to ensure that the project is successfully developed and operated. Some of the project conditions depend on the regulations by the local government. These conditions can be considered in developing policy measures for GB development in a particular region. Moreover, GB certification systems can include the identified conditions in their credit lists to ensure a higher correlation between certification and success.

This thesis investigated Green Building project success while considering the special requirements of these projects. The interrelationships among Success criteria are inquired for optimising GB project performance on multiple criteria. The Success conditions and their interrelationships are identified and this shows their cumulative effect on project performance. The findings of this study can help optimise the Green Building project performance during development. The application of the research findings

can reduce the likelihood of underperformance in GB projects. This can help further increase the uptake of sustainable development in the built environment.

10.1. Suggestions related to Green Building stakeholders

The Success conditions identified in this study are related to different GB stakeholders such as the client, end-users, and project team (Section 8.3, Chapter 8). These Success conditions are presented in this section as suggestions for GB stakeholders.

10.1.1. Suggestions for project client

Based on the findings of this study, for ensuring project success, a GB project client is suggested to:

Proficiency, motivation, leadership, and involvement

- Have the proficiency in project development particularly in terms of the understanding of GB requirements and sustainable building operation;
- Provide leadership in project development;
- Be motivated towards achievement of sustainable outcomes and endorse the sustainability brief of the project;
- Get involved in project development and provide coordination among the project team;

Setting goals

- Have clarity in communication of project goals;
- Reduce the likelihood of scope changes during project execution;
- Set detailed sustainability charter or brief;
- Ensure the involvement of project team, end-users and FM team in defining project aspirations;
- Ensure that appropriate project targets are set with project requirements specifically defined and sustainability brief aligned with project budget;
- Ensure that sustainability is engraved in project development;
- Procure the project site based on sustainability goals;

Ensuring rigour in planning and management

- Ensure rigorous project planning and in this regard allocate adequate time for project development;
- Ensure rigour in project design development with careful speculation in building design, and the use of integrated, energy-oriented, and life-cycle based design approach;
- Introduce project targets early, make decisions early in terms of sustainability goals, and incorporate sustainability early in the project;
- Ensure that the end-users have the understanding of building operation and operate the building in sustainable ways;
- Ensure that the neighbourhood communities and internal project stakeholders agree to project development;
- Conduct rigorous risk management;
- Ensure a rigorous inspection of the project upon construction and in this regard conduct commissioning and fine-tuning;

Team procurement

- Engage project team early, particularly contractor, design consultant, and sustainability consultant;
- Procure project team carefully, particularly the contractor and design consultant;

- Ensure proficiency of project team for GB development, particularly the proficiency of contractor, design consultant, and PM team;
- Empower sustainability consultants

10.1.2. Suggestions related to Design consultant

Based on the findings of this study, for ensuring project success, a GB design consultant is suggested to:

- Have the proficiency to develop GB projects;
- Have the motivation to achieve sustainable outcomes;
- Ensure that the design deliverables are well-defined;
- Ensure that the project design is complete and rigorously developed before execution;
- Ensure that there is access to sustainable building materials;
- Conduct a market survey for identifying successful building systems;
- Ensure that performance-based specifications are used;
- Engrave sustainability in project development;
- Have a reasonable control of project design;
- Liaise with sustainability consultant and client's team;
- Ensure that the project design is rigorously developed;
- Add adaptability and multiple layers of use in building design;
- Use reliable technologies and solutions;
- Ensure that during design development there is consideration towards future building usage;
- Optimise the level of complexity in project design;
- Use life-cycle based project development approach;
- Ensure careful speculations for project design;
- Consider building maintainability in design;
- Consider the suitability of project design for execution;
- Ensure that a proactive, balanced, context-oriented, energy-oriented, holistic, innovative, and integrated design approach is used

10.1.3. Suggestions related to Contractor

The contractor of a GB project can contribute to project success, in case following aspects are considered during project development:

- Before project execution, a complete and rigorously developed project design is available;
- Contractor team and sub-contractors are educated about GB development;
- Performance-based specifications are used;
- Contractor is required to engage a sustainability advisor;
- Contractor and sub-contractors are engaged early in the project development;
- There is the provision of sustainability specifications and other related information in tender;
- There is a pre-qualification process when engaging contractors and sub-contractors;
- Contractor is carefully selected based on different criteria such as the ability to deliver GBs, perception of GBs, and previous experience of delivering GBs.

For ensuring project success, the contractor of a GB project is suggested to:

- Have the proficiency to develop GB projects;
- Have the motivation to achieve sustainable outcomes;
- Play a proactive role in project development;
- Ensure rigorous and thorough execution of sustainable design during construction;
- Use environmental management systems in construction;
- Liaise with sustainability consultant

10.1.4. Suggestions related to Sustainability consultant

The Sustainability consultant can contribute to GB project success, in case following aspects are considered during project development:

- Sustainability consultant is empowered by the client and has the control over project design;
- Sustainability consultant is engaged early in project development and engaged for the entire duration of project development;
- Sustainability consultant is involved in the contractor's selection

For ensuring GB project success, the sustainability consultant is suggested to:

- Have the proficiency to develop GB projects;
- Have the motivation to achieve sustainable outcomes;
- Have the focus on project goals;
- Review the project design in terms of sustainability considerations;
- Liaise with project client, contractor team, design consultant, and other members of the project team

10.1.5. Suggestions related to Project Management team

For ensuring GB project success, the Project Management team is suggested to:

- Have the proficiency to develop GB projects;
- Have the motivation to achieve sustainable outcomes;
- Ensure that project planning is rigorously conducted;
- Ensure that an adequate budget is allocated for project development and the sustainability brief is aligned with project budget;
- Ensure that adequate time is allocated for project development and particularly for commissioning and testing activities;
- Ensure that risk management is rigorously conducted;
- Monitor project development and conduct Project reporting through different project stages to see if requirements are being met;
- Inspect project upon construction

10.1.6. Suggestions related to Facility Management team

The Facility Management (FM) team can contribute to GB project success, in case following aspects are considered:

- FM team is engaged early in project development and is involved in defining project aspirations;
- The operational performance targets of building are clearly defined;
- FM team is educated about building operation;

- A smooth transition of the project from inception to operation stage is ensured particularly in terms of the transfer of building-related information

For ensuring GB project success, the Facility Management team is suggested to:

- Have the proficiency to work on GB projects;
- Have the motivation to achieve sustainable outcomes;
- Monitor and control the operational performance of the building;
- Liaise with the project development team

10.1.7. Suggestions related to End-users

The End-users can contribute to GB project success, in case following aspects are considered:

- They are contractually required to consider sustainability;
- They are involved in defining project aspirations;
- They are educated about building operation

For ensuring GB project success, the End-users are suggested to:

- Have the motivation to achieve sustainable outcomes;
- Have the understanding of building operation and operate the building in sustainable ways

10.1.8. Suggestions related to other project stakeholders

The likelihood of GB project success increases in case:

- Commissioning professionals are engaged early in the project and they rigorously conduct commissioning and fine-tuning;
- Suppliers are engaged early in the project and they have access to sustainable building materials;
- Building control authorities cooperate in the GB project development. This can be in terms of providing timely approvals of project development and the provision of necessary infrastructure for meeting sustainability objectives in the project;
- Neighbourhood community and internal project stakeholders (that is, Client's organisation and end-users) approve the project development;
- GB certification organisation provides a timely feedback on the sustainability documentation of the project

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Appendix A

This appendix provides the aspects related to the theoretical framework used in this study (Chapter 3).

A.1. Pillars for sustainable construction

Table A.1: Four pillars for sustainable construction by Hill and Bowen (1997)

Pillar	Description
Social sustainability	<i>Social sustainability</i> underlines the improvements in the quality of human life, and human living environment, which includes health, culture, intergenerational equity, and education.
Economic sustainability	<i>Economic sustainability</i> involves the use of real-cost pricing and full-cost accounting methods for setting prices and tariffs of goods and services and to achieve the efficient use of resources.
Biological sustainability	<i>Biological sustainability</i> incorporates the view that sustainable construction needs to protect the natural environment instead of polluting it. This promotes the use of renewable resources and reduction of water, materials, energy and land use for each project lifecycle stage.
Technical sustainability	<i>Technical sustainability</i> entails durability, quality, high performance and mixed-use of a building.

A.2. Synergies between sustainable projects and lean construction

Lean is a systematic approach of enhancing value to the customer by identifying and eliminating waste (of time, effort and materials) through continuous improvement, by focusing on the entire value stream and by flowing the product at the pull of the customer in pursuit of perfection (Manrodt, Vitasek, & Thompson, 2008; Salem & Zimmer, 2005). Lean can also be considered a philosophy that uses tools and techniques to create a change of organisational culture in order to implement the 'good practice of process/operations improvement that allows the reduction of waste, improvement of flow, more focus on the needs of customers and which takes a process view' (Radnor, Walley, Stephens, & Bucci, 2006).

Some studies have been conducted to identify synergies between sustainable development and lean construction agendas. Banawi and Bilec (2014) realised lean and green as complementary in reducing waste during the construction process. Sustainable construction and lean construction have a common agenda for minimising the use of resources. As a result of lean construction, some goals of sustainable development such as the Waste reduction are spontaneously achieved. Hence, sustainability can be seen as an unintended consequence of lean construction. While the objectives of lean construction might be short-term oriented and the environmental concerns of sustainable construction are long-term, both have at their core, the efficient use of valuable resources (Horman et al., 2004). According to Huovila and Koskela (1998), the principles of lean construction contribute to the sustainability objectives as they result in the elimination of material waste and add value to the customer by minimising resource depletion and pollution while matching the business and environmental excellence.

While lean construction and sustainable development have overlapping agendas, some overlaps are also observed among lean construction and the practices of GB project development. From the case studies of three GB projects, Novak (2012) realised correlations among lean thinking and the integration of sustainability in design and delivery. GB project delivery practices are increasingly incorporating lean or TFV principles. As Castro-Lacouture et al. (2008) highlighted, the project participants are becoming involved earlier in the GB delivery process, information exchanges take place throughout the project lifecycle, and the results of those frequent exchanges impact the value to the owner. These features are configuring a framework for green project delivery. This framework approaches lean thinking, in particular the TFV theory of production by Lauri Koskela (2000), by generating value to the owner, improving flow, and transforming the inputs required for the selection of materials, resources and systems, to outputs in the form of green certifications. This shows that a successful GB incorporates

principles and practices originating from lean construction or The TFV theory therefore highlighting the potential of The TFV theory to explain success in GB project development.

TFV and lean construction can also help explain success in GB project development. A. R. Lapinski et al. (2006) found that in case the lean perspective is used to observe project development, it is possible to identify the aspects which result in Value-generation and therefore project success. With a lean perspective A. R. Lapinski et al. (2006) identified the presence of value and waste in a sustainable building project. Through an empirical investigation of the Real Estate and Facilities Division of Toyota Motor Sales, Toyota's capital facility delivery process was mapped to identify both, the steps in project delivery critical for success (i.e. value) and those that are waste.

A.3. Subjective nature of value

Value is a relative and subjective term, dependent and ever-changing with the context (Salvatierra-Garrido et al., 2010). Customer values represent different interests from the owner, users and society, all of which are embedded within a continuous value chain (Bertelsen & Emmitt, 2005). Understanding customer is essential for a project as without this the concept of value is undefined, and without a tangible concept of value, waste is even more intangible (Bertelsen & Emmitt, 2005). For instance, the generation of sustainable value can have different meanings depending on the type of customer. Huovila and Koskela (1998) provided examples of three customers i.e. client/user, environment, and contractor. For the case of a building facility, the sustainable Value-generation for a client/user can be in terms of conformity to business processes, location, life-cycle costs, and indoor conditions. For the environment as a customer, the sustainable Value-generation can be in terms of environmental burdens in operation, service life and risks for deterioration, and convertibility and flexibility. For contractor as a customer sustainable Value-generation can be in terms of safety, comfort, and embodied environmental burdens in building elements. Understanding what is valuable and what each customer regards as valuable is a significant source of innovation which can help streamline projects and improve the solutions to many of the challenges faced in sustainable projects (Horman et al., 2004).

A.4. Characterisation of complex systems

Complex systems are generally characterised by:

- Autonomous agents i.e. elements that may act on their own.
- Nonlinear relations i.e. relations between the agents, which are not simple and linear but characterised by feedback loops.
- Non-uniform parts (agents and relations) i.e. the agents, as well as their relations, are not the same all over the system.

Lucas (2005) listed 18 distinct characteristics (i.e. axioms) of complex systems that include the above three. The remaining fifteen can be named as complex systems' behaviour and Bertelsen and Emmitt (2005) considered these fifteen in three groups:

- General behaviour of complex systems: looking at the system's organisation
- Evolutionary behaviour of complex systems: looking at the system's learning and development
- Connective behaviour of complex systems: looking at the relations between the parts instead of the parts themselves (i.e. reductionism)

From a project management point of view, some characteristics of complex systems are of particular importance. Among these are emergence (i.e. the system as a whole shows characteristics that may not be deduced from studying its elements), self-organisation and self-modification (that is the system is able to create order and change itself), upward and downward causation (i.e. the system is affected

by its elements just as the elements are affected by the system's overall state), and unpredictability (i.e. the future state of the system cannot be predicted in any detail) (Bertelsen, 2004).

Appendix B

This appendix is related to research design (Chapter 4) and provides the content used in conducting the online survey and semi-structured interviews for this study. It also provides the demographic details of interview participants and their response to interview themes.

B.1. Plain language statement for online survey

PLAIN LANGUAGE STATEMENT

Survey: Interrelationships among performance criteria of Green Office projects

Dr Ajibade Aibinu (Supervisor)

Faculty of Architecture, Building and Planning
University of Melbourne
Ph: +61 3 8344 6811
Email: aaibinu@unimelb.edu.au

Dr André Stephan (Co-Supervisor)

Faculty of Architecture, Building and Planning
University of Melbourne
Ph: +61 3 8344 5929
Email: andre.stephan@unimelb.edu.au

Mr. Tayyab Ahmad (PhD Student)

Faculty of Architecture, Building and Planning
University of Melbourne
Ph: +61 4 5126 4345
Email: ahmadt@student.unimelb.edu.au



Project:

“An inquiry of conditions and criteria associated with Green Building project success”

Introduction

You are invited to participate in the above research project, which is being conducted by Dr. Ajibade Aibinu (**Supervisor**), Dr. Andre Stephan (**Co-Supervisor**) and Mr. Tayyab Ahmad (**PhD Student**) from the Faculty of Architecture, Building and Planning at the University of Melbourne. The aim of this study is to promote good project outcomes in Green Buildings.

We are interested in talking to you about the interrelationships among performance criteria of Green Office projects. The performance criteria being considered are project management criteria (that is Schedule, Cost, and Quality performance) and Sustainability criteria (that is Environmental, Economic, and Social sustainability).

What will I be asked to do?

As an expert in the field, if you agree to participate, you would be asked to contribute in the following ways:

You will be presented with a questionnaire comprised of questions regarding the performance criteria for green building office projects. The total time of interaction will be no more than twenty minutes.

For green office projects you will be asked to:

- Indicate the interrelationships among project management criteria and sustainability criteria.
- Indicate the conditions that affect the interrelationships between project management criteria and sustainability criteria?

In case of online survey, with your permission the electronic copy of the feedback you provide will be saved online. In case of paper-based survey, with your permission the paper document containing your feedback will be secured in a locked facility in Melbourne School of Design, The University of Melbourne.

How will my confidentiality be protected?

This project has been approved by the Human Research Ethics Committee and we intend to protect your anonymity and the confidentiality of your responses to the fullest possible extent, within the limits of the law. Your name and contact details will be kept in a separate, password-protected computer file from any data that you supply. This will only be able to be linked to your responses by the researchers. In the final report, if you agree, you will be referred to by a pseudonym. We will remove any references to

personal information that might allow someone to guess your identity; however, you should note that as the number of people we seek for this survey is very small, it is possible that someone may still be able to identify you. The data will be kept securely in the Faculty of Architecture, Building and Planning for five years from the date of publication, and may be destroyed after this time. It is also possible that the data you provide may be used by the researchers for related research in future.

How will I receive feedback?

Once the thesis based on this research has been concluded, a brief summary of the findings will be available to you on application at the Faculty of Architecture, Building and Planning. It is also possible that the results will be presented at academic conferences and in published papers.

Do I have to take part?

Participation in this study is voluntary. Should you wish to withdraw at any stage, or to withdraw any unprocessed data you have supplied, you are free to do so without prejudice. Your decision to participate or not, or to withdraw, will not affect any relationship you may have with this department or University and will not affect any services you may receive now or in the future.

Where can I get further information?

Please contact the researchers if you have any questions or if would like more information about the project please do not hesitate to contact the researchers at the contact details above.

If you have any concerns about the conduct of the project which you do not wish to discuss with the research team please contact the Manager, Human Research Ethics, Office for Research Ethics and Integrity, The University of Melbourne, on Ph: 8344 2073, or email address: humanethics-complaints@unimelb.edu.au.

How do I agree to participate?

If you would like to participate, please indicate that you have read and understood this information by signing the consent form (in case of paper-based form) or by typing your name (in case of online form).

B.2. Consent form for online survey

CONSENT FORM (Survey)



Faculty of Architecture, Building and Planning

Project title: An inquiry of conditions and criteria associated with Green Building project success

Name of participant: _____

Name of researchers: Dr Ajibade Aibinu (Primary Researcher), Dr André Stephan (Co-Supervisor); _____

Tayyab Ahmad (Student Researcher) _____

1. I consent to participate in this project, the details of which have been explained to me, and I have been provided with a written plain language statement to keep.
2. I understand that after I sign and return this consent form it will be retained by the researcher.
3. I understand that my participation will involve a survey and I agree that the researcher may use the results as described in the plain language statement.
4. I acknowledge that:
 - (a) The possible effects of participating in the survey have been explained to my satisfaction;
 - (b) I have been informed that I am free to withdraw from the project at any time without explanation or prejudice and to withdraw any unprocessed data I have provided;
 - (c) The project is for the purpose of research;
 - (d) I have been informed that the confidentiality of the information I provide will be safeguarded subject to any legal requirements;
 - (e) I have been informed that with my consent the answers to the questionnaire survey will be saved online (in case of online survey) / or saved in a locked cabinet at University of Melbourne (in case of paper-based survey) and may be destroyed after five years;
 - (f) My name will be used in publication/s arising from this research / or I will be referred to by a pseudonym, should I agree to this;
 - (g) I have been informed that a copy of the research findings will be forwarded to me, should I agree to this.

I wish to receive a copy of the summary project report on research findings

☐ **yes** ☐ **no**
(please tick)

I wish to be referred to by a pseudonym in any publication from this research

☐ **yes** ☐ **no**
(please tick)

Participant signature: _____

Date: _____

B.3. Questionnaire for online survey

A Survey of Performance Criteria Preferences in Green Building Office Projects

This questionnaire survey should not take more than 20 minutes of your time. Please provide your response based on your practical experience related to the delivery of green office projects. Your participation in this survey/interview is highly appreciated and your feedback for this survey/interview will help enrich the body of knowledge in area of sustainable development.

Yours Sincerely,
Tayyab Ahmad
PhD candidate-Architecture
The University of Melbourne
Email: ahmadt@student.unimelb.edu.au

* Required

1. Would you like to see the Consent Form and Plain Language Statement for the details of the research study? *

Mark only one oval.

- ☐ Yes, I would like to see Plain Language Statement *Skip to question 2.*
☐ No, I want to proceed directly to survey *Skip to question 4.*

2. I wish to receive a copy of the summary project report on research findings

Mark only one oval.

- ☐ Yes
☐ No

3. I wish to be referred to by a pseudonym in any publication from this research

Mark only one oval.

- ☐ Yes
☐ No

Your experience with Green Building projects

(Green projects are inclusive of the green certified and non-certified projects)

4. Please state your name *

5. Please mention your experience (no. of years) with green building delivery **Mark only one oval per row.*

	No experience	0-3 years	5-10 years	More than 10 years
Experience in all kind of green building projects	☐	☐	☐	☐
Experience in green office projects	☐	☐	☐	☐

6. Please mention your experience (no. of projects) with green building delivery **Mark only one oval per row.*

	No experience	1-5 projects	6-10 projects	11-15 projects	15-20 projects	More that 20 projects
Experience in all kind of green building projects	☐	☐	☐	☐	☐	☐
Experience in green office projects	☐	☐	☐	☐	☐	☐

7. In what capacity have you majorly acted in the delivery of green office projects *

(Please mention all the major roles you previously had)

Check all that apply.

- ☐ Design Consultant
☐ Owner/Developer
☐ Supplier
☐ Manufacturer
☐ Project Manager
☐ Construction Manager
☐ Facility Manager
☐ General Contractor
☐ Specialty Contractor/Trade Contractor/Sub-Contractor
☐ Sustainability Consultant
☐ Other: _____

8. Please indicate the area (country/city) where your experience is majorly based

Interrelationships among performance criteria of Green Office projects

Cost, Quality, Schedule, and Sustainability performance are different performance outcomes of a project. These performance outcomes have indirect relationships with each other and they can be correlated. For instance, in case of a Green Office building to positively impact environmental sustainability some materials/equipment may need to be imported that may take longer than usual and impact schedule negatively. While giving your response for different questions, please consider these

indirect interrelationship and also provide explanation for your answer.

For the following questions please note that:

Good Environmental Sustainability Performance means delivering projects having low emissions, more resource conservation, use of recyclable materials, etc.;

Good Social Sustainability Performance means delivering projects having better indoor air quality, healthy and more productive spaces, etc.;

Good Economic Sustainability Performance means delivering projects having lower life cycle cost, and lower operation and maintenance costs, etc.;

Good Cost Performance means delivering projects on budget or under budget;

Good Schedule Performance means delivering projects within specified time or before specified time;

Good Quality Performance means delivering projects within specified quality

Cost, Quality and Schedule Performance are limited to project construction stage; Environmental, Social and Economic Sustainability Performance involve the whole project life cycle including construction and operation stages

9. Effect of good "Environmental Sustainability Performance" on.... *

Good Environmental Sustainability Performance means delivering projects having low emissions, more resource conservation, use of recyclable materials, etc.



Mark only one oval per row.

	Highly Positive	Moderately Positive	No Effect	Moderately Negative	Highly Negative
Social Sustainability Performance	☐	☐	☐	☐	☐
Schedule Performance	☐	☐	☐	☐	☐
Quality Performance	☐	☐	☐	☐	☐
Cost (on-budget) Performance	☐	☐	☐	☐	☐

10. Please explain the reasons behind the options selected by you *

Why the good environmental sustainability performance increases/decreases other performance criteria?

11. Effect of good "Social Sustainability Performance" on.... *

Good Social Sustainability Performance means delivering projects having better indoor air quality, healthy and more productive spaces, etc.

Mark only one oval per row.

	Highly Positive	Moderately Positive	No Effect	Moderately Negative	Highly Negative
Environmental Sustainability Performance	☐	☐	☐	☐	☐
Economic Sustainability Performance	☐	☐	☐	☐	☐
Schedule Performance	☐	☐	☐	☐	☐
Quality Performance	☐	☐	☐	☐	☐
Cost (on-budget) Performance	☐	☐	☐	☐	☐

12. Please explain the reasons behind the options selected by you *

Why the good social sustainability performance increases/decreases other performance criteria?

13. Effect of good "Economic Sustainability Performance" on.... *

Good Economic Sustainability Performance means delivering projects having lower life cycle cost, and lower operation and maintenance costs, etc.

Mark only one oval per row.

	Highly Positive	Moderately Positive	No Effect	Moderately Negative	Highly Negative
Environmental Sustainability Performance	☐	☐	☐	☐	☐
Social Sustainability Performance	☐	☐	☐	☐	☐
Schedule Performance	☐	☐	☐	☐	☐
Quality Performance	☐	☐	☐	☐	☐
Cost (on-budget) Performance	☐	☐	☐	☐	☐

14. Please explain the reasons behind the options selected by you *

Why the good economic sustainability performance increases/decreases other performance criteria?

15. Effect of good "Cost Performance" on.... *

Good Cost Performance means delivering projects on budget or under budget
Mark only one oval per row.

	Highly Positive	Moderately Positive	No Effect	Moderately Negative	Highly Negative
Schedule Performance	☐	☐	☐	☐	☐
Quality Performance	☐	☐	☐	☐	☐
Social Sustainability Performance	☐	☐	☐	☐	☐
Economic Sustainability Performance	☐	☐	☐	☐	☐
Environmental Sustainability Performance	☐	☐	☐	☐	☐

16. Please explain the reasons behind the options selected by you *

Why the good cost performance increases/decreases other performance criteria?

17. Effect of good "Schedule Performance" on.... *

Good Schedule Performance means delivering projects within specified time or before specified time

Mark only one oval per row.

	Highly Positive	Moderately Positive	No Effect	Moderately Negative	Highly Negative
Cost (on-budget) Performance	☐	☐	☐	☐	☐
Quality Performance	☐	☐	☐	☐	☐
Social Sustainability Performance	☐	☐	☐	☐	☐
Economic Sustainability Performance	☐	☐	☐	☐	☐
Environmental Sustainability Performance	☐	☐	☐	☐	☐

18. Please explain the reasons behind the options selected by you *

Why the good schedule performance increases/decreases other performance criteria?

19. Effect of good "Quality Performance" on.... *

Good Quality Performance means delivering projects within specified quality

Mark only one oval per row.

	Highly Positive	Moderately Positive	No Effect	Moderately Negative	Highly Negative
Schedule Performance	☐	☐	☐	☐	☐
Cost (on-budget) Performance	☐	☐	☐	☐	☐
Social Sustainability Performance	☐	☐	☐	☐	☐
Economic Sustainability Performance	☐	☐	☐	☐	☐
Environmental Sustainability Performance	☐	☐	☐	☐	☐

20. Please explain the reasons behind the options selected by you *

Why the good quality performance increases/decreases other performance criteria?

Survey conclusion

21. Comments relating survey

Please let us know your views about the survey and how this survey can be improved (non-mandatory)

B.4. Plain language statement for semi-structured interviews

PLAIN LANGUAGE STATEMENT

Interview: An inquiry of conditions and criteria associated with Green Building project success

Dr Ajibade Aibinu (Supervisor)

Faculty of Architecture, Building and Planning
University of Melbourne
Ph: +61 3 8344 6811
Email: aaibinu@unimelb.edu.au

Dr André Stephan (Co-Supervisor)

Faculty of Architecture, Building and Planning
University of Melbourne
Ph: +61 3 8344 5929
Email: andre.stephan@unimelb.edu.au

Mr. Tayyab Ahmad (PhD Student)

Faculty of Architecture, Building and Planning
University of Melbourne
Ph: +61 4 5126 4345
Email: ahmadt@student.unimelb.edu.au



Project:

“An inquiry of conditions and criteria associated with Green Building project success”

Introduction

You are invited to participate in the above research project, which is being conducted by Dr. Ajibade Aibinu (**Supervisor**), Dr. Andre Stephan (**Co-Supervisor**) and Mr. Tayyab Ahmad (**PhD Student**) from the Faculty of Architecture, Building and Planning at the University of Melbourne. The aim of this study is to promote good project outcomes in Green Buildings.

We are interested in talking to you about the Success conditions and Success criteria involved in the development of green building projects.

What will I be asked to do?

As an expert of green building development, if you agree to participate, you would be asked to contribute in the following ways:

- Identifying the aspects that set Green building projects apart from traditional buildings
- Identifying the Success conditions involved in expected/beyond-expected performance of Green Building projects
- Identifying the criteria on which Success of of Green Building projects can be determined

This questionnaire for conducting the structured interview is comprised of 4 major questions which are further divided into sub-questions and it should not take more than 45 minutes of your time. Your participation in this interview is highly appreciated and your feedback for this interview will help enrich the body of knowledge in the area of sustainable development.

With your permission the interview would be digitally recorded so that we can make an accurate record of what you say. When the recording has been transcribed, you would be provided with a copy of the transcript, so that you can verify that the information is correct and/or request deletions.

How will my confidentiality be protected?

This project has been approved by the Human Research Ethics Committee and we intend to protect your anonymity and the confidentiality of your responses to the fullest possible extent, within the limits of the law. Your name and contact details will be kept in a separate, password-protected computer file from

any data that you supply. This will only be able to be linked to your responses by the researchers. In the final report, if you agree, you will be referred to by a pseudonym. We will remove any references to personal information that might allow someone to guess your identity. The data will be kept securely in the Faculty of Architecture, Building and Planning for five years from the date of publication, and may be destroyed after this time. It is also possible that the data you provide may be used by the researchers for related research in future.

How will I receive feedback?

Once the thesis based on this research has been concluded, a brief summary of the findings will be available to you on application at the Faculty of Architecture, Building and Planning. It is also possible that the results will be presented at academic conferences and in published papers.

Do I have to take part?

Participation in this study is voluntary. Should you wish to withdraw at any stage, or to withdraw any unprocessed data you have supplied, you are free to do so without prejudice. Your decision to participate or not, or to withdraw, will not affect any relationship you may have with this department or University and will not affect any services you may receive now or in the future.

Where can I get further information?

Please contact the researchers if you have any questions or if you would like more information about the project please do not hesitate to contact the researchers at the contact details above.

If you have any concerns about the conduct of the project which you do not wish to discuss with the research team please contact the Manager, Human Research Ethics, Office for Research Ethics and Integrity, The University of Melbourne, on Ph: 8344 2073, or email address: humanethics-complaints@unimelb.edu.au.

How do I agree to participate?

If you would like to participate, please indicate that you have read and understood this information by signing the consent form (in case of paper-based form) or by typing your name (in case of online form).

B.5. Consent form for semi-structured interviews

CONSENT FORM (Interview)



Faculty of Architecture, Building and Planning

Project title: An inquiry of conditions and criteria associated with Green Building project success

Name of participant: _____

Name of researchers: Dr. Ajibade Aibinu (Primary Researcher, Supervisor), Dr. André Stephan (Co-Supervisor)

Mr. Tayyab Ahmad (Student Researcher)

1. I consent to participate in this project, the details of which have been explained to me, and I have been provided with a written plain language statement to keep.
2. I understand that after I sign and return this consent form it will be retained by the researcher.
3. I understand that my participation will involve an interview and I agree that the researcher may use the results as described in the plain language statement.
4. I acknowledge that:
 - a) The possible effects of participating in the interview have been explained to my satisfaction;
 - b) I have been informed that I am free to withdraw from the project at any time without explanation or prejudice and to withdraw any unprocessed data I have provided;
 - c) The project is for the purpose of research;
 - d) I have been informed that the confidentiality of the information I provide will be safeguarded subject to any legal requirements;
 - e) I have been informed that with my consent the interview will be audio-taped and I understand that audio-tapes will be stored at University of Melbourne and may be destroyed after five years;
 - f) I will be referred to by a pseudonym, should I agree to this;
 - g) I have been informed that a copy of the research findings will be forwarded to me, should I agree to this.

I consent to this interview being audio-taped

☐ **yes** ☐ **no**
(please tick)

I wish to receive a copy of the summary project report on research findings

☐ **yes** ☐ **no**
(please tick)

I wish to be referred to by a pseudonym in any publication from this research

☐ **yes** ☐ **no**
(please tick)

Participant signature: _____

Date: _____

B.6. List of themes for semi-structured interviews



Interview to investigate Green Building project Success

Introduction of the Participant

Question	Fill the field
Please state your name (non-mandatory)	
In which region is your (Green Building) experience majorly based	

Question	Fill the field
Please mention your experience in Green Building projects	No. of years No. of projects (projects/year)
Please mention your experience in Green Office projects	No. of years No. of projects

Question	Roles
In what capacity have you majorly acted in the development of green building projects and green office projects (Please mention all the major roles you previously had)	

Interview Themes

Theme: Difference of Green Buildings from traditional buildings	Response
Please discuss the aspects that set Green building projects apart from traditional buildings	

Theme: Performance/Success criteria for Green Buildings	Response
Please define a successful Green Building project. Please highlight some key criteria/requirements a Green Building project requires to meet in order to be considered as successful.	
Do you think there are associations between project management criteria and sustainability criteria?	
In case you think such associations exist, what are the conditions that affect the interrelationships between project management criteria and sustainability criteria?	
Note: The project management criteria are <i>Schedule, Cost, and Quality performance</i>	
The Sustainability criteria include <i>Environmental, Economic, and Social sustainability</i>	

Theme: Success & Failure reasons	Response
What are the reasons/conditions of Green Building project success/failure?	
What are the most important steps/actions which a project developer/client needs to take in order to achieve successful outcomes in Green Building projects?	

Theme: Success and Failure conditions in specific projects

One of the most important inquiries of the Green Building research being conducted is to understand the causes of success in such projects. It is extremely important for this research to unveil the reasons for success and failure of Green Building development by discussing the real-life projects you have/had been involved in. Both the success and failure examples in projects can highlight the reasons/causes behind project performance. While referring to the cues listed below, please discuss the salient details relating particular projects from your professional career.

- Please mention a project in which the circumstances had been unusually difficult, yet the project team managed to develop and deliver the project successfully.
- Please mention a project in which the project team was confident of developing and delivering the project successfully, yet the final outcomes were not successful.
- Please mention a case in which the project was generally perceived as successfully developed/delivered, but you think that the project could have achieved a much higher performance, but achieved significantly low outcomes.

Green building projects (preferably Green Office) projects

Project ID	Project functional use	Duration of Project delivery (No. of years)	Project Completion Date (planned/actual)	Approximate project scope (Covered floor area/Cost etc.)	Level of technical complexity (select from High, Medium, Low)	Your/ your company's role in the project
Please comment on this Project as being a successful/failure project						
Please mention some of the reasons behind the success of the project.						

B.7. Details regarding interview participants

Table B.7.1: Demographic details of interview participants and themes addressed by them

Participant ID	Themes addressed by interview participants				Interview mode		Demographic details of interview participants	
	Success conditions	Success criteria	Underlying conditions	Differentiating conditions	Telephone	In-person	Region where experience based	Years of involvement in GBs
AE-F-1	x				x		UAE	Design Consultant
AE-F-2	x	x				x	UAE	Sustainability Consultant
AE-M-1	x		x	x		x	UAE	Sustainability Consultant
AE-M-2	x		x			x	UAE	Sustainability Consultant
AE-M-3				x	x		UAE	Sustainability Manager with GB regulatory organisation
AE-M-4	x			x		x	UAE	Design Consultant
AU-F-1				x	x		Australia	Sustainability Manager with GB certification organisation
AU-F-10	x	x		x	x		Australia	Sustainability manager; Design Consultant
AU-F-11	x	x			x		Australia	Design Consultant
AU-F-2	x		x			x	Australia	Design Consultant
AU-F-3	x					x	Australia	Sustainability Consultant
AU-F-4	x	x	x			x	Australia	Sustainability Consultant
AU-F-5	x			x		x	Australia	Sustainability Consultant
AU-F-6	x		x			x	Australia	Sustainability Consultant
AU-F-7	x		x		x		Australia	Design Consultant
AU-F-8	x	x	x		x		Australia	Design Consultant
AU-F-9	x	x			x		Australia	Sustainability Consultant
AU-M-1	x					x	Australia	Sustainability Consultant
AU-M-10	x					x	Australia	Sustainability Consultant
AU-M-11					x		Australia	Sustainability Consultant
AU-M-12	x	x		x	x		Australia	Electrical Engineer
AU-M-13	x	x				x	Australia	Sustainability Consultant
AU-M-14	x	x			x		Australia	Sustainability Consultant
AU-M-15	x	x			x		Australia	Sustainability manager
AU-M-16	x	x		x	x		Australia	Head contractor
AU-M-17	x		x		x		Australia	Design Consultant
AU-M-18	x	x			x		Australia	Sustainability Consultant
AU-M-19	x	x			x		Australia	Sustainability Consultant; Engineering Consultant
AU-M-2	x		x	x		x	Australia	Design Consultant

Participant ID	Themes addressed by interview participants				Interview mode		Demographic details of interview participants		
	Success conditions	Success criteria	Underlying conditions	Differentiating conditions	Telephone	In-person	Region where experience based	Role in GB projects	Years of involvement in GBs
AU-M-20	x	x	x		x		Australia	Sustainability and Design manager with Contractor	14
AU-M-21	x	x		x		x	Australia	Commercial Specification Consultant	5
AU-M-3	x	x				x	Australia	Engineering Consultant; Sustainability Consultant	28
AU-M-4	x		x			x	Australia	Design Consultant	10
AU-M-5	x		x	x	x		Australia	Design and BIM manager with contractor	10
AU-M-6	x	x				x	Australia	Design Manager and Director with Developer	15
AU-M-7	x	x	x	x		x	Australia	Sustainability Consultant	7.5
AU-M-8	x	x	x			x	Australia	Project Manager	15
AU-M-9	x				x		Australia	Quality and environmental manager with contractor	10
HK-F-1	x	x		x		x	Hong Kong	Sustainability consultant	2
HK-M-1	x	x				x	Hong Kong	Sustainability consultant	7
HK-M-2	x	x				x	Hong Kong	Sustainability consultant	7
HK-M-3	x	x				x	Hong Kong	Design consultant	10
HK-M-4	x	x	x			x	Hong Kong	Design consultant	10
HK-M-5	x					x	Hong Kong	Design consultant	10
HK-M-6	x	x				x	Hong Kong	Environmental and Applications Engineer with HVAC manufacturer	15
HK-M-7	x	x				x	Hong Kong	Design consultant	24
PK-M-1	x		x	x	x		Pakistan	Sustainability Consultant; Design Consultant	3.5
PK-M-2	x		x	x	x		Pakistan	Lead Engineer with contractor	1
SN-F-1	x					x	Singapore	Building-users' representative	7
SN-F-2	x	x				x	Singapore	Sustainability Consultant; Design Consultant	8
SN-M-1	x	x				x	Singapore	Engineering Consultant (Mechanical)	20
SN-M-10	x	x				x	Singapore	Engineering Consultant; Sustainability Manager	12
SN-M-11	x	x				x	Singapore	Design Consultant	15
SN-M-12	x	x				x	Singapore	Energy Manager	14
SN-M-2	x	x				x	Singapore	Commissioning Service Provider; Sustainability Manager	15
SN-M-3	x	x	x			x	Singapore	Facilities Management Professional	13
SN-M-4	x	x				x	Singapore	Facilities Management Professional	3
SN-M-5	x	x	x			x	Singapore	Design Consultant	22

Participant ID	Themes addressed by interview participants				Interview mode		Demographic details of interview participants		
	Success conditions	Success criteria	Underlying conditions	Differentiating conditions	Telephone	In-person	Region where experience based	Role in GB projects	Years of involvement in GBs
SN-M-6	x	x				x	Singapore	Sustainability consultant; Engineering Consultant (Mechanical)	7
SN-M-7	x					x	Singapore	Engineering Consultant (Mechanical); Sustainability Manager	12
SN-M-8	x	x				x	Singapore	Engineering Consultant (Mechanical); Sustainability Manager	10
SN-M-9	x	x	x			x	Singapore	Engineering Consultant (Electrical); Sustainability Manager	10
UK-F-1	x	x	x	x		x	UK	Design Consultant	10
UK-F-2	x			x		x	UK	Design Consultant	11
UK-F-3	x		x			x	UK	Sustainability Consultant	4
UK-F-4	x		x	x		x	UK	Sustainability Consultant; Environmental Designer	5
UK-F-5	x		x	x		x	UK	Design Consultant	15
UK-F-6	x		x	x		x	UK	Sustainability Consultant	10
UK-M-1	x		x	x		x	UK	Sustainability Consultant; Design Consultant	10
UK-M-2	x			x		x	UK	Sustainability Consultant	11
UK-M-3 (Res)	x		x			x	UK	Sustainability Consultant	7
UK-M-4	x		x	x		x	UK	Energy Auditor; Engineering Consultant	10
UK-M-5	x		x	x		x	UK	Sustainability Consultant; Design Consultant	6
UK-M-6	x	x				x	UK	Design consultant	11
UK-M-7	x		x	x		x	UK	Design Consultant; Contractor	12
Number of participants	72	40	30	25	21	54			
Key to participant ID: Part 1-Part 2-Part3 Part-1: Regional origins of interview participant/ Region where the GB project experience of interview participant is mainly based AE= UAE; AU= Australia; HK= Hong Kong; PK= Pakistan; SN= Singapore; UK= United Kingdom Part-2: The gender of interview participant M= Male; F= Female Part-3: Unique integer ID of an interview participant belonging to a pool of gender and region									

Table B.7.2: Attributes of Green Building projects discussed by interview participants

Project ID	Country	Project functional use	Duration of Project delivery (No. of years)	Project Completion Date (planned/actual)	Approximate project scope (Covered floor area/Cost etc.)	Level of technical complexity			Overall Performance			Sustainability performance			Interview participant ID	Role of participant/ participant's company in the project
						Low	Medium	High	Success	Failure	Mix	Achieved aspirations	Achieved more than aspirations	Achieved less than aspirations		
AE-A-1	UAE	Airport Terminal	4	2019	250,000 Sq. m.			x	x			x			AE-M-2	Sustainability Consultant
AE-I-1	UAE	Industrial facility	2	2012	Overall Covered Floor Area of complex= 11,000 Sq. m.		x		x			x			AE-M-4	Design consultant; Sustainability consultant
AE-M-1	UAE	Museum	3	2019	5000 Sq. m.			x	x			x			AE-M-1	Sustainability Consultant
AE-O-1	UAE	Office Building	1.3	2016	80,000 Sq. ft		x		x						AE-F-1	Client
AE-O-2	UAE	Office Building	0.5	2018	400 Sq. m.		x		x						AE-F-1	Client
AE-O-3	UAE	Office Building	2.5		3 floors		x		x			x			AE-F-2	Design consultant; Sustainability consultant
AU-DE-1	Australia	Defence Project	6								x	x			AU-M-3	Sustainability Consultant
AU-DO-1	Australia	Student accommodation	1.7	2018	150 beds			x				x			AU-M-8	Project Manager
AU-E-1	Australia	Higher-Education facility	3	2017	28,000 sq. m GFA; 4 Floors			x	x			x			AU-M-8	Project Manager
AU-H-1	Australia	Health care facility	5	2017	8 acres site area										AU-F-7	Design consultant
AU-MU-1	Australia	Mixed-use development	1	2017	1300 sq. m				x			x			AU-F-7	Design consultant
AU-O-1	Australia	Office Building	2	2009	17 storeys; 11 floor office tower @ 1650 sq. metres of NLA per floor		x		x			x			AU-F-2	Design consultant
AU-O-10	Australia	Office Building		2016	200 Million Dollars; 32 floors		x					x			AU-M-9	Head contractor
AU-O-11	Australia	Office Building	1.5	2016			x					x			AU-F-8	Design consultant
AU-O-12	Australia	Office Building					x			x		x			AU-F-8	Sustainability Certification Assessor
AU-O-13	Australia	Office Building							x			x			HK-M-4	Design consultant
AU-O-2	Australia	Office Building	4	2010	16,000 Sq. m.		x		x				x		AU-M-3	Sustainability Consultant
AU-O-3	Australia	Office Building	5	2004	3000 Sq. m.						x	x			AU-M-3	MEP Consultant; Sustainability consultant
AU-O-4	Australia	Office Building			15 Floors; 27,850 Sq. m. NLA				x				x		AU-F-3	MEP Consultant; Sustainability consultant
AU-O-5	Australia	Office Building			5000 Sq. m.; 2 floor					x				x	AU-F-3	Sustainability Consultant

Project ID	Country	Project functional use	Duration of Project delivery (No. of years)	Project Completion Date (planned/actual)	Approximate project scope (Covered floor area/Cost etc.)	Level of technical complexity			Overall Performance			Sustainability performance			Interview participant ID	Role of participant/ participant's company in the project
						Low	Medium	High	Success	Failure	Mix	Achieved aspirations	Achieved more than aspirations	Achieved less than aspirations		
AU-O-6	Australia	Office Building	3		27 floors	x			x			x			AU-F-4	MEP Consultant; Sustainability consultant
AU-O-7	Australia	Mixed-use development	3	Ongoing	15,000 Sq. m.; 2 floors		x		x				x		AU-F-6	MEP Consultant; Sustainability consultant
AU-O-8	Australia	Office Building	2	2013	63000 sq. m; 320 Million \$			x	x			x			AU-M-7	Head contractor
AU-O-9	Australia	Mixed-use development	3	2006	3 Floors; 40 Million Dollars			x					x		AU-M-8	Project Manager
AU-R-1	Australia	Town house project	6	2021	150 housing units	x					x			x	AU-M-1	Developer; Design consultant; Head contractor
AU-S-1	Australia	Retail			600 Million Dollars				x				x		AU-M-4	Design consultant
AU-S-2	Australia	Retail	5	2019	12,500 sq. m			x							AU-M-6	Client
AU-S-3	Australia	Retail		2019	6000 sq. metres		x								AU-M-10	Sustainability consultant
HK-EX-1	Hong Kong	Exhibition building		2013					x						HK-M-7	Design consultant
HK-HE-1	Hong Kong	Higher-Education facility							x						HK-M-7	Design consultant
HK-HE-2	Hong Kong	Higher-Education facility			GFA 45,000 m2			x							HK-M-2	Sustainability consultant
HK-O-1	Hong Kong	Office Building			13 floors		x								HK-M-2	Sustainability consultant
PK-I-1	Pakistan	Industrial facility	1.5	2017	50,500 Sq. ft; 500 Million PKR		x		x			x			PK-M-1	Design consultant; MEP Consultant; Sustainability consultant
PK-O-1	Pakistan	Office Building	1.1	2018	50,000 Sq. ft; 5 Million USD			x	x			x			PK-M-2	Head contractor
SN-H-1	Singapore	Health care facility	Ongoing	2020	250,000 sqm			x	x						SN-F-2	Sustainability consultant
SN-HE-1	Singapore	Higher-Education facility	Ongoing												SN-F-1	Client; Building-user
SN-MU-1	Singapore	Mixed-use development													HK-M-4	Design consultant
SN-O-1	Singapore	Office Building	3	2016	GFA: 4.5 million			x							SN-F-2	Design consultant; Sustainability consultant

Project ID	Country	Project functional use	Duration of Project delivery (No. of years)	Project Completion Date (planned/actual)	Approximate project scope (Covered floor area/Cost etc.)	Level of technical complexity			Overall Performance			Sustainability performance			Interview participant ID	Role of participant/ participant's company in the project
						Low	Medium	High	Success	Failure	Mix	Achieved aspirations	Achieved more than aspirations	Achieved less than aspirations		
UK-DO-1	UK	Student Accommodation	1.5	2016	26 Floors		x		x				x		UK-F-2	Sustainability Consultant; Sustainability Certification Assessor; Renewable feasibility consultant; Post-occupancy assessor
UK-E-1	UK	School Building	6	2017	2000 Sq. m.	x				x				x	UK-F-4	Sustainability Certification Assessor
UK-E-2	UK	School Building	2	2015			x		x				x		UK-M-1; UK-M-2	Sustainability Consultant
UK-HE-1	UK	Higher-Education facility	4	2017				x	x				x		UK-F-6	Sustainability Consultant
UK-HE-2	UK	Higher-Education facility	20	2020	2 B Pounds			x	x			x			UK-M-6	Sustainability Consultant
UK-MU-1	UK	Mixed-use development	6	2014	85M Pounds			x	x			x			UK-F-1	Energy Consultant; Sustainability Consultant
UK-O-1	UK	Office Building	1.5	2017	5 floors; 15,000 Sq. m.		x			x		x			UK-F-1	Sustainability Certification Assessor
UK-O-10	UK	Office Building	2.5	2017	40 M£			x	x					x	UK-M-7	Head contractor
UK-O-11	UK	Office Building	3	2018	70 M£			x		x		x			UK-M-7	Head contractor
UK-O-12	UK	Office Building	1	2015	10 M£	x			x			x			UK-M-7	Sustainability Consultant
UK-O-2	UK	Office Building	1.5	2016	Six Floors; 3,000 Sq. m.		x		x				x		UK-F-2	Sustainability Consultant; BREEM Assessor; Renewable feasibility consultant
UK-O-3	UK	Office Building								x		x			UK-F-3	
UK-O-4	UK	Office Building	3	2019	10,000 Sq. m.; 70 M Pounds		x		x						UK-F-4	Engineering Consultant (Structure, Civil, VT, Acoustics, MEP, Sustainability)
UK-O-5	UK	Office Building	7				x		x			x			UK-F-5	Design consultant
UK-O-6	UK	Office Building	2	2017	5000 Sq. m.			x	x			x			UK-F-6	Sustainability Consultant
UK-O-7	UK	Office Building	3	2015			x		x			x			UK-F-6	Sustainability Consultant
UK-O-8	UK	Office Building	5	2017	625 M Pounds			x	x			x			UK-M-5	Sustainability Consultant
UK-O-9	UK	Office Building	5	2017	615 M Pounds	x				x		x			UK-M-5	Sustainability Certification Assessor
UK-R-1	UK	Religious building	8	2016			x			x				x	UK-M-1; UK-M-2	Sustainability Consultant
UK-SC-1	UK	Retail	11		500 M Pounds				x			x			UK-F-3	

Appendix C

This appendix is related to Chapter 6 and provides a table explaining correlations among performance criteria indicated by survey participants. It also provides a table highlighting the Underlying conditions identified from the survey and semi-structured interviews.

C.1. Correlations among performance criteria

Table C.1: Correlations among performance criteria of Green Building projects¹

						Experience									Region														
						Overall (n=104)			0-10 Green Office experience			10+ Green Office experience			Australia (n=43)						India and Pakistan (n=19)			Singapore (n=18)			UAE (n=16)		
Correlations						Positive (%)	No Effect (%)	Negative (%)	Positive (%)	No Effect (%)	Negative (%)	Positive (%)	No Effect (%)	Negative (%)	Positive (%)	No Effect (%)	Negative (%)	Positive (%)	No Effect (%)	Negative (%)	Positive (%)	No Effect (%)	Negative (%)						
						Environmental Sustainability Performance	Performance affecting Social Sustainability	85	7	9	80	7	13	91	7	2	88	7	5	84	5	11	78	11	11	81	6	13	
Economic Sustainability Performance	Performance affecting Environmental Sustainability	78	16	6	79	16	5	77	16	7	81	14	5	84	16	0	67	28	6	88	6	6							
Social Sustainability Performance	Performance affecting Environmental Sustainability	77	14	9	77	15	8	77	14	9	74	14	12	84	11	5	67	17	17	88	13	0							
Quality Performance	Performance affecting Environmental Sustainability	76	18	6	77	20	3	74	16	9	70	26	5	89	11	0	61	28	11	94	6	0							
Social Sustainability Performance	Performance affecting Economic Sustainability	72	15	13	67	18	15	79	12	9	67	19	14	79	11	11	61	28	11	81	0	19							
Social Sustainability Performance	Performance affecting Quality Performance	71	27	2	74	23	3	67	33	0	63	37	0	79	16	5	67	33	0	88	13	0							
Quality Performance	Performance affecting Social Sustainability	64	29	7	62	31	7	67	26	7	74	23	2	68	21	11	33	61	6	63	25	13							
Environmental Sustainability Performance	Performance affecting Quality Performance	63	19	17	61	20	20	67	19	14	70	16	14	32	53	16	72	11	17	81	0	19							
Quality Performance	Performance affecting Economic Sustainability	63	25	12	66	25	10	60	26	14	63	28	9	63	16	21	50	44	6	81	13	6							
Environmental Sustainability Performance	Performance affecting Economic Sustainability	63	14	23	64	8	28	60	23	16	56	14	30	63	16	21	67	22	11	88	0	13							
Economic Sustainability Performance	Performance affecting Cost Performance	63	19	18	64	16	20	60	23	16	51	33	16	74	0	26	61	22	17	88	6	6							
Economic Sustainability Performance	Performance affecting Social Sustainability	62	29	10	61	28	11	63	30	7	63	30	7	74	21	5	50	39	11	63	25	13							
Economic Sustainability Performance	Performance affecting Quality Performance	62	27	12	62	25	13	60	30	9	53	35	12	79	11	11	50	44	6	69	13	19							

¹ Correlations listed in the descending order of the pattern strength

	Experience									Region											
	Overall (n=104)			0-10 Green Office experience			10+ Green Office experience			Australia (n=43)			India and Pakistan (n=19)			Singapore (n=18)			UAE (n=16)		
Positive (%)	No Effect (%)	Negative (%)	Positive (%)	No Effect (%)	Negative (%)	Positive (%)	No Effect (%)	Negative (%)	Positive (%)	No Effect (%)	Negative (%)	Positive (%)	No Effect (%)	Negative (%)	Positive (%)	No Effect (%)	Negative (%)	Positive (%)	No Effect (%)	Negative (%)	
Correlations																					
Schedule Performance affecting Cost Performance	62	17	21	62	18	20	60	16	23	53	21	26	68	11	21	67	17	17	63	19	19
Social Sustainability Performance affecting Schedule Performance	22	58	20	21	54	25	23	63	14	16	65	19	21	63	16	22	56	22	38	50	13
Schedule Performance affecting Social Sustainability Performance	26	56	18	31	54	15	19	58	23	14	63	23	47	47	5	17	67	17	38	44	19
Cost Performance affecting Economic Sustainability Performance	54	18	28	62	11	26	42	28	30	30	28	42	74	0	26	50	28	22	94	0	6
Economic Sustainability Performance affecting Schedule Performance	30	50	20	30	48	23	30	53	16	23	58	19	47	42	11	17	61	22	44	31	25
Environmental Sustainability Performance affecting Cost Performance	48	19	33	56	18	26	37	21	42	35	23	42	74	11	16	44	17	39	63	25	13
Cost Performance affecting Quality Performance	46	17	37	49	18	33	42	16	42	26	23	51	63	16	21	56	11	33	69	13	19
Schedule Performance affecting Environmental Sustainability Performance	29	46	25	36	43	21	19	51	30	16	51	33	58	42	0	17	50	33	38	38	25
Environmental Sustainability Performance affecting Schedule Performance	45	35	20	49	34	16	40	35	26	35	40	26	89	11	0	33	33	33	38	50	13
Cost Performance affecting Schedule Performance	44	32	24	48	28	25	40	37	23	42	35	23	42	37	21	44	28	28	50	25	25
Social Sustainability Performance affecting Cost Performance	43	25	32	44	23	33	42	28	30	28	37	35	63	5	32	44	28	28	56	13	31
Quality Performance affecting Cost Performance	36	21	43	44	16	39	23	28	49	19	33	49	63	16	21	33	22	44	50	0	50
Schedule Performance affecting Economic Sustainability Performance	41	41	17	44	36	20	37	49	14	23	53	23	68	26	5	33	50	17	63	19	19
Cost Performance affecting Environmental Sustainability Performance	39	29	32	49	28	23	26	30	44	21	28	51	68	26	5	33	50	17	63	13	25
Quality Performance affecting Schedule Performance	30	32	38	31	31	38	28	33	40	21	37	42	47	26	26	22	28	50	38	31	31
Cost Performance affecting Social Sustainability Performance	31	34	36	38	33	30	21	35	44	16	35	49	68	21	11	11	56	33	44	19	38
Schedule Performance affecting Quality Performance	35	35	31	39	30	31	28	42	30	12	47	42	63	26	11	33	28	39	56	19	25

C.2. Underlying conditions identified from online survey and semi-structured interviews

Table C.2: Underlying conditions identified from the survey and interviews

Representative conditions	Conditions identified from survey and interviews
Access to sustainable building materials	Limited tenders on sustainable materials; Local sourcing of materials
Adequate allocation of project budget	Appropriate budget allocation for project sustainability aspects
Adequate time allocation for project development	Appropriate delivery time allocation for the project
Attention towards details	Attention towards detailing, finishing and workmanship
Complexity in design	Increased innovation and complexity
Early incorporation of sustainability in project	Early design decisions involving green building concepts
Execution of commissioning and fine-tuning	Commissioning and tuning process
Execution of sustainable design during construction	Incorporation of predefined specifications
Focus on the capital cost of the project	Competitive cost-driven procurement; Inappropriately high cuts in capital cost
Focus on reducing operational costs	Inappropriately high operating and maintenance cost reductions
Involvement of project team in defining project requirements	Articulation of the deliverables by team members
Life-cycle based project development approach	Long term project considerations in project development
Material delivery time	Longer green material delivery time
Monitoring and controlling operational performance of building	Building maintenance and tuning upon handover
Monitoring of project development	Contract administration; Quality checks and audits
Motivation of Users towards sustainable outcomes	Occupants' learning and motivation for sustainability
Preferences in contractor's engagement	Appropriate contractor selection
Project team's understanding of project goals and aspirations	Detailed understanding of the project's vision; Understanding of quality targets by the project team; Misconceptions of the project design team
Rework because of poor workmanship	Re-working because of poor workmanship
Rigour of project design development	Better design and installation; Design specifications
Setting of a detailed sustainability charter or brief	Clear definition of project scope in documentation
Suitability of the project design for execution	Constructability considerations
Sustainability brief aligned with project budget	Congruence among cost planning and scope of work
System and material selection	Decisions related to equipment selections; Focus on the choice of materials and products; Use of materials with low VOCs; Use of non-standard materials, practices and requirements; Use of pragmatic solutions; Use of recycled materials; Restrained use of resources; Considerations towards product quality during selection; Use of systems with low emissions (because of low energy use)
Team working on project with value management mindset	Cost-benefit optimisation; Exercise to find suitable economic solutions
Use of clearly defined and standardised approaches for GB development	Using the formal process of a Green Building rating scheme; Compliance requirements
Use of energy-oriented design methodology	Use of energy-efficient building features and systems
Use of integrated design approach	Using an integrated and holistic design approach
Using appropriate project delivery method	Using the Fast-Track delivery approach; Using appropriate Procurement Methodology; Using appropriate project delivery process
Value Engineering exercise	Appropriately conducted Value Engineering exercises

Appendix D

This appendix is related to Chapter 8 and provides the tables describing the Success conditions and their reasons of importance; providing the network attributes of Success conditions; explaining the overall behaviour of the network upon the elimination of Success conditions; and provide the resemblance in findings of GB literature and the Success conditions identified in this study.

D.1. Description and reason for the importance of Success conditions

Table D.1.1 lists the reasons for the importance of Success conditions. Each reason for importance is further associated with the core reason/s of importance. It is possible for Success conditions to have different primary reasons for importance but have common core reason/s for importance. For instance, a sub-condition, 'Early involvement of commissioning professionals' is important as these professionals with knowledge of building commissioning can ensure from project start that the building performs according to design intent. Another sub-condition, 'Early engagement of design consultants in project' is important as these professionals have an overarching understanding of the project and can set the process of sustainable development. The core reason for the importance of both, 'Early involvement of commissioning professionals' and 'Early engagement of design consultants in project' is 'Provision of specialised knowledge of building development early in the project'. Table D.1.2 provides a detailed explanation of Success conditions. It is based on the analysis provided in Table D.1.1.

Table D.1.1: Description and reason for the importance of Success conditions

Theme	Sr.no	Condition title	Condition description	Reported reason of importance (Description)	Interpreted reason of importance
Changes during project development and fulfilling design intent	1	Change in project team members	Same project team members working on the project as it passes through different phases (i.e. Base building and fit-outs)	So that there is no risk of losing information related to project development in the form of team members leaving project midst of its development; so that synergies are created as the same team members work on the project during different phases of its development	Reducing the risk of information wastage; Establishing and promoting synergies
	2	Execution of sustainable design during construction	Ensuring the execution of sustainability features during project construction	So that the built form of the project follows aspirations and goals	Enabling the achievement of aspirations while constructing project
	3	Scope changes during project execution	Changes in project scope during project execution	Because changes in the project scope lead to the revision and reconsideration of different aspects of a project development which affect the aspired targets of budget and schedule performance	Enabling the achievement of aspirations while developing project
	3.1	Permanence in client's requirements during project delivery	Client's requirements not changing during project delivery	Because changes in requirements result in a revision and reconsideration of many aspects of project development; Change in client's requirements during project delivery results in variations of building design speculations from reality	Enabling the achievement of aspirations while developing project; Speculation in building design

Theme	Sr.no	Condition title	Condition description	Reported reason of importance (Description)	Interpreted reason of importance
	3.2	Client's motivation to achieve original project intent	Client's motivation to achieve originally aspired project goals	So that the project team can be driven towards the fulfilment of project goals even when it is challenging; Because it affects the completeness of project documentation for certification purpose	Enabling project team to pursue project goals; Completeness of project documentation for certification
Clarity in project development	4	Clarity in process of developing project	Transparency and clarity in the process of project development; Project team having clear understanding of how the project goals will be achieved	To enable the project team to focus its attention on project goals; To enable the alignment of team interests with project interest	Creating and using opportunities for efficiently achieving project outcomes; Alignment of team interest with project interest
	4.1	Use of clearly defined and standardised approaches for GB development	Following standardised approaches of Green Building development; Use of clearly defined approaches for GB development; Use of rating systems to define project goals; Having a project development strategy/plan from inception	To enable the project team to accomplish project goals in an effective way	Creating and using opportunities for efficiently achieving project outcomes
	5	Delegating clear responsibilities to project team	Delegating clear responsibilities to project team	So that the project team members can be held accountable for what they are required to achieve in project development	Alignment of team interest with project interest
	5.1	Project team contractually required to deliver sustainable outcomes	Project team contractually required to deliver sustainable project outcomes; Contractor contractually required to deliver sustainable project outcomes	So that project team members can be held accountable for what they are required to accomplish in project development	Alignment of team interest with project interest; Delegating clear responsibilities to project team
	5.2	Provision of sustainability specifications and other related information in the tender	Sustainability specifications and other related information provided in tender documents	So that the contractor can be held responsible for delivering sustainable features in the project; So that sustainability is focused on during project development and is not overlooked	Delegating clear responsibilities to project team; Reducing the risk of not meeting project requirements; Enabling the achievement of aspirations while constructing project
	5.3	Specificity of deliverables from Design Consultants	Well-defined deliverables required from design consultants	So that the design team can be held accountable for what they are required to deliver in the project; Because unclear deliverables from design consultants result in incomplete project design outcomes	Alignment of team interest with project interest; Delegating clear responsibilities to project team; Completeness and rigour of project design before execution; Reducing the risk of not meeting project requirements
Client's characteristics	6	Client's leadership in project	Client's leadership in project	So that the project team can be driven towards the fulfilment of project goals	Enabling project team to pursue project goals; Project team motivation to achieve sustainable outcomes
	7	Consensus within client organisation	Consensus within the Client's organisation regarding project features	So that the project requirements are clearly defined	Robust development of project goals, aspirations and requirements; Client's rational decision-making
	8	Proficiency of project client	Experience, knowledge and understanding of client in developing projects	Because an experienced client has links with building professionals engaged in previous projects and based	Provision of specialised knowledge of building development early in the project

Theme	Sr.no	Condition title	Condition description	Reported reason of importance (Description)	Interpreted reason of importance
Completeness and rigour of deliverables				on the existing liaison of client and building professionals a team can be developed to be involved early in project development; Because a client experienced in developing GBs can result in early engagement of contractor; Because an experienced client is aware of the requirements of a GB development	Early engagement of the contractor; Client's rational decision-making
	8.1	Client understanding the need of sustainable outcomes	Clarity in client's thinking that why sustainable outcomes are required	Because it motivates the client to pursue sustainability in the project; Because it results in the client's motivation to achieve original project intent	Client's motivation to achieve sustainable outcomes; Client's motivation to achieve original project intent; Client's rational decision-making
	8.2	Client's understanding of GB requirements	Client's understanding of what a GB project requires in terms of development	So that the client can make decisions which can lead to efficient and effective incorporation of sustainability in the project; To enable the timely incorporation of sustainability in project	Enabling the achievement of aspirations while developing project; Enabling integrated project development; Early incorporation of sustainability in project; Client's rational decision-making
	8.3	Client's understanding of sustainable building operation	Client's understanding of how to operate the GB upon delivery	To result in the operation of the building as aspired	Enabling the achievement of aspirations while operating project
	8.4	Client's rational decision-making	The ability of the client to make logical decisions related to project development; Willingness of client's organisation to make decisions	So that project procurement can be ensured in accordance with aspired outcomes	Enabling the achievement of aspirations while developing project; Enabling rigorous decision-making; Client's motivation to achieve original project intent
	9	Structure and nature of client organisation	Whether the client is public or private, developing a project for occupation or developing it to lease or sell it	Because it determines the drivers for a client to pursue sustainability in project	Client's motivation to achieve sustainable outcomes
	10	Completeness of project documentation for certification	Completeness of project documentation for certification	To result in the achievement of aspired sustainability certification for project	Enabling the achievement of aspired certification/s for the project
	11	Completeness and rigour of project design before execution	Well defined and complete project design before execution; Project design including sustainability initiatives	So that there is a low possibility of design-related problems during construction stage; So that the project goals can be effectively achieved by implementing the design in construction stage; Because it affects the suitability of the project design for execution	Rigour of project design development; Enabling the achievement of aspirations while developing project; Suitability of the project design for execution
	12	Setting of a detailed sustainability charter or brief	Setting of a detailed sustainability charter or brief; Sustainability incorporated in project agenda; Having a sustainability agenda or brief for the project; Documenting project goals; project brief based on needs of	So that the project team understands the sustainability objectives and works towards their achievement; So that sustainability is incorporated early in the project development	Enabling project team to pursue project goals; Early incorporation of sustainability in project; Project team's understanding of project goals and aspirations

Theme	Sr.no	Condition title	Condition description	Reported reason of importance (Description)	Interpreted reason of importance
Constraints			stakeholders such as operational staff, building users, and investors		
	13	Access to sustainable building materials	Access to sustainable building materials for use in project development	To ensure the use of aspired sustainable materials within the project budget	Enabling the achievement of aspirations while constructing project
	14	Accessibility of project funding	Availability of funding for project development	So that the project development is not constrained by the lack of funds	Enabling the achievement of aspirations while developing project
Cooperation and interest of stakeholders	15	Ease of logistics at project location	Availability of facilities and logistics at the project location	Since the facilities and logistics at the project location contribute towards fulfilling project aspirations	Enabling the achievement of aspirations while developing project
	16	Client's involvement in project development	Client's involvement in project development	So that the client can be aware of what the project will entail and how s/he needs to operate it in future; so that the client can facilitate the process of project development	Client's understanding of sustainable building operation; Enabling project team to pursue project goals; Client's understanding of GB requirements
	16.1	Client's facilitation of coordination among project team	Client's facilitation of coordination among project team	Since it ensures that the sustainability agenda advocated by sustainability consultants is taken seriously by the project team	Enabling project team to pursue project goals; Client's endorsement of sustainability brief; Project team motivation to achieve sustainable outcomes
	17	Client's motivation to achieve sustainable outcomes	Client's commitment towards sustainable outcomes	So that the project team can be driven towards the fulfilment of sustainability goals; Since it results in the accessibility of project funding; So that the sustainable features are less affected during the value engineering exercise	Enabling the achievement of aspirations while developing project; Accessibility of project funding; Thoroughness of value engineering exercise; Project team motivation to achieve sustainable outcomes
	17.1	Client's endorsement of sustainability brief	Client's endorsement of sustainability requirements in the project brief	So that the project team and end-users can be driven towards the fulfilment of sustainability goals	Enabling the achievement of aspirations while developing project; Project team motivation to achieve sustainable outcomes; End-users' motivation to achieve sustainable outcomes
	17.2	Drivers for client to achieve sustainable outcomes	Aspects driving the client towards the achievement of sustainable outcomes in project	Since it determines the client's motivation for sustainable outcomes	Client's motivation to achieve sustainable outcomes
	17.3	Investor's motivation to achieve sustainable outcomes	Motivation of Investor towards sustainable outcomes	So that there is enough funding to fulfil the sustainability goals in the project	Accessibility of project funding
	18	Cooperative role of building control authorities	Cooperative role of building control authorities towards project development	Since it results in building planning approvals and the provision of necessary infrastructure for meeting sustainable objectives in project	Enabling the achievement of aspirations while developing project
	19	End-users' operation of building in sustainable ways	End-users operating the building as it was intended during the design process	Since it results in the operation of the building as aspired	Enabling the achievement of aspirations while operating project
	19.1	End-users' motivation to achieve sustainable outcomes	Motivation of Users towards the achievement of sustainable outcomes in project	Since it becomes a driver for the project development team to pursue sustainability; Since it results in the sustainable operation of the building	Enabling the achievement of aspirations while operating project

Theme	Sr.no	Condition title	Condition description	Reported reason of importance (Description)	Interpreted reason of importance
Defining project goals					Project team motivation to achieve sustainable outcomes
	19.2	End-users' understanding of building operation	End-users understanding how to operate the building	Since it becomes easier for end-users to operate the building according to aspirations; Since it results in the building operator efficiently operating the building systems according to design intent	Enabling the achievement of aspirations while operating project; End-users' operation of building in sustainable ways
	19.3	Tenants contractually required to consider sustainability		So that the tenants take interest in sustainable development and operation of the project	End-users' operation of building in sustainable ways; End-users' motivation to achieve sustainable outcomes; Enabling the achievement of aspirations while operating project
	20	Stakeholders' approval of project	Stakeholders' approval of different project development aspects	As it results in the development of the project according to aspirations	Enabling the achievement of aspirations while developing project
	21	End-users' involvement in defining project aspirations	Involvement of building occupants in decision-making	So that appropriate targets are defined for the project; So that users can understand how the building will operate once developed; So that the end-users show an interest in project development	End-users' understanding of building operation; Robust development of project goals, aspirations and requirements; End-users' motivation to achieve sustainable outcomes; Reducing the risk of not meeting the operational aspirations of the project
	21.1	FM team involvement in defining project aspirations	Involvement of facility managers in defining project aspirations	So that appropriate targets are defined for the project	Robust development of project goals, aspirations and requirements; Reducing the risk of not meeting the operational aspirations of the project
	22	Project team involvement in defining project aspirations	Project Requirements decided in consensus with the project team	So that the team feels more connected to the project and is motivated to deliver project aspirations; So that the project during the goals-defining stage can benefit from the sustainability-related understanding and experience of the project team	Alignment of team interest with project interest; Project team's understanding of project goals and aspirations; Robust development of project goals, aspirations and requirements
	23	Setting appropriate project targets	Setting appropriate project targets; Setting project's sustainability targets in coherence with client's aspirations; Client's sustainability goals independent of GB certification systems; Development of project vision; Working on mutually beneficial outcomes for all main stakeholders	So that the project goals are aligned with the client's requirements; So that all the key stakeholders are satisfied from project development; So that the project outcomes are not affected by the limitations of GB certification systems	Robust development of project goals, aspirations and requirements
	23.1	Clarity in building's operational performance targets	Clarity in building's operational performance targets	So that the FM team/end-users can monitor operational performance and take steps to achieve the operational targets	Monitoring and controlling the operational performance of the building;

Theme	Sr.no	Condition title	Condition description	Reported reason of importance (Description)	Interpreted reason of importance
Design methodology					End-users' operation of building in sustainable ways; Reducing the risk of not meeting the operational aspirations of the project
	23.2	Nature of GB certification aspired for project		So that the sustainability aspirations in a project can be rigorously met	Enabling project team to pursue project goals; Creating and using opportunities for efficiently achieving project outcomes
	23.3	Sustainability brief aligned with project budget		So that sustainability features are not eliminated in later stages of project development to avoid cost overruns	Reducing the risk of not meeting project requirements
	23.4	Specificity of project requirements	Client being prescriptive of what s/he wants; Client providing specific details of the expected building performance; Project outcomes clearly defined at the project start; Having a well-defined project scope	So that project team understands the sustainability objectives and works towards their achievement; So that there are no ambiguities related to project goals; So that the operational outcomes of the project are in accordance with client's requirements	Enabling project team to pursue project goals; Project team's understanding of project goals and aspirations; Reducing the risk of not meeting the operational aspirations of the project
	24	Stringency level of project sustainability requirements	Stringency of the project's sustainability requirements	As it determines the ease with which project team fulfils project goals	Enabling the achievement of aspirations while developing project
	24.1	Stringency level of GB certification requirements	Stringency of sustainability requirements of GB certification	As it determines the ease with which project team fulfils project goals	Enabling the achievement of aspired certification/s for the project
	25	Market survey to identify successful building systems	Market survey to identify successful building systems	So that the building systems with better prospects can be incorporated in the project	Use of reliable technology and solutions; Creating and using opportunities for efficiently achieving project outcomes
	26	Rigour of project design development	Well-developed project design; Better design and installation; Well-developed Design specifications	So that the design outcomes can help achieve project outcomes when executed in construction	Enabling the achievement of aspirations while developing project
	26.01	Adding adaptability and multiple layers of use in building design	Adding adaptability and multiple layers of use in building design	So that the project can meet changing requirements of the client and end-users once it is operational	Rigour of project design development; Reducing the risk of not meeting the operational aspirations of the project
	26.02	Use of reliable technology and solutions	Use of reliable technology and solutions	So that project objectives can be achieved in a reliable way	Rigour of project design development; Reducing the risk of not meeting the operational aspirations of the project
	26.03	Design consideration towards future building usage	Future building usage considered in the design	So that the project can meet the changing requirements of the client once it is operational	Rigour of project design development; Reducing the risk of not meeting the operational aspirations of the project
	26.04	Level of complexity in project design	Avoiding complexity in design; Use of simplistic project design	So that the probability of problems in construction and operation of GB is reduced	Reducing the risk of not meeting project requirements; Enabling the achievement of aspirations while constructing project; Enabling the achievement of aspirations while operating project; Rigour of project design development

Theme	Sr.no	Condition title	Condition description	Reported reason of importance (Description)	Interpreted reason of importance
	26.05	Life-cycle based project development approach	Ensuring a life-cycle based project approach	So that sustainability outcomes can be achieved in project development	Enabling the achievement of aspirations while developing project; Rigour of project design development
	26.06	Maintainability considered in building design	Maintainability considered in building design	So that the project operation-related goals can be achieved	Rigour of project design development; Reducing the risk of not meeting the operational aspirations of the project
	26.07	Speculation in building design	Speculation in building design	As a project design based on realistic speculations can result in the achievement of aspired goals while a design based on unrealistic speculations results in failure of meeting aspired goals	Rigour of project design development; Reducing the risk of not meeting the operational aspirations of the project
	26.08	Suitability of the project design for execution	Suitability of the project design for execution; constructability considerations in the design	So that the design can be effectively executed on the site to fulfil project goals; So that there is a low possibility of design-related problems during construction stage; As an unsuitable project design can lead to scope changes during project execution	Rigour of project design development; Enabling project team to pursue project goals Scope changes during project execution
	26.09	Use of a proactive design approach	Avoiding the use of self-contradictory design approach; Using the proactive design approach and avoiding the approach of making mistakes and then correcting them	So that the project goals can be efficiently achieved (i.e. With minimum possible resources); Since complexity in design development can be avoided by using the proactive design approach and avoiding the approach of making mistakes and then correcting them	Rigour of project design development; Creating and using opportunities for efficiently achieving project outcomes; Level of complexity in project design
	26.1	Use of balanced design approach	Ensuring the use of balanced design approach considering mutually contradicting design objectives	So that different project goals may not contradict each other	Rigour of project design development; Creating and using opportunities for efficiently achieving project outcomes
	26.11	Use of context-oriented design approach	Ensuring the use of context-oriented design approach	So that the sustainability outcomes can be achieved in project development	Rigour of project design development; Creating and using opportunities for efficiently achieving project outcomes
	26.12	Use of energy-oriented design approach	Ensuring the use of energy-oriented design methodology; Ensuring the use of a design hierarchy which leads to efficient energy outcomes	So that the sustainability outcomes can be achieved in project development	Rigour of project design development; Reducing the risk of not meeting the operational aspirations of the project; Creating and using opportunities for efficiently incorporating sustainability in project
	26.13	Use of holistic design approach	Use of holistic design approach	So that the project goals can be efficiently achieved (i.e. With minimum possible resources); So that different project goals may not contradict each other	Rigour of project design development; Creating and using opportunities for efficiently incorporating sustainability in project
	26.14	Use of innovative design approach	Revisiting typical project design approach; Use of innovative design approach	So that the sustainability outcomes can be efficiently achieved in project development; So that the solutions with better prospects can be incorporated in project development	Rigour of project design development; Creating and using opportunities for efficiently achieving project outcomes
	26.15	Use of integrated design approach	Use of integrated design approach; System integration in building design	So that there is an increased value associated with building components; So that the sustainability outcomes can be effectively achieved in project development	Rigour of project design development; Creating and using opportunities for efficiently achieving project outcomes; Increasing the value of building components

Theme	Sr.no	Condition title	Condition description	Reported reason of importance (Description)	Interpreted reason of importance
Education	27	Use of performance-based specifications	Performance-based specifications equipment	So that there is flexibility in the procurement of materials and building systems	Enabling integrated project development; Creating and using opportunities for efficiently incorporating sustainability in project Enabling the achievement of aspirations while constructing project; Creating and using opportunities for efficiently achieving project outcomes
	28	Educating client about sustainability in project	Client educated about sustainability in the project; Demonstrating the ROI of sustainable solutions to the client; Client educated about the tangible and intangible benefits of GB development	So that the client can see value in sustainable development; So that the client is motivated to support the project team in sustainable development of project; So that the client can make decisions regarding sustainable development of project	Client's motivation to achieve sustainable outcomes; Client understanding the need of sustainable outcomes; Client's understanding of GB requirements; Enabling the achievement of aspirations while developing project
	29	Educating end-users and FM team about building operation	Facility management team learning in project design development about their future role in project operation; Users educated about sustainable operation of building; Building operation-related training of facility management team; Building operation-related knowledge sharing with the client; Building operators trained by Mechanical Design consultants to operate the mechanical systems according to design intent	So that the FM team and end-users understand the requirements of sustainably operating the building; So that the building can be operated sustainably to meet the project aspirations; So that the end-users' experience of using the building improves based on their understanding of how building systems work; Since it results in Smooth transition of the project from inception to operation stage; As the building operators trained by mechanical consultants to operate the mechanical systems according to design intent can help achieve the design intent	FM team motivation to achieve sustainable outcomes; End-users' motivation to achieve sustainable outcomes; End-users' understanding of building operation; Enabling the achievement of aspirations while operating project; Smooth transition of the project from inception to operation stage; End-users' operation of building in sustainable ways
	30	Educating project team about GB development	Bringing whole project team on the same page of understanding GB development; Orientation of project team regarding GB rating system requirements; Educating project team members unaware of GB development; Educating project team members about their role in the delivery of sustainable outcomes	So that the project team will know about the process of developing GB project; So that the project team will know their role in developing GB project; So that the project team is on the same page of understanding related to GB development	Proficiency of project team; Project team motivation to achieve sustainable outcomes; Project team's understanding of project goals and aspirations; Enabling the achievement of aspirations while developing project
	30.1	Educating contractors about GB development	Educating contractors unaware of GB development; Educating contractors of the intentions behind sustainable design	So that the contractors will know about the process of developing GB project; So that the contractors will know their role in developing a GB project; As educating contractors about GB development compensates their lack of awareness related to GB development	Proficiency of contractor; Contractor team motivation to achieve sustainable outcomes; Enabling the achievement of aspirations while constructing project
	30.2	Educating sub-contractors about GB development	Educating sub-contractors unaware of GB development; Head contractor discussing the building requirements with sub-contractors	So that the sub-contractors will know about the process of developing GB project; So that the sub-contractors will know their role in developing a GB project	Proficiency of sub-contractor; Contractor team motivation to achieve sustainable outcomes;

Theme	Sr.no	Condition title	Condition description	Reported reason of importance (Description)	Interpreted reason of importance
Engraving sustainability in project development	31	Engraving sustainability in project development	Adopting the approach of engraving sustainability in project development	Since increased value results from engraving sustainability instead of considering it in a bolt-on approach	Enabling the achievement of aspirations while constructing project Creating and using opportunities for efficiently achieving project outcomes; Use of integrated design approach
	32	Procurement of project site based on sustainability goals	Procurement of project site based on sustainability goals	So that an optimum site for the building project can help achieve sustainability goals	Enabling the achievement of aspirations while developing project; Engraving sustainability in project development
	33	Use of environmental management systems in construction	Use of well-developed environmental management systems in project construction	So that the sustainability objectives at the construction site can be fulfilled	Enabling the achievement of aspirations while developing project; Engraving sustainability in project development
Flow of project information	34	Clarity in communication of project goals	Clarity in the communication of project goals among project team	So that the project team knows what to deliver as the project outcome	Enabling project team to pursue project goals; Reducing the risk of not meeting project requirements
	35	Communication among project team	Communication among project team	So that different parties in the project team keep working together; So that different team members know how their work is related to the work of others; Because as a result of establishing an open and honest communication process with the design team early in the project, all the design team members can join the conversation defining sustainability goals of the project	Project team collaboration; Enabling integrated project development; Project team involvement in defining project aspirations
	35.1	Use of effective communication tools and strategies	Use of effective tools and strategies for communication among project team	So that different parties in the project team can work together; So that different team members know how their work is related to the work of others	Project team collaboration; Enabling integrated project development
	36	Project team's access to robust information	Project team's timely access to robust information regarding different aspects of project development, including building materials; Sharing of project information among project team	So that the project team can make rigorous decisions	Enabling rigorous decision-making
	36.1	Sharing of information related to project changes	Sharing of information regarding project changes among project team	So that the project team can see the changes being made and subsequently can provide an opinion of how these changes will affect the sustainability requirements	Reducing the risk of not meeting project requirements
	37	Smooth transition of project from inception to operation stage	Smooth transition of the project among different parties at different project stages	So that the loss of project-related information can be avoided as the project transition takes place from one party to another; So that it is possible to educate end-users and FM team about building operation	Enabling the achievement of aspirations while operating project; Reducing the risk of information wastage
	38	Inspection of project upon construction	Inspection of the project once construction is complete	So that the project aspirations are fulfilled during construction	Enabling the achievement of aspirations while operating project;

Theme	Sr.no	Condition title	Condition description	Reported reason of importance (Description)	Interpreted reason of importance
Inspection, monitoring, and control					Enabling the achievement of aspirations while developing project
	38.1	Execution of commissioning and fine-tuning	Performing commissioning and seasonal testing of the building; Performing fine-tuning of the building; Rigorous commissioning of Building Systems by a third party	So that when operational the building performs according to design intent	Enabling the achievement of aspirations while operating project; Reducing the risk of not meeting the operational aspirations of the project
	39	Monitoring and controlling operational performance of building	Third-party verification of building's operational performance; Monitoring and controlling the operational performance of building; Conducting a follow-through to ensure that users understand the sustainable operation of building; Conducting regular audits and reporting of the building's operational performance to ensure that it is performing as aspired	So that the end-users and the project client can know if the building in its operational life is performing as aspired; So that by follow-through it can be ensured that users understand the sustainable operation of the building	Reducing the risk of not meeting the operational aspirations of the project; End-users' operation of building in sustainable ways
	40	Monitoring of project development	Contract administration; Quality checks and audits; Monitoring of building construction; Keeping account of deliverables for different project stages; Using checkpoints for reviewing sustainable development; Regular site visits by the consultant and material review; Quality assurance and quality control during construction; Managing quality of design work from different consultants	To ensure that project team is held accountable for delivering the project as per aspirations; Monitoring of building construction results in Design and specifications effectively followed during construction; Monitoring of building construction compensates Contractor's lack of awareness of GB development	Enabling the achievement of aspirations while developing project; Reducing the risk of not meeting project requirements; Proficiency of contractor; Execution of sustainable design during construction
	40.1	Project reporting	Project reporting continued through different project stages; Reporting continued at regular intervals to see if project requirements are being met	To track project performance at different stages of development for seeing if project development is up to the expectations; to ensure that the need of following sustainability objectives is stated in project reporting so that project team continues to take interest in it	Enabling the achievement of aspirations while developing project; Reducing the risk of not meeting project requirements
	41	Review of project design by sustainability consultant	Sustainability consultant freely critiquing project design and other aspects; Sustainability consultant reviewing the project design and asking for revisions in case designs are inadequate	To ensure that design team fulfils sustainability objectives during project development; Sustainability consultant reviewing the project design and asking for revisions in case designs are inadequate can compensate Building services engineers not on-board in terms of project's sustainability objectives	Rigour of project design development; Reducing the risk of not meeting project requirements; Alignment of team interest with project interest
Planning approach	42	Thoroughness of value engineering exercise	Appropriately conducting Value Engineering exercises to reduce the risk of eliminating sustainable features	To ensure that the aspired sustainability features are not eliminated	Reducing the risk of not meeting project requirements; Increasing the value of building components
	43	Attention towards details	Focus on developing the project in an accurate way	It enables rigour and accuracy in project development	Enabling the achievement of aspirations while developing project

Theme	Sr.no	Condition title	Condition description	Reported reason of importance (Description)	Interpreted reason of importance
	44	Rigour of project planning	Project planning rigorously performed to consider all aspects of project development	To result in preparedness when the project is developed	Enabling the achievement of aspirations while developing project; Reducing the risk of not meeting project requirements
	44.1	Adequate budget allocation for project development	Allocation of project budget which aligns with project scope	To result in the fulfilment of all project requirements when the project is developed; to avoid the risk of eliminating project features because of later realisation that the allocated budget is not enough	Enabling the achievement of aspirations while developing project; Reducing the risk of not meeting project requirements
	44.2	Adequate time allocation for commissioning and testing	Allocation of time for commissioning and testing	To avoid the risk of inappropriate commissioning and testing	Execution of commissioning and fine-tuning
	44.3	Adequate time allocation for project development	Allocation of time for development which aligns with project scope	To result in the fulfilment of all project requirements when the project is developed; to avoid the risk of eliminating project features because of later realisation that the allocated time is not enough; Inadequate time allocation for project development results in incomplete project design before execution and lack of innovative design approach	Enabling the achievement of aspirations while developing project; Reducing the risk of not meeting project requirements; Completeness and rigour of project design before execution; Use of innovative design approach; Creating and using opportunities for corrective action
	45	Rigour of risk management	Conducting risk management in project	Reducing the risk of not meeting project requirements	Reducing the risk of not meeting project requirements
Team authorities, responsibilities, and contractual relationships	46	Control of project design by Design and Sustainability Consultant	Design and sustainability consultant having control over project design	So that these professionals can design the building systems which meet the sustainability aspirations	Reducing the risk of not meeting project requirements; Rigour of project design development
	47	Empowerment of sustainability consultant by client	Empowerment of sustainability consultant by the client; considering sustainability consultant as a coordinator for the project	So that the project team considers the sustainability objectives advocated by these professionals seriously	Enabling project team to pursue project goals; Reducing the risk of not meeting project requirements
	48	Project team's involvement in decision-making	Team involvement in decision-making regarding project development	To keep the project team motivated towards the project; to capitalise on the specialised knowledge of different team members for benefitting project	Enabling rigorous decision-making; Alignment of team interest with project interest
	49	Using appropriate project delivery method	Using a PDM appropriate for project conditions	To result in contractual interrelationships of project team and client which can benefit a project	Alignment of team interest with project interest
	49.1	Contractual interrelationships between client and project team	Contractual interrelationships between client and project team	To result in contractual interrelationships of project team and client which can benefit a project	Alignment of team interest with project interest
Team characteristics	50	Like-mindedness of project team members	Like-mindedness of team members working on GB project	So that the project team members can effectively collaborate	Project team collaboration
	51	Proficiency of FM team	Knowledge and understanding of the Facility Management team regarding the operation of GB project	So, the professionals are aware of how to effectively operate the GB project	Enabling the achievement of aspirations while operating project

Theme	Sr.no	Condition title	Condition description	Reported reason of importance (Description)	Interpreted reason of importance
	52	Proficiency of project team	Project team's awareness, technical expertise and experience of developing GBs; Project team's awareness of sustainability frameworks and GB certifications	Because the project team can strive towards successful development and certification of GB project using its expertise and knowledge of GB development.	Enabling project team to pursue project goals
	52.1	Leadership qualities among project team members	Leadership qualities among project team members to pursue project goals and to push status-quo and innovate	So that the project team can work on innovative solutions; so that the project team can focus on goals even in challenging circumstances	Enabling project team to pursue project goals; Creating and using opportunities for efficiently achieving project outcomes
	52.2	Proficiency of contractor	Proficiency of contractor to bridge knowledge gaps; Contractor's proficiency to look for sustainability compliance by sub-contractors; Contractor's awareness of GB development; Contractor experienced in developing GB projects; Contractor's ability to adopt a good documentation procedure for GB projects; Contractor's ability to understand the building design intent	So that contractor can monitor whether the deliverables from sub-contractors and suppliers meet the sustainability aspirations of the project; so that the contractor can complete the documentation required for GB certification; so that contractor can bridge knowledge gaps in design documentation to deliver the project according to expectations; Head contractor proficient to look for sustainability compliance by sub-contractors can compensate Lack of expertise of sub-contractors; Proficiency of contractor to bridge knowledge gaps compensates incomplete design before execution	Execution of sustainable design during construction; Reducing the risk of not meeting project requirements; Proficiency of sub-contractor; Completeness and rigour of project design before execution
	52.3	Proficiency of design consultant	Design consultant's awareness of local regulations; Design consultant's awareness of design requirements regarding efficient MEP systems; Design consultant's understanding and expertise of GB development process and GB certification process	So that these professionals can create conditions for other design consultants (i.e. MEP consultants) to achieve higher efficiencies in building systems; So that these professionals can design the project such that it meets the sustainability aspirations; So that these professional aware of local regulations can avoid the regulatory barriers; Design consultant's awareness of design requirements regarding efficient MEP systems results in the use of energy-oriented design methodology; Design consultant's understanding of GB development compensates Client's understanding of GB requirements; Engagement of proficient design consultant results in a complete Project design before execution	Enabling project team to pursue project goals; Reducing the risk of not meeting project requirements; Rigour of project design development; Use of energy-oriented design approach; Client's understanding of GB requirements; Completeness and rigour of project design before execution
	52.4	Proficiency of MEP consultant	MEP consultant's experience of working on GBs; problem rectification experience of MEP consultants; Ability to make better design speculations	So that these professionals can design the building systems which meet the sustainability aspirations; So that these professionals are able to rectify potential problems in building systems once the project is operational	Rigour of project design development; Reducing the risk of not meeting project requirements; Enabling the achievement of aspirations while operating project
	52.5	Proficiency of PM team	Project Management team's ability to discern good and bad design; Project Management team's understanding of the suitability of project task delegation among	So that these professionals can check if the design is being rigorously developed to meet project aspirations; So that these professionals can delegate responsibilities to suitable professionals in the project development; So that these professionals	Rigour of project design development; Creating and using opportunities for efficiently achieving project outcomes; PM team motivation to achieve sustainable outcomes

Theme	Sr.no	Condition title	Condition description	Reported reason of importance (Description)	Interpreted reason of importance
			different team members; Project manager team's experience of delivering GBs	know the requirements of GB development and can focus their attention towards fulfilling sustainability outcomes	
	52.6	Proficiency of sub-contractor	Sub-contractor's awareness and expertise of GB development	So that these professionals can deliver the project tasks assigned to them while meeting sustainability aspirations	Execution of sustainable design during construction; Reducing the risk of not meeting project requirements
	52.7	Proficiency of sustainability consultant	Ability of sustainability consultant to engage with project team; Sustainability consultant's experience of GBs	So that these professionals advocating sustainability in the project can lead the project team to deliver sustainable outcomes	Enabling project team to pursue project goals; Reducing the risk of not meeting project requirements
	53	Project team's understanding of project goals and aspirations	Project team's understanding of project goals and aspirations	It can enable the team to work towards the achievement of goals	Enabling project team to pursue project goals
	54	Size of design team	The size of design team working on a project	Because the coordination among a bigger design team is difficult as compared to a smaller design team	Project team collaboration
Team collaboration	55	Conflicts among project team	Misunderstandings among project team members	It affects the project team's ability to work together for achieving project goals	Project team collaboration
	56	Project team collaboration	Project team collaboration	It reduces the risk of design-sub optimisation; it can ensure the use of integrated design approach	Enabling integrated project development; Reducing the risk of information wastage; Use of integrated design approach
	56.1	Liaison between design team and client	Design consultant liaising with Client on sustainable building aspects	It enables a trust of the client on design consultant resulting in consultant's ability to incorporate sustainable building features	Creating and using opportunities for efficiently incorporating sustainability in project
	56.2	Liaison between FM team and project development team	Facility management team communicating with the project development team about operational performance of building	It enables a long-term assessment of building sustainability spanning from project development to operation	Monitoring and controlling operational performance of building
	56.3	Liaison between sustainability consultant and client	Sustainability Consultant communicating with the project client	It results in mutual understanding of sustainability consultant and client that which sustainability targets to pursue	Project team involvement in defining project aspirations
	56.4	Liaison between sustainability consultant and contractor team	Sustainability consultant liaising with the contractor team	It enables sustainability consultant to lead the project team towards sustainability objectives	Enabling project team to pursue project goals; Educating contractors about GB development
	56.5	Liaison between sustainability consultant and design consultant	Sustainability consultant liaising with Design Consultant	It enables collaboration between Sustainability Consultant and Design Consultant	Project team collaboration
	56.6	Liaison between sustainability consultant and project team	Sustainability consultant liaising with the project team	It enables sustainability consultant to lead the project team towards sustainability objectives	Enabling project team to pursue project goals
	56.7	Willingness of project team to work together	Project team willing to work together for achieving project outcomes	It enables the project team to support sustainability agenda advocated by sustainability consultant; It enables a better communication among project team	Project team collaboration; Enabling integrated project development

Theme	Sr.no	Condition title	Condition description	Reported reason of importance (Description)	Interpreted reason of importance
Team commitment to the project	57	Alignment of team interest with project interest	Interests of project team aligned with project goals	So that the project team is motivated to achieve project goals; Misalignment of the design team's interest with project interest results in incomplete design before execution	Enabling project team to pursue project goals; Completeness and rigour of project design before execution
	57.1	Rewards for achieving performance targets	Incentivising project team	So that the project team works towards project goals collaboratively	Project team collaboration; Alignment of team interest with project interest
	58	Contractor's proactive role in project development	Contractor able to foresee and avoid potential risks in project	It enables the contractor to deliver project outcomes such that the aspirations are met; it ensures the completion of project documentation for certification	Reducing the risk of not meeting project requirements; Completeness of project documentation for certification
	59	FM team motivation to achieve sustainable outcomes	Facility management team operating a GB project with special consideration	So that these professionals can contribute towards meeting operational outcomes of the project	Enabling the achievement of aspirations while operating project
	60	Project team motivation to achieve sustainable outcomes	Motivation of the project team towards sustainable development of project	So that the project team can strive to meet sustainable outcomes in the project; so that the focus of project team towards sustainability is maintained	Enabling project team to pursue project goals
	60.1	Contractor team motivation to achieve sustainable outcomes	Motivation of Contractor, Sub-contractors and Suppliers towards sustainable outcomes	So that the contractor team can strive to meet sustainable outcomes in the project; it enables educating sub-contractors about GB development; so that the focus of contractor team towards sustainability is maintained	Execution of sustainable design during construction; Enabling project team to pursue project goals; Educating sub-contractors about GB development
	60.2	Design Consultant's motivation to achieve sustainable outcomes	Motivation of Design Consultant towards sustainable outcomes	So that the Design Consultant can develop a design which meets sustainability requirements	Rigour of project design development; Enabling project team to pursue project goals
	60.3	MEP Consultant's motivation to achieve sustainable outcomes	Motivation of MEP Consultants to deliver sustainable outcomes	So that the MEP Consultants can develop a design which meets sustainability requirements	Rigour of project design development; Enabling project team to pursue project goals
	60.4	PM team motivation to achieve sustainable outcomes	Motivation of the Project Management team to deliver sustainable outcomes	So that the focus of the project team towards sustainability is maintained	Enabling project team to pursue project goals
	60.5	Sustainability Consultant's motivation to achieve sustainable outcomes	Motivation of Sustainability Consultant towards sustainable outcomes	It enables sustainability consultant to lead the project team towards sustainability objectives	Enabling project team to pursue project goals
Team mindset and priorities	61	Establishing and promoting synergies	Developing the project in such a way that the whole that is greater than the sum of its parts	It enables building components to have increased value	Increasing the value of building components
	62	Focus of sustainability consultant on project goals	Sustainability Consultant having a focus on project goals and able to distinguish important aspects from unimportant aspects in project	It enables these professionals to deliver aspired sustainability outcomes in project	Enabling the achievement of aspirations while developing project

Theme	Sr.no	Condition title	Condition description	Reported reason of importance (Description)	Interpreted reason of importance
	63	Open-mindedness and flexibility of project team	Readiness of project team to accept new ideas and new ways of developing project	It can enable the team to work on approaches of project development with better prospects; It can enable project team to listen to each other's ideas; Open-mindedness and flexibility of design team members to accept each other's opinions results in Establishing an open and honest communication process with design team early in project	Creating and using opportunities for efficiently achieving project outcomes; Project team collaboration; Communication among project team
	64	Priority of sustainability in project development	Team focused on achieving sustainable outcomes even though other objectives (such as on-time delivery, within budget delivery, building aesthetics) have to be compromised	It drives the project team to achieve sustainability in project development; Priority towards project sustainability results in the use of energy-oriented design methodology	Enabling the achievement of aspirations while developing project; Use of energy-oriented design approach
	65	Team working on project with innovative mindset	Team thinking of project innovatively instead of thinking of the project in terms of business as usual	It can result in solutions and approaches of project development with better prospects	Creating and using opportunities for efficiently achieving project outcomes
	66	Team working on project with value management mindset	Project team considering the effect of project features on cost	It can reduce the risk of project feature elimination in the later stages of development	Reducing the risk of not meeting project requirements
	67	Involvement of sustainability consultant in contractor's selection	Sustainability consultant providing advice in the selection of contractors	It can result in engaging professionals proficient in constructing GBs	Selecting professionals suitable for the job
	68	Preferences in project team selection	Careful selection of project team based on some criteria	It can result in engaging a project team proficient in GB development; It can result in engaging a project team which is able to effectively collaborate for delivering the project	Selecting professionals suitable for the job
Team procurement methodology	68.1	Long-term engagement of sustainability consultant	Engagement of sustainability consultant in the project until project delivery	The professionals advocating sustainability when engaged for the entire duration of project development can ensure that sustainability aspirations are incorporated in project; Enabling a continuous focus on sustainability while developing project	Priority of sustainability in project development
	68.2	Preferences in consultant's engagement	Careful selection of consultants on different criteria (i.e. Ability to deliver GBs; perception of GBs; ability to collaborate; multidisciplinary appointment of consultant organisation to ease collaboration; Appointing consultants in close proximity to ease collaboration)	It can result in engaging professionals proficient in designing GBs; It can result in engaging professionals who can effectively collaborate for delivering the project	Selecting professionals suitable for the job
	68.3	Preferences in contractor's engagement	Careful selection of contractors on different criteria (i.e. Ability to deliver GBs; perception of GBs; Previous experience of delivering GBs)	It can result in engaging professionals proficient in constructing GBs	Selecting professionals suitable for the job; Enabling the achievement of aspirations while constructing project

Theme	Sr.no	Condition title	Condition description	Reported reason of importance (Description)	Interpreted reason of importance
	68.4	Pre-qualification of contractors and sub-contractors	Careful selection of contractors and Sub-contractors on different criteria (i.e. Ability to deliver GBs; Previous experience of delivering GBs)	It can result in engaging professionals proficient in constructing GBs	Selecting professionals suitable for the job; Enabling the achievement of aspirations while constructing project
	68.5	Requirement for contractor to engage a sustainability advisor	Contractor team having professionals with expertise in sustainable development	It can result in engaging professionals proficient in constructing GBs	Selecting professionals suitable for the job
Timeliness of project activities	69	Early engagement of project team	Early engagement of project team	The professionals with knowledge of different aspects of the project can help define and monitor the process of development	Provision of specialised knowledge of building development early in the project
	69.1	Early engagement of commissioning professionals	Early involvement of commissioning professionals	The professionals with knowledge of building commissioning can ensure from project start that the building performs according to design intent	Provision of specialised knowledge of building development early in the project
	69.2	Early engagement of contractor	Early engagement of contractor in the project	The professionals with knowledge of building construction and material procurement can review the project design from the viewpoint of constructability and cost-effectiveness; It ensures early engagement of suppliers and sub-contractors; It ensures access to sustainable building materials	Provision of specialised knowledge of building development early in the project; Early engagement of suppliers; Access to sustainable building materials; Early engagement of sub-contractor
	69.3	Early engagement of design consultants	Early engagement of design consultants in project	The professionals having an overarching understanding of the project can set the process of sustainable development	Provision of specialised knowledge of building development early in the project
	69.4	Early engagement of FM team	Early engagement of facility management team	The professionals having an understanding of building operation can advise design team by reviewing design from building operations and maintenance viewpoint; it can result in educating end-users and FM team about building operation; it can result in FM team involvement in defining project aspirations; it can result in client's understanding of GB requirements; It can result in increased understanding of the professionals of how to operate the GB project upon its delivery	Provision of specialised knowledge of building development early in the project; Enabling the achievement of aspirations while operating project; Educating end-users and FM team about building operation; FM team involvement in defining project aspirations; Client's understanding of GB requirements
	69.5	Early engagement of sub-contractor	Early engagement of sub-contractor in project	The professionals with specialised knowledge of different building elements can review project design from the perspective of constructability and cost-efficiency	Provision of specialised knowledge of building development early in the project
	69.6	Early engagement of suppliers	Early engagement of suppliers in the project	The professionals aware of innovative building systems and materials create the opportunity of increased building efficiency	Provision of specialised knowledge of building development early in the project
	69.7	Early engagement of sustainability consultant	Early engagement of sustainability consultant	The professionals advocating sustainability can help establish the process of sustainable development from the start of project; it results in Setting project's sustainability targets in coherence with client's	Provision of specialised knowledge of building development early in the project; Setting appropriate project targets

Theme	Sr.no	Condition title	Condition description	Reported reason of importance (Description)	Interpreted reason of importance
				aspirations; it results in Project design including sustainability initiatives; it results in Early introduction of project targets; it results in Early incorporation of sustainability in the project; it results in Educating the client about sustainability in the project; It also results in more opportunities of incorporating sustainability in project design at low cost	Completeness and rigour of project design before execution; Early introduction of project targets; Early incorporation of sustainability in project; Educating client about sustainability in project
	70	Early introduction of project targets	Early introduction of project targets	Project requirements can be integrated well within the project development process	Creating and using opportunities for efficiently incorporating sustainability in project; Following a logical order of project activities
	70.1	Client's early decision-making regarding sustainability goals	Client's early decision-making regarding sustainability goals	Project requirements can be integrated well within the project development process	Creating and using opportunities for efficiently incorporating sustainability in project
	70.2	Early incorporation of sustainability in project	Early incorporation of sustainability in project	More opportunities of incorporating sustainability in project design at low cost are created; it results in Use of energy-oriented design methodology; it results in Use of integrated design approach; it results in Misalignment of team interest with project interest	Creating and using opportunities for efficiently incorporating sustainability in project; Use of energy-oriented design approach; Use of integrated design approach; Alignment of team interest with project interest; Following a logical order of project activities
	71	Timeliness of building approval	Building approval in scheduled time	Construction activity can only start once a building has planning approval	Following a logical order of project activities
	72	Timeliness of feedback on sustainability documentation	Feedback on sustainability documentation available on time	It creates opportunities for corrective actions	Creating and using opportunities for corrective action
	73	Timely submission of GB certification documentation for review	Submission of GB certification documentation for review according to scheduled time	It creates opportunities for corrective actions; Timely submission of GB certification documentation for review results in a timely feedback on sustainability documentation	Creating and using opportunities for corrective action; Enabling the achievement of aspired certification/s for the project; Timeliness of feedback on sustainability documentation

Table D.1.2: Detailed explanation of Success conditions

Theme	Sr.no	Condition title	Is a sub-condition of the above	Relevant Figure	Detailed explanation
Changes during project development and fulfilling design intent	1	Change in project team members	No	Figure 8-4	Change in project team members: The likelihood of project success increases in case the team members remain unchanged as the project develops. GB project success may also result if the same design and sustainability team works on the base building as well as the fit-outs. This condition is important as the knowledgeable team members may not leave during the project development, therefore, reducing the risk of losing project information. Further, as the same people work on the project during the different phases of its development, team synergies are created.
	2	Execution of sustainable design during construction	No		Execution of sustainable design during construction: GB project success is enabled when the project design is effectively executed in the construction stage and the contractor follows the design specifications. This condition is important as it ensures that the built form of the project follows the aspirations and goals.
	3	Scope changes during project execution	No		Scope changes during project execution: GB project success is enabled by minimising scope changes during project execution and ensuring that the project design remains unchanged. The importance of this condition is that the changes in project scope may lead to the revision and reconsideration of different aspects of project development eventually affecting the aspired targets of budget and schedule performance.
	3.1	Permanence in client's requirements during project delivery	Yes		Permanence in client's requirements during project delivery: GB project success can be enabled if the client's requirements remain unchanged as the project is being developed. The importance of this condition is that it helps avoid the changes in project scope. This condition is also important for the operational performance of the project. This is because when the client's requirements change during the project delivery, this increases the gap between design speculations and reality; hence, the operational performance of the project may not be as expected.
	3.2	Client's motivation to achieve original project intent	Yes		Client's motivation to achieve original project intent: GB project success is enabled in case the client is motivated to achieve the original project intent. This condition is important since it drives the project team towards the project goals even in challenging circumstances. Further, a client motivated to achieve the original project intent, can ensure the completeness of project documentation for GB certification purpose.
Clarity in project development	4	Clarity in process of developing project	No	Figure 8-5	'Clarity in process of developing project' is a condition related to project team and client. This condition also represents a <i>cluster</i> having a sub-condition i.e. 'Use of clearly defined and standardised approaches for GB development'. This condition implies that for realising the successful achievement of project outcomes transparency needs to be ensured in the process of project development. The importance of this condition is that it ensures a team focus on project goals and enables the alignment of team interests with project interest.
	4.1	Use of clearly defined and standardised approaches for GB development	Yes		'Use of clearly defined and standardised approaches for GB development' is a sub-condition related to project team and client. The condition implies that for project success, a project development strategy or plan should exist from the project outset and a standardised and clearly-defined approach of GB development should be followed. In this regard, a green certification system can be used to define project goals. This sub-condition is important as it enables the project team to accomplish project goals in an effective way.
	5	Delegating clear responsibilities to project team	No		'Delegating clear responsibilities to project team' is a condition related to the project team and represents a <i>cluster</i> having three sub-conditions. This condition means that the project-related activities need to be clearly delegated to project team members. It is important as this way the project team can be held accountable for what they are required to achieve in a project.
	5.1	Project team contractually required to deliver sustainable outcomes	Yes		'Project team contractually required to deliver sustainable outcomes' is also a sub-condition related to the project team. According to this, the project team and particularly the contractor team should be contractually required to deliver sustainable outcomes. The importance of this sub-condition is that the project team can be held contractually accountable for what they are required to accomplish in project development.

Theme	Sr.no	Condition title	Is a sub-condition of the above	Relevant Figure	Detailed explanation
	5.2	Provision of sustainability specifications and other related information in tender	Yes		'Provision of sustainability specifications and other related information in tender' is a sub-condition related to the contractor team. This sub-condition means that the necessary project-related information needs to be provided in tender documents. The importance of this sub-condition is that the contractor can be held responsible for delivering sustainable features in a project. Moreover, as a result of this sustainability is focused on during project development and is not overlooked.
	5.3	Specificity of deliverables from Design Consultants	Yes		'Specificity of deliverables from Design Consultants' is a sub-condition related to the design team. This sub-condition implies that the specific deliverables required from the design team can ensure project success while the ambiguities in those deliverables can result in project failure. The importance of this is that the design team can be held accountable for what they are required to deliver in the project. Moreover, it can reduce the possibility of incomplete project design outcomes resulting from unclear deliverables.
Client's characteristics	6	Client's leadership in project	No	Figure 8-6	'Client's leadership in project' implies that GB project success is associated with the condition that the client uses leadership skills during project development. This condition is important as it can drive the project team towards the fulfilment of project goals.
	7	Consensus within client organisation	No		'Consensus within client organisation' implies that GB project success is associated with the condition that there is agreement among members of the client team regarding project development and the project faces no bureaucratic hindrances from the client organisation. The importance of this condition is that it can help clearly define the project requirements.
	8	Proficiency of project client	No		'Proficiency of project client' implies that GB project success is associated with the conditions that the client is experienced in developing GB projects or construction projects in general, and the client possesses the ability to discern good and bad design. This condition is important because an experienced client is aware of the requirements of a GB development. A client experienced in developing GBs can also lead to early engagement of a contractor. This is because an experienced client has links with building professionals engaged in previous projects and based on the existing liaison of client and building professionals a team can be developed to be involved early in project development.
	8.1	Client understanding the need of sustainable outcomes	Yes		'Client understanding the need for sustainable outcomes' implies that GB project success is associated with the clarity in the client's thinking that why sustainable outcomes are required. The importance of this sub-condition is that it motivates the client to pursue sustainability in the project; and also because it results in the client's motivation to achieve the original project intent.
	8.2	Client's understanding of GB requirements	Yes		'Client's understanding of GB requirements' implies that GB project success is associated with the client's understanding of GB projects and the requirements related to the development of such projects. This sub-condition is important because the client can make decisions which can lead to efficient and effective incorporation of sustainability in the project. Moreover, because of this, the early incorporation of sustainability in a project can be achieved.
	8.3	Client's understanding of sustainable building operation	Yes		'Client's understanding of sustainable building operation' implies that GB project success is associated with the understanding of the client team to sustainably operate the building. This sub-condition is important because it can lead to the aspired operational performance of the building.
	8.4	Client's rational decision-making	Yes		'Client's rational decision-making' implies that GB project success is associated with the sub-conditions that the client's decision-making is based on logical reasoning instead of prejudices; client's organisation can confidently make project decisions, including the decision about project innovation; client's confidence in sustainable solutions; and client's willingness to follow project guidelines. The importance of this sub-condition is that it contributes to the project procurement in accordance with aspired outcomes.
	9	Structure and nature of client organisation	No		'Structure and nature of client organisation' implies that GB project success is associated with the conditions that a client is a private or a public organisation; the client's mindset is to occupy the building upon development, lease it or sell it; and the variations in viewpoints of the decision-makers within the client organisation. The importance of this condition is that it determines the drivers for a client to pursue sustainability in the project.

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Completeness and rigour of deliverables	10	Completeness of project documentation for certification	No	Figure 8-7	'Completeness of project documentation for certification' is a condition related to the project team and implies that the level of completion of project documentation for GB certification can determine the successful achievement of project outcomes. The importance of this condition lies in the fact that it results in the achievement of aspired sustainability certification for a project.
	11	Completeness and rigour of project design before execution	No		'Completeness and rigour of project design before execution' is a condition related to the design team and contractor team. This condition means that for realising successful project outcomes the project design needs to be complete and in a well-defined form before the start of execution. Moreover, before execution, the project design needs to be complete in terms of sustainability initiatives. This condition is important as it contributes towards the suitability of the project design for execution and reduces the possibility of design-related problems during the construction stage. Furthermore, by helping implement the project design in construction stage this condition contributes towards the effective achievement of project goals.
	12	Setting of a detailed sustainability charter or brief	No		'Setting of a detailed sustainability charter or brief' is a condition related to the project client. This condition implies that for achieving project success a detailed sustainability charter or brief is to be developed or sustainability is to be incorporated in the project agenda. Moreover, project goals are to be documented, and project brief is to be based on the needs of stakeholders such as operational staff, building users, and investors. The importance of this condition is that it contributes to the project team's understanding and support for the achievement of sustainability objectives. Furthermore, it contributes towards the early incorporation of sustainability in the project development.
Constraints	13	Access to sustainable building materials	No	Figure 8-8	'Access to sustainable building materials' is a condition related to the design team and suppliers. This is because it is the prerogative of the design team to specify building systems and materials and the suppliers have a role in the procurement of those systems and materials. This condition implies that the failure to achieve aspired project outcomes can result from a lack of access to sustainable building materials. The lack of sustainable material access also means the limited tender submissions for building materials and restrained sourcing of locally available materials. The importance of this condition is that it ensures the use of aspired sustainable materials within the project budget.
	14	Accessibility of project funding	No		'Accessibility of project funding' is a condition related to the project client since a client is often the party in control of project funds. This condition means that the availability of project funding can determine the achievement of project outcomes. The importance of this condition is that it enables the development of the project as originally planned.
	15	Ease of logistics at project location	No		'Ease of logistics at project location' is a condition affecting a project not only during its development but also in its operation and therefore it is related to the project client as well as end-users. This condition implies that for achieving a successful project development and operation it needs to have an easily accessible location from the logistics viewpoint. The importance of this condition is that the facilities and logistics at the project location contribute towards fulfilling project aspirations.
Cooperation and interest of stakeholders	16	Client's involvement in project development	No	Figure 8-9	'Client's involvement in project development' implies that GB project success is associated with the condition that client's engagement in the project is throughout the design process and the client is directly involved in sustainability-related aspects of project development. This condition is important as it enables the client to be aware of what the project will entail and how s/he needs to operate it in future. Moreover, it enables the client to facilitate the process of project development.
	16.1	Client's facilitation of coordination among project team	No		'Client's facilitation of coordination among project team' implies that GB project success is associated with the case that the client facilitates the coordination among project team members. This sub-condition is important since it ensures that the sustainability agenda advocated by sustainability consultants is taken seriously by the project team.
	17	Client's motivation to achieve sustainable outcomes	No		'Client's motivation to achieve sustainable outcomes' implies that GB project success is associated with the conditions that the client is motivated and convinced of sustainable development; the client has firm thinking regarding sustainability requirements in the project; and the client considers GB as a special building significantly different from a traditional building. This condition is important as because of this, the project team can be driven towards the fulfilment of sustainability goals; the accessibility of project funding can be ensured; and the sustainable features are less affected during the value engineering exercise.

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	17.1	Client's endorsement of sustainability brief	Yes		'Client's endorsement of sustainability brief' implies that GB project success is associated with the case that the client endorses the sustainability brief and mandates the tenants to follow sustainability guidelines. This sub-condition is important as it can ensure that the project team and end-users can be driven towards the fulfilment of sustainability goals.
	17.2	Drivers for client to achieve sustainable outcomes	Yes		'Drivers for client to achieve sustainable outcomes' implies that GB project success is associated with the motivations for a client to achieve sustainability in the project. It is identified that some drivers positively contribute to sustainable outcomes. These drivers include the client's motivation to showcase project; the client's stakes in operational performance; potential tenants' formal expression of interest in the sustainable performance of the project. However, it is identified that some drivers such as satisfying regulatory requirements do not strongly contribute towards sustainable outcomes. This sub-condition is important since it determines the degree of the client's motivation to pursue sustainable outcomes.
	17.3	Investor's motivation to achieve sustainable outcomes	Yes		'Investor's motivation to achieve sustainable outcomes' implies that GB project success is associated with the investor's motivation in project sustainability. This sub-condition is important as it can help realise sufficient funding for the project to fulfil the sustainability goals.
	18	Cooperative role of building control authorities	No		'Cooperative role of building control authorities' implies that GB project success is associated with the condition that building control authorities cooperate in the GB project development. This condition is important since it can result in building planning approvals and the provision of necessary infrastructure for meeting sustainability objectives in the project.
	19	End-users' operation of building in sustainable ways	No		'End-users' operation of building in sustainable ways' implies that GB project success is associated with the conditions that end-users and Facility Management team operate the building in sustainable ways and the building systems are efficiently operated according to design intent. This condition is important since it can help achieve the aspired operation of the building.
	19.1	End-users' motivation to achieve sustainable outcomes	Yes		'End-users' motivation to achieve sustainable outcomes' implies that GB project success is associated with the case that the end-users are motivated to achieve sustainable outcomes in the project. This sub-condition is important as it becomes a driver for the project development team to pursue sustainability. Moreover, it results in the sustainable operation of the building.
	19.2	End-users' understanding of building operation	Yes		'End-users' understanding of building operation' implies that GB project success is associated with the case that end-users have an understanding of building operation and also an understanding of the objectives behind system design. This sub-condition is important since it enables the end-users to efficiently operate the building according to aspirations and design intent.
	19.3	Tenants contractually required to consider sustainability	Yes		'Tenants contractually required to consider sustainability' implies that GB project success is associated with the provision of sustainability-related clauses in the lease contract between owner and tenants. This sub-condition is important as it can ensure the tenants' interest in sustainable development and operation of the project.
	20	Stakeholders' approval of project	No		'Stakeholders' approval of project' implies that GB project success is associated with the condition that there is approval from neighbourhood community and internal project stakeholders (i.e. client's organisation, end-users) to develop the project. This condition is important as it results in the development of the project according to aspirations.
	21	End-users' involvement in defining project aspirations	No	Figure 8-10	'End-users' involvement in defining project aspirations' implies that the GB project success is associated with the involvement of end-users in project decision-making and defining project aspirations. This condition is important as it helps define the appropriate targets for a project. Moreover, because of it, the end-users show an interest in project development and they can have an understanding of how the building will operate once developed. This condition also represents a <i>cluster</i> having one sub-condition i.e. 'FM team involvement in defining project aspirations' (n=1).
Defining project goals	21.1	FM team involvement in defining project aspirations	Yes		'FM team involvement in defining project aspirations' implies that GB project success is associated with the involvement of facility managers in defining project aspirations. This sub-condition is important as it helps define the appropriate targets for the project.
	22	Project team involvement in	No		'Project team involvement in defining project aspirations' implies that GB project success is associated with the condition that the project requirements are decided in consensus with the project team as the client consults with experts to define the project scope. This condition is important as it can make the team members feel more connected to the project and motivates

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		defining project aspirations			them to deliver project aspirations. Moreover, it enables the project during the goals-defining stage to benefit from the sustainability-related understanding and experience of the project team.
	23	Setting appropriate project targets	No		'Setting appropriate project targets' implies that GB project success is associated with the conditions that the project targets are appropriately set and project vision is rigorously developed; sustainability targets of the project are set in coherence with the client's aspirations; there is the intention to work on mutually beneficial outcomes for all key stakeholders; there is not an overreliance on GB certification schemes and point pursuing mentality. This condition is important as because of it the project goals can be aligned with client's requirements; all the key stakeholders can be satisfied from project development; and the project outcomes are not affected by the limitations of GB certification systems. This condition also represents a <i>cluster</i> having 4 sub-conditions which are 'Clarity in building's operational performance targets' (n=1), 'Nature of GB certification aspired for project' (n=2), 'Sustainability brief aligned with project budget' (n=3), and 'Specificity of project requirements' (n=12).
	23.1	Clarity in building's operational performance targets	Yes		'Clarity in building's operational performance targets' implies that GB project success is associated with the clearly defined targets of operational performance. This sub-condition is important as it enables the FM team and end-users to monitor the operational performance of building and take steps to achieve the operational targets.
	23.2	Nature of GB certification aspired for project	Yes		'Nature of GB certification aspired for project' implies that GB project success is associated with the condition that the GB certification system being used in the project acknowledges the sustainability and innovation related to project features. This sub-condition is important as it can help rigorously achieve the sustainability aspirations in the project. In case the certification system acknowledges and credits a variety of sustainable and innovative building features it is easier for the design consultants to advocate the importance of those features to the project client.
	23.3	Sustainability brief aligned with project budget	Yes		'Sustainability brief aligned with project budget' implies that the GB project success is associated with the condition that the project aspects featured in sustainability brief are allocated an adequate cost in the project budget. This sub-condition is important as it can ensure that the sustainability features are not eliminated in later stages of project development to avoid the cost overruns.
	23.4	Specificity of project requirements	Yes		'Specificity of project requirements' implies that GB project success is associated with the conditions that the client is prescriptive of what s/he wants in the project; the client provides specific details of the expected building performance; project outcomes are clearly defined at the project start; and the project has a well-defined scope. This sub-condition is important as it enables the project team to understand the sustainability objectives and works towards their achievement; ensures non-ambiguity in project goals; and helps confirm that the operational outcomes of the project are in accordance with client's requirements.
	24	Stringency level of project sustainability requirements	No		'Stringency level of project sustainability requirements' implies that GB project success is associated with the condition that the project sustainability requirements are not so stringent that they cannot be achieved using the available resources. This condition is important as it determines the ease with which project team fulfils project goals. This condition also represents a <i>cluster</i> having one sub-condition i.e. 'Stringency level of GB certification requirements' (n=2).
	24.1	Stringency level of GB certification requirements	Yes		'Stringency level of GB certification requirements' implies that GB project success is associated with the condition that the requirements of an aspired GB certification are not so stringent that they cannot be achieved using the available resources. This sub-condition is important as it determines the ease with which the project team fulfils project goals.
Design methodology	25	Market survey to identify successful building systems	No	Figure 8-11	'Market survey to identify successful building systems' implies that GB project success is associated with the condition that an exercise is conducted to identify the successful building systems available in the marketplace. This condition is important as it enables the incorporation of such building systems in a project which has better prospects.
	26	Rigour of project design development	No		'Rigour of project design development' implies that GB project success is associated with the condition that the project design and specifications are rigorously developed. This condition is important as the design outcomes can help achieve project outcomes when executed in construction. 'Rigour of project design development' represents a <i>cluster</i> having 15 sub-conditions which are about adaptability in design (n=1), reliable design solutions (n=2), consideration of building's functional use (n=3),

Theme	Sr.no	Condition title	Is a sub-condition of the above	Relevant Figure	Detailed explanation
					design complexity (n=4), life-cycle based design (n=4), maintainability considerations (n=3), design speculations (n=7), design suitability for execution (n=3), proactive design (n=5), balanced design (n=1), context-oriented design (n=3), energy-oriented design (n=12), holistic design (n=9), innovative design (n=6), and integrated design (n=13).
	26.01	Adding adaptability and multiple layers of use in building design	Yes		'Adding adaptability and multiple layers of use in building design' implies that GB project success is associated with the consideration of adaptability and multiple natures of building usage while developing building design. This sub-condition is important as it can help meet the changing requirements of the client and end-users once the building is operational.
	26.02	Use of reliable technology and solutions	Yes		'Use of reliable technology and solutions' implies that GB project success is associated with the use of reliable technology and solutions. This sub-condition is important as it helps achieve the project objectives and aspired performance reliably.
	26.03	Design consideration towards future building usage	Yes		'Design consideration towards future building usage' implies that the GB project success is associated with the condition that the project design is able to satisfy the intended functional use of the building. This sub-condition is important since it can help meet the changing requirements of the client and end-users once the building is operational.
	26.04	Level of complexity in project design	Yes		'Level of complexity in project design' implies that GB project success is associated with the condition that complexity is avoided in design development. This sub-condition is important as it can reduce the problems in the construction and operation of a GB which may arise because of a complex design.
	26.05	Life-cycle based project development approach	Yes		'Life-cycle based project development approach' implies that GB project success is associated with the condition that a life-cycle based approach is used in project development. This sub-condition is important to help achieve sustainability outcomes in project development and this is because sustainable development intrinsically requires a life-cycle perspective.
	26.06	Maintainability considered in building design	Yes		'Maintainability considered in building design' implies that GB project success is associated with the condition that the potential maintenance aspects related to building elements are considered in design development. This sub-condition is important as it can ensure that the project operation-related goals can be achieved.
	26.07	Speculation in building design	Yes		'Speculation in building design' implies that GB project success is associated with the conditions that the project scope is established based on the client's understanding of building use in future; and a rigorous exercise is conducted to reduce the gap between the speculated design conditions and actual conditions (i.e. temperature, occupancy conditions, building usage, etc.). This sub-condition is important as a project design based on realistic speculations can result in the achievement of aspired goals while a design based on unrealistic speculations results in a failure of meeting aspired goals.
	26.08	Suitability of the project design for execution	Yes		'Suitability of the project design for execution' implies that the GB project success is associated with the condition that constructability is considered in project design. This sub-condition is important as it can ensure effective execution of design on-site to fulfil project goals; it can reduce the design-related problems during construction stage; and it can also help avoid the scope changes during project execution resulting from unsuitable project design.
	26.09	Use of a proactive design approach	Yes		'Use of a proactive design approach' implies that GB project success is associated with the condition that the use of self-contradictory design approach is avoided; a proactive design approach is adopted which is about avoiding the practice of making mistakes and then correcting them later. This sub-condition is important as it can help achieve the project goals efficiently by the minimum expense of resources. The practice of making mistakes and then correcting them results in increased project complexity; hence, the use of a proactive design approach helps reduce the project complexity.
	26.1	Use of balanced design approach	Yes		'Use of balanced design approach' implies that GB project success is associated with the use of a balanced design approach considering mutually contradicting design objectives. This sub-condition is important to ensure that different project goals may not contradict each other.
	26.11	Use of context-oriented design approach	Yes		'Use of context-oriented design approach' implies that GB project success is associated with the use of a context-oriented design approach. Sustainability performance of a GB project significantly depends on how the building responds to its context (i.e. community, natural habitat, etc.). Hence, the importance of this sub-condition is that it can help achieve sustainability outcomes in project development.

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	26.12	Use of energy-oriented design approach	Yes		'Use of energy-oriented design approach' implies that GB project success is associated with the condition that such design hierarchies and methodologies are used in design development which leads to efficient energy outcomes. This sub-condition is important as it ensures that sustainability outcomes can be achieved in project development.
	26.13	Use of holistic design approach	Yes		'Use of holistic design approach' implies that GB project success is associated with the condition that the design approach used in the project has a holistic consideration towards different aspects of the building project. This sub-condition is important as it helps achieve the project goals efficiently (i.e. with minimum possible resources); and it ensures that different project goals may not contradict each other.
	26.14	Use of innovative design approach	Yes		'Use of innovative design approach' implies that GB project success is associated with the condition that the typical project design approach is revisited to introduce improvements. This sub-condition is important as it can help efficiently achieve the sustainability outcomes in project development, and it can ensure that the solutions with better prospects can be incorporated into project development.
	26.15	Use of integrated design approach	Yes		'Use of integrated design approach' implies that GB project success is associated with the condition that an integrated approach is considered in different aspects of building design, including system design. As a result of integrated design, more functions can be added in building systems, increasing their value. Hence, the importance of this sub-condition is that it helps efficiently achieve sustainability outcomes and help associate increased value with building components.
	27	Use of performance-based specifications	No		'Use of performance-based specifications' implies that GB project success is associated with the condition that the performance-based equipment specifications are used in project procurement. The importance of this sub-condition is that it helps achieve flexibility in the procurement of materials and building systems without compromising the aspired performance.
Education	28	Educating client about sustainability in project	No	Figure 8-12	'Educating client about sustainability in project' implies that GB project success is associated with the condition that the client is educated about sustainability in the project and the tangible (i.e. ROI) and intangible benefits of GB development. This condition is important as it ensures that the client can see value in sustainable development; the client is motivated to support the project team in the sustainable development of the project; and the client is well-informed to make rational decisions regarding the sustainable development of the project.
	29	Educating end-users and FM team about building operation	No		'Educating end-users and FM team about building operation' implies that GB project success is associated with the condition that, the FM team learns during project design development about its future role in project operation; the FM team is trained by mechanical consultants to operate the mechanical systems according to design intent; and the client and end-users are educated about sustainable operation of the building. This condition is important since it ensures that the FM team and end-users understand the requirements of sustainably operating the building; the FM team can help achieve the design intent, the end-users' experience of using the building improves based on their understanding of building systems; and a smooth transition of the project takes place from inception to operation stage.
	30	Educating project team about GB development	No		'Educating project team about GB development' implies that GB project success is associated with the condition that, the orientation of project team is conducted to bring all members on the same page of understanding related to GB development and GB certification system; and the project team members unaware of GB development are educated about GB development and their role in the delivery of sustainable outcomes. This condition is important as it ensures that, the project team members will know about the process of developing a GB project and their role in developing the project. Moreover, the entire team will be on the same page of understanding related to GB development. 'Educating project team about GB development' represents a <i>cluster</i> having two sub-conditions which are 'Educating contractors about GB development' (n=3) and 'Educating sub-contractors about GB development' (n=2).
	30.1	Educating contractors about GB development	Yes		'Educating contractors about GB development' implies that GB project success is associated with the condition that the contractors are educated about the aspects of GB development, including the intentions behind the sustainable design. This sub-condition is important as it can ensure that, the contractors will know about the process of developing GB project; the

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Engraving sustainability in project development	30.2	Educating sub-contractors about GB development	Yes	Figure 8-13	contractors will know their role in developing a GB project; and it can compensate the contractor's lack of awareness regarding GB development. 'Educating sub-contractors about GB development' implies that GB project success is associated with the condition that the sub-contractors are educated about GB development and the head contractor discusses the building requirements with them. This sub-condition is important as it ensures that the sub-contractors will know about the process of developing a GB project and their role in such a project.
	31	Engraving sustainability in project development	No		'Engraving sustainability in project development' is a condition related to the project design team. This condition implies that for realising successful GB project outcomes, sustainability is to be engraved in project development instead of being considered in a bolt-on approach. Engraving sustainability and using bolt-on approach are two opposite conditions within this condition. Engraving sustainability means including sustainability considerations thoroughly in different aspects of project development. Contrary to this, the bolt-on approach is about considering sustainability once the major aspects of a project are already planned or developed and not many opportunities are left to efficiently incorporate sustainability. The importance of this condition is that an increased project value can be achieved by engraving sustainability instead of considering it in a bolt-on approach.
	32	Procurement of project site based on sustainability goals	No		'Procurement of project site based on sustainability goals' is a condition related to the project client. This condition means that for realising a successful GB, the procurement of project site needs to be in accordance with the sustainability aspirations of the project. While 'Ease of logistics at project location', a condition occurring in the Constraints theme, considers the logistics aspect of the project site, there can be many other sustainability considerations related to project site which occur within the scope of this condition i.e. 'Procurement of project site based on sustainability goals'. The importance of this condition is that a well-planned and thoughtful consideration of sustainability aspects during site procurement contribute towards the achievement of project sustainability goals.
Flow of project information	33	Use of environmental management systems in construction	No	Figure 8-14	'Use of environmental management systems in construction' is a condition related to the contractor team. This condition implies that for realising project success, well-developed environmental management systems are used during the construction stage. The importance of this condition is that it contributes towards the fulfilment of sustainability goals at the project construction site.
	34	Clarity in communication of project goals	No		'Clarity in communication of project goals' implies that GB project success is associated with the condition that the project goals are clearly communicated to project team early in the project, and the client discusses the sustainability brief with design consultant and contractor and emphasises its importance. This condition is important as because of it the project team knows what to deliver as a project outcome.
	35	Communication among project team	No		'Communication among project team' implies that GB project success is associated with the condition that effective communication takes place among the project team members to resolve project issues and to work collaboratively. This condition is important as it, enables the different parties in the project team to keep working together; enables the team members to know how their work is related to the work of others; and enables the design team members to join the conversation defining sustainability goals of the project. This condition represents a <i>cluster</i> having one sub-condition i.e. 'Use of effective communication tools and strategies' (n=5)
	35.1	Use of effective communication tools and strategies	Yes		'Use of effective communication tools and strategies' implies that GB project success is associated with the condition that the project team communicates effectively and clearly; the multi-disciplinary design team has meetings to discuss green initiatives and green implementation; workshops of the project team are conducted on a regular basis from project inception to completion; and an open and honest communication process is established with the design team early in the project. This sub-condition is important as it can help different parties in the project team to work together. Moreover, because of this different team members can understand how their work is related to the work of others.

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Inspection, monitoring, and control	36	Project team's access to robust information	No	Figure 8-15	'Project team's access to robust information' implies that GB project success is associated with the condition that the team has a timely access to robust information regarding different aspects of project development, including building materials; the project information is shared among the project team. This condition is important as it can help the project team make rigorous decisions. This condition represents a <i>cluster</i> having one sub-condition i.e. 'Sharing of information related to project changes' (n=1).
	36.1	Sharing of information related to project changes	Yes		'Sharing of information related to project changes' implies that GB project success is associated with the condition that the information related to changes in project development is shared among the project team. This sub-condition is important as it enables the project team to see the project changes being made and based on this information the team can provide an opinion that how these changes will affect the sustainability requirements.
	37	Smooth transition of project from inception to operation stage	No		'Smooth transition of project from inception to operation stage' implies that GB project success is associated with the condition that Soft Landings approach is used in project development, and there is a smooth handing over of the project to the contractor once the tender is awarded. This condition is important as it helps avoid the loss of project-related information as the project transition takes place from one party to another, and it can educate the end-users and FM team about building operation.
	38	Inspection of project upon construction	No		'Inspection of project upon construction' implies that GB project success is associated with the condition that upon completion the project is thoroughly inspected for conformance with specifications. This condition is important as it can ensure that the construction deliverables fulfil the project aspirations. This condition represents a <i>cluster</i> having one sub-condition i.e. 'Execution of commissioning and fine-tuning' (n=7).
	38.1	Execution of commissioning and fine-tuning	Yes		'Execution of commissioning and fine-tuning' implies that GB project success is associated with the condition that commissioning, fine-tuning and seasonal testing of the building is rigorously conducted; and building systems are commissioned by a third party. This sub-condition is important as it can ensure that the building in its operational life performs according to design intent.
	39	Monitoring and controlling operational performance of building	No		'Monitoring and controlling operational performance of building' implies that GB project success is associated with the condition that a third-party verifies the operational performance of the building; the FM team monitors the building performance; a follow-through is conducted to ensure that the users understand the sustainable operation of building; and the regular audits are conducted to report the operational performance of the building. This condition is important as it can ensure that the end-users and the project client will know if the building in its operational life is performing as intended by design; and ensure through a follow-through exercise that the end-users understand the sustainable operation of the building.
	40	Monitoring of project development	No		'Monitoring of project development' implies that GB project success is associated with the conditions that contract administration is rigorously performed; quality of design work from different consultants is managed; quality assurance and quality control is performed during project development; building construction is monitored for conformance with specifications; materials used in construction are reviewed; the site is regularly visited by design consultant; the deliverables for different project stages are kept in account; and the checkpoints are used for reviewing the sustainable development of the project. This condition is important as, it can ensure that the project team is held accountable for delivering the project as per aspirations; it results in effective execution of design and specifications during construction; and it can ensure that project aspirations are met in construction while compensating the contractor's lack the awareness related to GB development. This condition represents a <i>cluster</i> having one sub-condition i.e. 'Project reporting' (n=2).
	40.1	Project reporting	Yes		'Project reporting' implies that GB project success is associated with the condition that project reporting is conducted at regular intervals to see if project requirements are being met and this reporting is continued throughout the different project stages. This sub-condition is important as it enables the tracking of project performance at different stages of development and helps see if the project development is up to the expectations. Moreover, by clearly stating in project reporting the need for following sustainability objectives, the project team continues to take interest in it.

Theme	Sr.no	Condition title	Is a sub-condition of the above	Relevant Figure	Detailed explanation
	41	Review of project design by sustainability consultant	No		'Review of project design by sustainability consultant' implies that GB project success is associated with the condition that the sustainability consultant has, the freedom to critically review project design and other aspects of project development; and the authority to demand revisions in case the project design is inadequate. This condition is important as, it helps ensure that the design team fulfils sustainability objectives during project development; and it also helps compensate the shortcomings in the design left by MEP consultants.
	42	Thoroughness of value engineering exercise	No		'Thoroughness of value engineering exercise' implies that GB project success is associated with the condition that the value engineering exercises are appropriately conducted to reduce the risk of eliminating sustainable features. This condition is important as it can ensure that sustainability aspirations are not compromised during project development.
Planning approach	43	Attention towards details	No	Figure 8-16	'Attention towards details' implies that GB project success is associated with the condition that attention is given to key details in project development and operation and even the small details (i.e. instrumentation, measurement of the relative temperatures, etc.); and attention is given to detailing, finishing and workmanship. This condition is important as it enables rigour and accuracy in project development.
	44	Rigour of project planning	No		'Rigour of project planning' implies that GB project success is associated with the condition that the project is rigorously planned to consider all the aspects of project development. This condition is important as it ensures a preparedness while the project is being developed. This condition represents a <i>cluster</i> having three sub-conditions i.e. 'Adequate budget allocation for project development' (n=13), 'Adequate time allocation for commissioning and testing' (n=1), and 'Adequate time allocation for project development' (n=11).
	44.1	Adequate budget allocation for project development	Yes		'Adequate budget allocation for project development' implies that GB project success is associated with the condition that there is an appropriate budget allocation to support the sustainability initiatives in project development; the project budget aligns with project scope; and there are buffers provided in the project budget. This sub-condition is important as it enables the fulfilment of aspirations while developing the project, and it helps avoid the risk of eliminating project features because of an inadequate budget.
	44.2	Adequate time allocation for commissioning and testing	Yes		'Adequate time allocation for commissioning and testing' implies that GB project success is associated with the condition that in project schedule appropriate time is provided for commissioning and testing exercise. This sub-condition is important as it can help avoid the risk of inappropriately conducted commissioning and testing resulting from a time shortage.
	44.3	Adequate time allocation for project development	Yes		'Adequate time allocation for project development' implies that GB project success is associated with the condition that appropriate delivery time is allocated for project stages, including inception, planning, and design stage. Moreover, the time allocation needs to consider sustainability aspects in project development. This sub-condition is important as it can help ensure the completeness of design deliverables before execution; avoid the lack of innovative design approaches resulting from time shortage; avoid the risk of eliminating project features resulting from the retrospective realisation that the allocated time is insufficient; and can enable the fulfilment of aspirations while developing the project.
	45	Rigour of risk management	No		'Rigour of risk management' implies that GB project success is associated with the condition that the risk management is rigorously performed in which the risk assessment is performed regularly and the remediation actions are promptly taken. Moreover, risk also needs to be managed in terms of the project objectives. This condition is important as it reduces the risk of not meeting project requirements.
Team authorities, responsibilities,	46	Control of project design by Design and Sustainability Consultant	No	Figure 8-17	'Control of project design by Design and Sustainability Consultant' implies that GB project success is associated with the condition that the design and sustainability consultants have the authority to control project design development. This condition is important as it ensures that these professionals can control the project development to meet sustainability aspirations.

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and contractual relationships	47	Empowerment of sustainability consultant by client	No		'Empowerment of sustainability consultant by client' implies that GB project success is associated with the condition that the sustainability consultant is empowered by the client and considered a coordinator in the project. This condition is important as it can ensure that the project team seriously considers the sustainability objectives advocated by sustainability consultant.
	48	Project team's involvement in decision-making	No		'Project team's involvement in decision-making' implies that GB project success is associated with the condition that the project team and particularly the sustainability and design consultants are involved in project-related decision-making. This condition is important as it can help capitalise on the specialised knowledge of different team members for benefitting the project. Moreover, it can keep the project team motivated towards the project.
	49	Using appropriate project delivery method	No		'Using appropriate project delivery method' implies that GB project success is associated with the condition that an appropriate delivery method is used for the project. This condition is important as it can result in such contractual associations among the project team and client which can benefit a project.
	49.1	Contractual interrelationships between client and project team	Yes		'Contractual interrelationships between client and project team' implies that GB project success is associated with the contractual links which a client has with the project team and particularly the design and sustainability consultant. This sub-condition is important as it can result in such contractual associations among the project team and client which can benefit a project.
Team characteristics	50	Like-mindedness of project team members	No	Figure 8-18	'Like-mindedness of project team members' implies that GB project success is associated with the differences in knowledge, thinking approach, and skill-sets of project team members. This condition is important as it affects collaboration among project team members.
	51	Proficiency of FM team	No		'Proficiency of FM team' implies that GB project success is associated with the condition that the FM team have a good understanding of building features and systems, as well as building operation. This condition is important since it determines the awareness of FM team to effectively operate the GB project.
	52	Proficiency of project team	No		'Proficiency of project team' implies that GB project success is associated with the condition that the project team is experienced in developing GBs; has the appropriate technical expertise required for GB projects; and understands the process of GB development and certification. This condition is important as it can ensure that the project team can contribute towards the development and certification of a GB project using its expertise and knowledge.
	52.1	Leadership qualities among project team members	Yes		'Leadership qualities among project team members' implies that GB project success is associated with leadership qualities among project team members to pursue project goals, push status-quo, and innovate. This sub-condition is important as it can enable the project team to work on innovative solutions and focus on goals even in challenging circumstances.
	52.2	Proficiency of contractor	Yes		'Proficiency of contractor' implies that GB project success is associated with the condition that the contractor, can bridge the knowledge gaps and can understand design intent; has the skill set to look for sustainability compliance by sub-contractors; has the awareness and experience of GB development; and has the skill set for documentation procedure related to GB certification. This sub-condition is important as it ensures that the contractor, is able to monitor the deliverables from sub-contractors and suppliers for compliance; can compensate the lack of sub-contractors' expertise; can complete the documentation required for GB certification; can bridge the knowledge gaps in design documentation to deliver the project aspirations even in case design deliverables are incomplete and flawed.
	52.3	Proficiency of design consultant	Yes		'Proficiency of design consultant' implies that GB project success is associated with the condition that the design consultant has, the awareness of local regulations; awareness of design requirements regarding efficient MEP systems; and the understanding and expertise for GB development and certification process. This sub-condition is important as it ensures that the design consultants, are aware of local regulations to avoid the regulatory barriers; can create conditions for MEP consultants and sustainability consultants to achieve higher efficiencies in building systems; can compensate the client's lack of awareness regarding GB development; can design the project such that it meets the sustainability aspirations; and can develop the design completely before execution.

Theme	Sr.no	Condition title	Is a sub-condition of the above	Relevant Figure	Detailed explanation
	52.4	Proficiency of MEP consultant	Yes		'Proficiency of MEP consultant' implies that GB project success is associated with the condition that MEP consultants have, the experience of working on GBs; the experience of problem rectification in building systems; and the ability to make better design speculations. This sub-condition is important as it ensures that the MEP consultants can design the building systems which can meet the sustainability aspirations. Moreover, it means that the potential problems in building systems can be rectified once the project is operational.
	52.5	Proficiency of PM team	Yes		'Proficiency of PM team' implies that GB project success is associated with the condition that the Project Management team has, the experience of delivering GBs; the ability to discern good and bad design; and can appropriately delegate the project tasks among the project team. This sub-condition is important as it, enables the PM team to monitor and control the design development to meet the project aspirations; ensures an appropriate delegation of responsibilities among suitable professionals; and enables the PM team to focus its attention towards fulfilling sustainability outcomes.
	52.6	Proficiency of sub-contractor	Yes		'Proficiency of sub-contractor' implies that GB project success is associated with the condition that the sub-contractor has awareness and expertise of GB development. This sub-condition is important as it can ensure that these professionals can deliver the project tasks assigned to them while meeting sustainability aspirations.
	52.7	Proficiency of sustainability consultant	Yes		'Proficiency of sustainability consultant' implies that GB project success is associated with the condition that the sustainability consultant has the experience of GB development and the ability to engage with the project team. This sub-condition is important as it ensures that these professionals can lead the project team to deliver sustainable outcomes.
	53	Project team's understanding of project goals and aspirations	No		'Project team's understanding of project goals and aspirations' implies that GB project success is associated with the condition that the project team has a detailed understanding of project vision, goals, aspirations and quality targets. This condition is important as it enables the team to work towards the achievement of project aspirations.
	54	Size of design team	No		'Size of design team' implies that GB project success is associated with the size of the design team and the number of design consultant organisations involved in project development. This condition is important as the coordination among a bigger design team is more complex and difficult as compared to a smaller design team.
Team collaboration	55	Conflicts among project team	No	Figure 8-19	'Conflicts among project team' implies that GB project success is associated with the condition that misunderstandings and conflicts among team members are avoided as the project develops. This condition is important as it affects the project team's ability to work together for achieving project goals.
	56	Project team collaboration	No		'Project team collaboration' implies that GB project success is associated with the conditions that, the project team is excited to work on the project and willing to collaborate for the project; and the collaboration among project team starts from the project onset as the design team members join the conversation which defines sustainability goals of the project. This condition is important as it can reduce the risk of design sub-optimisation and ensure an integrated design approach.
	56.1	Liaison between design team and client	Yes		'Liaison between design team and client' implies that GB project success is associated with the condition that there is an active communication link between the design team and client. This sub-condition is important as it helps develop the client's trust in the design consultant enabling the consultant to incorporate sustainable building features.
	56.2	Liaison between FM team and project development team	Yes		'Liaison between FM team and project development team' implies that GB project success is associated with the condition that the facility management team communicates with the project development team about the operational performance of the building. This sub-condition is important as it enables a long-term assessment of building sustainability spanning from project development to operation.
	56.3	Liaison between sustainability consultant and client	Yes		'Liaison between sustainability consultant and client' implies that GB project success is associated with the condition that there is an active communication link between sustainability consultant and client. This sub-condition is important as it results in a mutual consensus among the sustainability consultant and client that which sustainability aspects are to be pursued in project development.

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	56.4	Liaison between sustainability consultant and contractor team	Yes		'Liaison between sustainability consultant and contractor team' implies that GB project success is associated with the condition that there is an active communication link between the sustainability consultant and contractor team. This sub-condition is important as it can enable the sustainability consultant to lead the contractor team towards sustainability goals.
	56.5	Liaison between sustainability consultant and design consultant	Yes		'Liaison between sustainability consultant and design consultant' implies that GB project success is associated with the condition that there is an active communication link between the architect, MEP consultant and sustainability consultant. This sub-condition is important as it can enable collaboration between the sustainability consultant and design consultant to achieve sustainable outcomes in the project.
	56.6	Liaison between sustainability consultant and project team	Yes		'Liaison between sustainability consultant and project team' implies that GB project success is associated with the condition that there is an active communication link between the sustainability consultant and the project team. This sub-condition is important as it enables the sustainability consultant to lead the project team towards sustainability goals.
	56.7	Willingness of project team to work together	Yes		'Willingness of project team to work together' implies that GB project success is associated with the condition that the project team has effective working dynamics and is willing to work together. This sub-condition is important as it can result in better communication among the project team, and can ensure that the team supports the project sustainability agenda.
Team commitment to the project	57	Alignment of team interest with project interest	No	Figure 8-20	'Alignment of team interest with project interest' implies that GB project success is associated with the condition that there is an alignment of team interest with project interest and the project team is on-board to achieve project goals. In particular, the entire design team works in the same direction to achieve sustainability aspirations. This condition is important as it can ensure that the project team is motivated to achieve project goals. For instance, as a result of this, the design team can be motivated to rigorously develop the project design.
	57.1	Rewards for achieving performance targets	Yes		'Rewards for achieving performance targets' implies that GB project success is associated with the incentives for the team to achieve the project goals. This sub-condition is important as it ensures that the team interest is aligned with project interest and the team collaboratively works towards the project goals.
	58	Contractor's proactive role in project development	No		'Contractor's proactive role in project development' implies that GB project success is associated with the condition that the contractor, can foresee and avoid the potential risks in project; ensures that the project design is buildable; and plays a proactive role in delivering a well-performing project particularly in the project documentation required for GB certification. This condition is important as it enables the contractor to deliver the project outcomes and ensures the completion of project documentation for green certification.
	59	FM team motivation to achieve sustainable outcomes	No		'FM team motivation to achieve sustainable outcomes' implies that GB project success is associated with the condition that the FM team considers a GB as significantly different from other buildings and operates it with special consideration. This condition is important as it can enable the FM professionals to contribute towards the sustainable operational goals of the project.
	60	Project team motivation to achieve sustainable outcomes	No		'Project team motivation to achieve sustainable outcomes' implies that GB project success is associated with the interest and motivation of the project team towards sustainable outcomes. This condition is important as it enables the project team to maintain a focus on sustainability and strive for sustainable outcomes in the project.
	60.1	Contractor team motivation to achieve sustainable outcomes	Yes		'Contractor team motivation to achieve sustainable outcomes' implies that GB project success is associated with the condition that the sub-contractors, suppliers, head contractor team and particularly the environmental manager in contractor team are cooperative, convinced and motivated towards sustainable development of the project. This sub-condition is important as it, enables the contractor team to strive for sustainable outcomes in the project; can increase the awareness of sub-contractors about GB development; and can result in a continuous focus of contractor team towards project sustainability.

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	60.2	Design Consultant's motivation to achieve sustainable outcomes	Yes		'Design Consultant's motivation to achieve sustainable outcomes' implies that GB project success is associated with the condition that the Design Consultants are, motivated to deliver sustainable outcomes; willing to put the required effort in the design process for achieving sustainable outcomes; and willing to accept the recommendations from sustainability consultant. This sub-condition is important as it enables the Design Consultant to develop a design which fulfils the sustainability aspirations.
	60.3	MEP Consultant's motivation to achieve sustainable outcomes	Yes		'MEP Consultant's motivation to achieve sustainable outcomes' implies that GB project success is associated with the condition that the MEP Consultants are motivated to deliver sustainable outcomes. This sub-condition is important as it enables the MEP Consultants to develop a design which fulfils the sustainability goals.
	60.4	PM team motivation to achieve sustainable outcomes	Yes		'PM team motivation to achieve sustainable outcomes' implies that GB project success is associated with the condition that the project management team takes interest in sustainable outcomes of the project and considers them as important aspects of project development. This sub-condition is important as it ensures that the project team is focused on sustainability.
	60.5	Sustainability Consultant's motivation to achieve sustainable outcomes	Yes		'Sustainability Consultant's motivation to achieve sustainable outcomes' implies that GB project success is associated with the condition that the sustainability consultant is motivated to achieve sustainable outcomes in project development. This sub-condition is important as it enables the sustainability consultant to lead the project team towards sustainability objectives.
Team mindset and priorities	61	Establishing and promoting synergies	No	Figure 8-21	'Establishing and promoting synergies' implies that GB project success is associated with the condition that synergies among project team are established and promoted during the course of project development. This condition is important as it increases the value of different project features.
	62	Focus of sustainability consultant on project goals	No		'Focus of sustainability consultant on project goals' implies that GB project success is associated with the condition that the sustainability consultant has a focus on project goals and can distinguish the important aspects from unimportant aspects in the project. This condition is important since it enables these professionals to deliver aspired sustainability outcomes in project development.
	63	Open-mindedness and flexibility of project team	No		'Open-mindedness and flexibility of project team' implies that GB project success is associated with the conditions that, the project team has the flexibility to adapt to the GB project requirements; the project team is ready to accept new ideas and new ways of developing projects; and the design team members have the open-mindedness to accept each other's opinions. This condition is important since the open-mindedness and flexibility of design team members to accept each other's opinions can lead to an open and honest communication process early in the project. Moreover, as a result of this, the team is able to work on the approaches of project development with better prospects.
	64	Priority of sustainability in project development	No		'Priority of sustainability in project development' implies that GB project success is associated with the condition that, sustainability is prioritised in project agenda and considered a key requirement in project development; the recommendations and guidelines from sustainability consultant are seriously followed; there is a willingness from the client's side to pay for green features; and the design consultant prioritises sustainability during design development. This condition is important since it can drive the project team to achieve sustainability in project development. Moreover, it can result in the use of efficient sustainable development approaches such as energy-oriented design methodology.
	65	Team working on project with innovative mindset	No		'Team working on project with innovative mindset' implies that GB project success is associated with the condition that the project team works on the project with an innovative mindset instead of considering the project in terms of business as usual. This condition is important as it results in solutions and approaches to project development with better prospects.
	66	Team working on project with value management mindset	No		'Team working on project with value management mindset' implies that GB project success is associated with the condition that the project team works on the project with a value management mindset; and an exercise is conducted to find suitable economic solutions and ensure cost-benefit optimisation. For instance, a sustainability consultant collaborates with the Quantity Surveyor to propose sustainable solutions which are affordable. This condition is important as it reduces the risk of eliminating project features in the later stages of project development.

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Team procurement methodology	67	Involvement of sustainability consultant in contractor's selection	No	Figure 8-22	'Involvement of sustainability consultant in contractor's selection' implies that GB project success is associated with the condition that the sustainability consultant is involved to provide advice in terms of contractor's selection. This condition is important as it can result in the engagement of contractors who are proficient in GB development.
	68	Preferences in project team selection	No		'Preferences in project team selection' implies that GB project success is associated with the condition that the project team is carefully selected based on some criteria, including the behavioural aspects. This condition is important since it results in the engagement of a project team which is proficient in GB development and which can effectively collaborate for delivering the project.
	68.1	Long-term engagement of sustainability consultant	Yes		'Long-term engagement of sustainability consultant' implies that GB project success is associated with the condition that the sustainability consultant is engaged for the whole duration of project development. This sub-condition is important as it enables the sustainability consultant to incorporate sustainability aspirations in the project. Moreover, it ensures a continuous focus on sustainability while developing a project.
	68.2	Preferences in consultant's engagement	Yes		'Preferences in consultant's engagement' implies that GB project success is associated with the conditions that, the design consultants are carefully selected considering their ability to work on GB projects and their ability to adapt themselves to the project requirements; the proximity of design consultants to each other is a criterion of their selection; and the consultant organisations are appointed in multidisciplinary roles (i.e. the same organisation providing both the MEP consultancy and sustainability consultancy). This sub-condition is important since it results in engaging professionals who are proficient in designing GB and who can effectively collaborate for delivering the project.
	68.3	Preferences in contractor's engagement	Yes		'Preferences in contractor's engagement' implies that GB project success is associated with the conditions that a careful selection of the contractor is undertaken to consider the parties, who can adapt themselves to project requirements; who are experienced in the development of building projects and particularly the GB projects; who have the skill set required for GB projects; who are aware of the requirements and development process of GB projects; and who are motivated to work on GB projects. This sub-condition is important since it results in the engagement of such contractors who are proficient in GB development.
	68.4	Pre-qualification of contractors and sub-contractors	Yes		'Pre-qualification of contractors and sub-contractors' implies that GB project success is associated with the condition that a pre-qualification process of contractors and sub-contractors is conducted to carefully select the parties on different criteria such as their ability to deliver GBs and their previous experience of delivering GBs. This sub-condition is important since it results in the engagement of professionals who are proficient in constructing GBs.
	68.5	Requirement for contractor to engage a sustainability advisor	Yes		'Requirement for contractor to engage a sustainability advisor' implies that GB project success is associated with the condition that the contractor team is required to have a sustainability advisor. This sub-condition is important since it results in the engagement of such professionals who are proficient in constructing GBs.
Timeliness of project activities	69	Early engagement of project team	No	Figure 8-23	'Early engagement of project team' is a condition representing a <i>cluster</i> of 7 sub-conditions. This condition implies that project success associates with the early involvement of team members in the project lifecycle. The importance of this condition is that the professionals in the project team have an understanding of different aspects of project development. Their early engagement means that there is an opportunity for them to define the project development process, to support the decision-making process, to help define the project requirements and to review the project design.
	69.1	Early engagement of commissioning professionals	Yes		'Early engagement of commissioning professionals' is a sub-condition which means that the condition of early involvement of commissioning professionals in project development is associated with GB project success. Importance of this sub-condition is because the professionals with the knowledge of building commissioning can ensure from the project start that the building performs according to design intent. It also ensures that the various design features and solutions devised for the project would meet the aspired quality standards and operational targets.

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	69.2	Early engagement of contractor	Yes		‘Early engagement of contractor’ is a sub-condition which implies that project success associates with the contractor’s engagement in the project as early as the design development stage. The importance of early engagement of contractors for GBs is that these professionals with the knowledge of building construction and material procurement can review project design and provide their input from constructability and cost viewpoints. In GBs their input can be particularly useful in terms of special, non-standard materials and items. Moreover, by virtue of the early contractor engagement a client can use the contractor’s supply chain (i.e. subcontractors, suppliers) to benefit from the specialised knowledge of different trades, mitigate the risks and reduce the costs.
	69.3	Early engagement of design consultants	Yes		‘Early engagement of design consultants’ is a sub-condition which implies that the early engagement of design consultants in the project lifecycle associates with project success. This sub-condition is important as the design consultants have an overarching understanding of building development; hence, their early engagement can lead to design strategies and decision-making which can result in fulfilling client’s requirements.
	69.4	Early engagement of FM team	Yes		‘Early engagement of FM team’ is a sub-condition implying that GB project success associates with the condition that the FM team is brought on-board during the project development and this team is involved in project design development to discuss the building maintenance-related issues. The importance of this sub-condition is that it results in a liaison between the FM team and the project development team which becomes a learning opportunity for both these teams. The FM professionals can advise the design team, help define project aspirations, and review project design from the building operations and maintenance viewpoint. Because of the early involvement, the FM team is also able to develop a better understanding of how the building will need to be operated once developed.
	69.5	Early engagement of sub-contractor	Yes		‘Early engagement of sub-contractor’ is a sub-condition implying that the early involvement of sub-contractors in the project is associated with GB project success. The importance of this sub-condition is that these professionals with the specialised knowledge of construction trades can review the project design from constructability and cost point of view.
	69.6	Early engagement of suppliers	Yes		‘Early engagement of suppliers’ is a sub-condition indicating an association of GB project success with the condition that suppliers are engaged early in the project. This sub-condition is important since suppliers as compared to other project team members are more aware of the innovative building systems and materials. Hence, the early involvement of these professionals can create the opportunity of increased building efficiency.
	69.7	Early engagement of sustainability consultant	Yes		‘Early engagement of sustainability consultant’, is a sub-condition implying that GB project success associates with the early involvement of a sustainability consultant in a project. The importance of early engagement of sustainability consultants is that these professionals advocate sustainability in a project and can set the process of sustainable development from the start of the project. As a result of early involvement, the sustainability consultant can liaise with the project client and can contribute towards the early introduction of appropriate project targets hence easing the early incorporation of sustainability in the project. This way the sustainability consultant is in a position to plan GB project development according to the client’s innate requirements. Early engagement of sustainability consultant can also contribute towards the client’s understanding of GB requirements and can ensure that the sustainability requirements are not missed as the project is being planned and designed.
	70	Early introduction of project targets	No		‘Early introduction of project targets’ is a condition implying that GB success associates with the condition that the project targets are introduced at the project outset. This condition represents a <i>cluster</i> , including two sub-conditions, namely ‘Client’s early decision-making regarding sustainability goals’ and ‘Early incorporation of sustainability in project’. This condition is important as it integrates project requirements within the development process. This can be explained by the fact that the GB project outcomes such as green certifications depend on the process used for developing a project. Hence, for the process of development to be articulated, the introduction of project targets acts as a predecessor. In case targets are introduced early, the project requirements can be integrated well within the project development process. However, the late introduction of targets means that some project activities such as design development may have to be repeated. Furthermore, depending on

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					the time of introducing targets, there may not exist the opportunity of integrating and fulfilling some of the sustainability aspirations.
	70.1	Client's early decision-making regarding sustainability goals	Yes		'Client's early decision-making regarding sustainability goals' is a sub-condition implying that GB project success associates with the client's early decision-making regarding sustainability goals and consideration towards the practicality of project goals being proposed. The importance of this sub-condition is that owing to the client's authoritative role in a GB project, his/her early decision-making regarding project goals can ensure that sustainability requirements are integrated well within the project.
	70.2	Early incorporation of sustainability in project	Yes		'Early incorporation of sustainability in project' is a sub-condition implying that GB project success associates with the consideration of sustainability from project start. In practice, it means that the early design decisions involve the GB concepts and the idea of GB development is to clearly articulated in site selection and town planning stage. The importance of sustainability incorporation early in the project is that the ease of sustainability integration in project development depends on the point at which it is introduced in the project lifecycle. For instance, building orientation significantly affects sustainable outcomes of the project, and in case of sustainability is incorporated in the project once orientation has already been decided then achieving sustainable outcomes is realised at higher costs, the expense of more resources and with more difficulty. Depending on the regional context, a GB project may be offered certain incentives from the regional authorities. However, achieving such incentives is determined by the time when sustainability is introduced in the project. Early incorporation of sustainability in the project may also determine the alignment of team interest with project interest. This is because in case sustainability is introduced in the project after team engagement, the job expectations of the project team may not match with the changed project requirements.
	71	Timeliness of building approval	No		'Timeliness of building approval' is a condition implying that project success is associated with the condition that building planning approvals are processed in due time. It is important as the project construction activity depends on the planning approvals and the project development cannot start unless planning approvals are not processed in time.
	72	Timeliness of feedback on sustainability documentation	No		'Timeliness of feedback on sustainability documentation' is a condition implying that GB project success is associated with the timely arrival of feedback on the project's sustainability documentation from GB certification organisation. The importance of this condition is that the feedback on documents related to the project's sustainability features can result in corrective actions. However, in case such feedback arrives late in a project the opportunity of taking corrective action may not exist.
	73	Timely submission of GB certification documentation for review	No		'Timely submission of GB certification documentation for review' is a condition implying that GB project success is associated with the timely submission of GB certification documentation for review. The importance of a timely submission of GB certification documentation is not only that it contributes towards GB project success by achieving a typical objective in GBs (i.e. achieving GB certification) but also because the early submission can result in early feedback which can help take corrective actions.

D.2. Network attributes of Success conditions

Table D.2: Network attributes of Success conditions

Sr. no	Condition	Number of sub-conditions	Frequency	Betweenness Centrality	Average Shortest Path Length	Closeness Centrality	Clustering Coefficient	Eccentricity	Edge Count	Indegree	Is Single Node	Neighbourhood Connectivity	Out degree	Partner of Multi-edged Node Pairs	Stress
1	Change in project team members	0	2	0.00	1.00	1.00	0.00	1	1	0	0.00	1.00	1	0	0
2	Execution of sustainable design during construction	0	5	0.00	0.00	0.00	0.33	0	3	3	0.00	5.67	0	0	0
3	Scope changes during project execution	2	9	0.02	1.00	1.00	0.00	1	4	2	0.00	7.33	2	1	57
4	Clarity in process of developing project	1	9	0.00	5.00	0.20	0.00	8	1	0	0.00	10.00	1	0	0
5	Delegating clear responsibilities to project team	3	6	0.00	4.85	0.21	0.50	8	2	0	0.00	8.00	2	0	0
6	Client's leadership in project	0	3	0.00	4.93	0.20	0.00	8	1	0	0.00	8.00	1	0	0
7	Consensus within client organisation	0	2	0.00	3.19	0.31	0.00	5	1	0	0.00	8.00	1	0	0
8	Proficiency of project client	4	20	0.16	2.27	0.44	0.07	4	9	5	0.00	4.75	4	1	462
9	Structure and nature of client organisation	0	5	0.00	5.19	0.19	0.00	9	1	0	0.00	8.00	1	0	0
10	Completeness of project documentation for certification	0	2	0.00	0.00	0.00	0.00	0	2	2	0.00	2.00	0	0	0
11	Completeness and rigour of project design before execution	0	9	0.00	2.00	0.50	0.10	3	6	5	0.00	7.00	1	0	22
12	Setting of a detailed sustainability charter or brief	0	10	0.00	5.41	0.18	0.00	9	2	0	0.00	4.50	2	0	0
13	Access to sustainable building materials	0	2	0.00	0.00	0.00	0.00	0	1	1	0.00	8.00	0	0	0
14	Accessibility of project funding	0	6	0.00	0.00	0.00	0.00	0	1	1	0.00	8.00	0	0	0
15	Ease of logistics at project location	0	1	0.00	0.00	0.00	0.00	0	0	0	1.00	None	0	0	0
16	Client's involvement in project development	1	5	0.00	2.67	0.38	0.33	5	3	0	0.00	8.00	3	0	0
17	Client's motivation to achieve sustainable outcomes	3	32	0.04	4.35	0.23	0.07	8	8	4	0.00	3.88	4	0	123
18	Cooperative role of building control authorities	0	2	0.00	0.00	0.00	0.00	0	0	0	1.00	None	0	0	0
19	End-users' operation of building in sustainable ways	3	12	0.04	4.88	0.20	0.07	8	6	5	0.00	4.83	1	0	108
20	Stakeholders' approval of project	0	4	0.00	0.00	0.00	0.00	0	0	0	1.00	None	0	0	0
21	End-users' involvement in defining project aspirations	1	8	0.00	5.65	0.18	0.00	9	2	1	0.00	7.00	1	0	5
22	Project team involvement in defining project aspirations	0	3	0.01	4.96	0.20	0.17	8	4	2	0.00	7.00	2	0	32
23	Setting appropriate project targets	4	21	0.01	5.27	0.19	0.08	9	4	1	0.00	5.25	3	0	24
24	Stringency level of project sustainability requirements	1	4	0.00	0.00	0.00	0.00	0	0	0	1.00	None	0	0	0
25	Market survey to identify successful building systems	0	1	0.00	2.00	0.50	0.00	3	1	0	0.00	12.00	1	0	0
26	Rigour of project design development	15	41	0.03	1.50	0.67	0.02	2	13	12	0.00	4.33	1	1	90
27	Use of performance-based specifications	0	1	0.00	0.00	0.00	0.00	0	0	0	1.00	None	0	0	0
28	Educating client about sustainability in project	0	6	0.00	2.88	0.35	0.50	5	3	1	0.00	8.00	2	0	7
29	Educating end-users and FM team about building operation	0	9	0.02	5.12	0.20	0.00	9	4	1	0.00	4.00	3	0	71
30	Educating project team about GB development	2	8	0.17	3.42	0.29	0.08	6	5	2	0.00	7.50	3	1	489
31	Engraving sustainability in project development	0	8	0.00	2.00	0.50	0.00	3	3	2	0.00	4.67	1	0	6
32	Procurement of project site based on sustainability goals	0	3	0.00	2.50	0.40	0.00	4	1	0	0.00	3.00	1	0	0
33	Use of environmental management systems in construction	0	1	0.00	2.50	0.40	0.00	4	1	0	0.00	3.00	1	0	0

Sr. no	Condition	Number of sub-conditions	Frequency	Betweenness Centrality	Average Shortest Path Length	Closeness Centrality	Clustering Coefficient	Eccentricity	Edge Count	Indegree	Is Single Node	Neighbourhood Connectivity	Out degree	Partner of Multi-edged Node Pairs	Stress
34	Clarity in communication of project goals	0	7	0.00	0.00	0.00	0.00	0	0	0	1.00	None	0	0	0
35	Communication among project team	1	11	0.00	4.07	0.25	0.33	7	3	1	0.00	5.67	2	0	4
36	Project team's access to robust information	1	5	0.00	0.00	0.00	0.00	0	0	0	1.00	None	0	0	0
37	Smooth transition of project from inception to operation stage	0	5	0.00	0.00	0.00	0.00	0	1	1	0.00	4.00	0	0	0
38	Inspection of project upon construction	1	8	0.00	0.00	0.00	0.00	0	1	1	0.00	3.00	0	0	0
39	Monitoring and controlling operational performance of building	0	5	0.01	5.62	0.18	0.17	9	3	2	0.00	7.00	1	0	17
40	Monitoring of project development	1	12	0.00	3.52	0.28	0.50	6	2	0	0.00	5.00	2	0	0
41	Review of project design by sustainability consultant	0	2	0.00	4.78	0.21	0.00	8	2	0	0.00	11.00	2	0	0
42	Thoroughness of value engineering exercise	0	3	0.00	0.00	0.00	0.00	0	1	1	0.00	8.00	0	0	0
43	Attention towards details	0	5	0.00	0.00	0.00	0.00	0	0	0	1.00	None	0	0	0
44	Rigour of project planning	3	19	0.00	1.60	0.63	0.17	3	3	0	0.00	6.33	3	0	0
45	Rigour of risk management	0	4	0.00	0.00	0.00	0.00	0	0	0	1.00	None	0	0	0
46	Control of project design by Design and Sustainability Consultant	0	2	0.00	2.00	0.50	0.00	3	1	0	0.00	12.00	1	0	0
47	Empowerment of sustainability consultant by client	0	3	0.00	5.00	0.20	0.00	8	1	0	0.00	10.00	1	0	0
48	Project team's involvement in decision-making	0	2	0.00	5.00	0.20	0.00	8	1	0	0.00	10.00	1	0	0
49	Using appropriate project delivery method	1	3	0.00	5.00	0.20	0.00	8	1	0	0.00	10.00	1	0	0
50	Like-mindedness of project team members	0	2	0.00	4.22	0.24	0.00	7	1	0	0.00	11.00	1	0	0
51	Proficiency of FM team	0	3	0.00	0.00	0.00	0.00	0	0	0	1.00	None	0	0	0
52	Proficiency of project team	7	32	0.16	2.65	0.38	0.14	5	7	2	0.00	6.14	5	0	445
53	Project team's understanding of project goals and aspirations	0	3	0.00	0.00	0.00	0.00	0	4	4	0.00	3.50	0	0	0
54	Size of design team	0	2	0.00	4.22	0.24	0.00	7	1	0	0.00	11.00	1	0	0
55	Conflicts among project team	0	1	0.00	4.22	0.24	0.00	7	1	0	0.00	11.00	1	0	0
56	Project team collaboration	7	29	0.14	3.35	0.30	0.03	6	11	7	0.00	3.91	4	0	428
57	Alignment of team interest with project interest	1	9	0.09	4.15	0.24	0.02	7	10	8	0.00	3.40	2	0	291
58	Contractor's proactive role in project development	0	2	0.00	1.00	1.00	0.00	1	1	0	0.00	2.00	1	0	0
59	FM team motivation to achieve sustainable outcomes	0	1	0.00	0.00	0.00	0.00	0	1	1	0.00	4.00	0	0	0
60	Project team motivation to achieve sustainable outcomes	5	20	0.08	4.08	0.25	0.09	7	9	6	0.00	5.50	3	1	243
61	Establishing and promoting synergies	0	2	0.00	0.00	0.00	0.00	0	1	1	0.00	1.00	0	0	0
62	Focus of sustainability consultant on project goals	0	1	0.00	0.00	0.00	0.00	0	0	0	1.00	None	0	0	0
63	Open-mindedness and flexibility of project team	0	3	0.00	4.11	0.24	0.50	7	2	0	0.00	7.00	2	0	0
64	Priority of sustainability in project development	0	9	0.00	2.00	0.50	0.00	3	2	1	0.00	7.00	1	0	3
65	Team working on project with innovative mindset	0	1	0.00	0.00	0.00	0.00	0	0	0	1.00	None	0	0	0
66	Team working on project with value management mindset	0	5	0.00	0.00	0.00	0.00	0	0	0	1.00	None	0	0	0
67	Involvement of sustainability consultant in contractor's selection	0	1	0.00	0.00	0.00	0.00	0	0	0	1.00	None	0	0	0
68	Preferences in project team selection	5	12	0.00	4.11	0.24	0.00	7	2	0	0.00	6.50	2	0	0
69	Early engagement of project team	7	30	0.09	2.23	0.45	0.04	5	9	1	0.00	4.13	8	1	246
70	Early introduction of project targets	2	22	0.03	4.73	0.21	0.10	8	5	3	0.00	8.00	2	0	83

Sr. no	Condition	Number of sub-conditions	Frequency	Betweenness Centrality	Average Shortest Path Length	Closeness Centrality	Clustering Coefficient	Eccentricity	Edge Count	Indegree	Is Single Node	Neighbourhood Connectivity	Out degree	Partner of Multi-edged Node Pairs	Stress
71	Timeliness of building approval	0	2	0.00	0.00	0.00	0.00	0	0	0	1.00	None	0	0	0
72	Timeliness of feedback on sustainability documentation	0	1	0.00	0.00	0.00	0.00	0	1	1	0.00	1.00	0	0	0
73	Timely submission of GB certification documentation for review	0	2	0.00	1.00	1.00	0.00	1	1	0	0.00	1.00	1	0	0

D.3. Analysis of network behaviour upon elimination of Success conditions

Table D.3: Analysis of network behaviour upon the elimination of Success conditions

Scenario	Network attributes	Scenario	Network attributes
BC	Clustering coefficient : 0.060 Connected components : 18 Network diameter : 9 Network radius : 1 Shortest paths : 939 (17%) Characteristic path length : 4.181 Avg. number of neighbors : 2.411 Number of nodes : 73 Network density : 0.0 Isolated nodes : 15 Number of self-loops : 0 Multi-edge node pairs : 3 Analysis time (sec) : 0.051	R	Clustering coefficient : 0.025 Connected components : 27 Network diameter : 5 Network radius : 1 Shortest paths : 138 (3%) Characteristic path length : 2.239 Avg. number of neighbors : 1.343 Number of nodes : 67 Network density : 0.0 Isolated nodes : 24 Number of self-loops : 0 Multi-edge node pairs : 1 Analysis time (sec) : 0.031
M	Clustering coefficient : 0.060 Connected components : 18 Network diameter : 7 Network radius : 1 Shortest paths : 471 (9%) Characteristic path length : 2.790 Avg. number of neighbors : 2.333 Number of nodes : 72 Network density : 0.0 Isolated nodes : 15 Number of self-loops : 0 Multi-edge node pairs : 2 Analysis time (sec) : 0.034	S	Clustering coefficient : 0.016 Connected components : 29 Network diameter : 4 Network radius : 1 Shortest paths : 84 (1%) Characteristic path length : 1.810 Avg. number of neighbors : 1.182 Number of nodes : 66 Network density : 0.0 Isolated nodes : 25 Number of self-loops : 0 Multi-edge node pairs : 1 Analysis time (sec) : 0.028

Scenario	Network attributes	Scenario	Network attributes
N	Clustering coefficient : 0.054 Connected components : 19 Network diameter : 7 Network radius : 1 Shortest paths : 352 (7%) Characteristic path length : 2.716 Avg. number of neighbors : 2.141 Number of nodes : 71 Network density : 0.0 Isolated nodes : 16 Number of self-loops : 0 Multi-edge node pairs : 1 Analysis time (sec) : 0.032	T	Clustering coefficient : 0.017 Connected components : 34 Network diameter : 4 Network radius : 1 Shortest paths : 69 (1%) Characteristic path length : 1.855 Avg. number of neighbors : 1.015 Number of nodes : 65 Network density : 0.0 Isolated nodes : 30 Number of self-loops : 0 Multi-edge node pairs : 1 Analysis time (sec) : 0.063
O	Clustering coefficient : 0.039 Connected components : 19 Network diameter : 7 Network radius : 1 Shortest paths : 340 (7%) Characteristic path length : 2.744 Avg. number of neighbors : 2.029 Number of nodes : 70 Network density : 0.0 Isolated nodes : 16 Number of self-loops : 0 Multi-edge node pairs : 1 Analysis time (sec) : 0.067	U	Clustering coefficient : 0.005 Connected components : 36 Network diameter : 4 Network radius : 1 Shortest paths : 65 (1%) Characteristic path length : 1.908 Avg. number of neighbors : 0.90625 Number of nodes : 64 Network density : 0.0 Isolated nodes : 31 Number of self-loops : 0 Multi-edge node pairs : 1 Analysis time (sec) : 0.07
P	Clustering coefficient : 0.030 Connected components : 22 Network diameter : 7 Network radius : 1 Shortest paths : 205 (4%) Characteristic path length : 2.410 Avg. number of neighbors : 1.768 Number of nodes : 69 Network density : 0.0 Isolated nodes : 19 Number of self-loops : 0 Multi-edge node pairs : 1 Analysis time (sec) : 0.05	V	Clustering coefficient : 0.006 Connected components : 37 Network diameter : 4 Network radius : 1 Shortest paths : 58 (1%) Characteristic path length : 1.862 Avg. number of neighbors : 0.857 Number of nodes : 63 Network density : 0.0 Isolated nodes : 31 Number of self-loops : 0 Multi-edge node pairs : 1 Analysis time (sec) : 0.046
Q	Clustering coefficient : 0.022 Connected components : 26 Network diameter : 5 Network radius : 1 Shortest paths : 158 (3%) Characteristic path length : 2.215 Avg. number of neighbors : 1.529 Number of nodes : 68 Network density : 0.0 Isolated nodes : 23 Number of self-loops : 0 Multi-edge node pairs : 1 Analysis time (sec) : 0.026	W	Clustering coefficient : 0.0 Connected components : 43 Network diameter : 3 Network radius : 1 Shortest paths : 22 (0%) Characteristic path length : 1.182 Avg. number of neighbors : 0.613 Number of nodes : 62 Network density : 0.0 Isolated nodes : 34 Number of self-loops : 0 Multi-edge node pairs : 0 Analysis time (sec) : 0.046

D.4. Association of Success conditions with previous research on Green Building projects

Table D.4: Association of Success conditions with previous research on Green Building projects

Theme	Sr.no	Identified conditions and sub-conditions	Overall participants	Driver	Critical Success Factors	Project Delivery Attribute	Risk	Barrier	Performance criterion	Failure factor	Source	Description
				D	C	P	R	B	M	F		
Changes during project development and fulfilling design intent	1	Change in project team members	2									
	2	Execution of sustainable design during construction	5		×		×				C (Y. Y. Li et al., 2011); R (Zou & Couani, 2012)	(R) Subcontractor unable to conform to specifications; (C) Strong/detailed effort in construction
	3	Scope changes during project execution	9		×	×	×	×	×		C (Kiani Mavi & Standing, 2018); P (Bon Gang Hwang et al., 2015; Bon Gang Hwang et al., 2016); R (Qin et al., 2016); B (Bon Gang Hwang & Ng, 2013); M (El Asmar et al., 2013; Enache-Pommer & Horman, 2009)	(M) Project Changes/Rework; (B) High frequency of design alterations and variations during construction; (R) Changes in GB evaluation standard; (C) Avoiding design changes; (C) Minimal scope change; (C) Minimising change orders during construction
	3.1	Permanence in client's requirements during project delivery	2		×						C (B. G. Hwang et al., 2017)	(C) Moderate variation in requirements during construction
	3.2	Client's motivation to achieve original project intent	3									
	4	Clarity in process of developing project	9			×					P (Enache-Pommer & Horman, 2009)	(P) Transparent delivery process
Clarity in project development	4.1	Use of clearly defined and standardised approaches for GB development	5		×		×				C (B. G. Hwang et al., 2017; Robichaud & Anantamula, 2010); R (Zou & Couani, 2012)	(R) Non-standard workflows; (C) Designing building in accordance with standards; (C) Following LEED checklist and documenting system at the feasibility stage
	5	Delegating clear responsibilities to project team	6		×	×	×	×			C (Banihashemi et al., 2017; Pheng Low et al., 2014); P (Elforgani et al., 2014); R (Qin et al., 2016); B (Lam et al., 2009; Shi et al., 2013)	(R) Lack of clarity related to the responsibility of later upgrades in the building; (B) Lack of certainty in the liability for project-related works; (R) Lack of clarity in the responsibility of green certification; (C) Clear written lines of responsibilities; (C) Creating accountabilities, expectations, roles and responsibilities; (P) Clarity of Design Team Roles
	5.1	Project team contractually required to deliver sustainable outcomes	2		×	×					C (Pheng Low et al., 2014); P (S Korkmaz et al., 2010; S. Korkmaz et al.,	(P;C) "Green" requirements in the contract

Theme	Sr.no	Identified conditions and sub-conditions	Overall participants	Driver	Critical Success Factors	Project Delivery Attribute	Risk	Barrier	Performance criterion	Failure factor	Source	Description
				D	C	P	R	B	M	F		
Client's characteristics											2011; Molenaar et al., 2009; Swarup et al., 2011)	
	5.2	Provision of sustainability specifications and other related information in tender	4									
	5.3	Specificity of deliverables from Design Consultants	2									
	6	Client's leadership in project	3									
	7	Consensus within client organisation	2		x			x		x	C (B. Aktas & Ozorhon, 2015; Bakar et al., 2009; Bond, 2010; B. G. Hwang et al., 2017; Ihuah et al., 2014; Kiani Mavi & Standing, 2018; Y. Y. Li et al., 2011; Pheng Low et al., 2014; Shen et al., 2017; Venkataraman & Cheng, 2018); B (Afshari, Issa, & Peng, 2013; Chan, Darko, Ameyaw, & Owusu-Manu, 2017; Dalibi et al., 2017; Lam et al., 2009; Shi et al., 2013); F (Venkataraman & Cheng, 2018)	(B) Competing stakeholder interests; (B) Conflicting interests among stakeholders in adopting green technologies; (B;C) Support from senior management and decision-makers; (F) Conflicts in the selection of GB credits or process
	8	Proficiency of project client	20		x	x					C (B. G. Hwang et al., 2017); P (Elforgani et al., 2014)	(C) Client's ability to clearly convey project objectives and goals; (P) Clients' experience of GBs; Client's capability of managing design process
	8.1	Client understanding the need of sustainable outcomes	5		x						C (Ahn & Pearce, 2007)	(C) Owners aware of potential savings from GB project
	8.2	Client's understanding of GB requirements	12			x					P (Elforgani et al., 2014)	(P) Clients' knowledge of GBs
	8.3	Client's understanding of sustainable building operation	2									
	8.4	Client's rational decision-making	1		x	x					C (C. B. Aktas et al., 2012; Pheng Low et al., 2014); P (Gultekin et al., 2013; S. Korkmaz et al., 2011; Molenaar et al., 2009)	(C;P) Owner's ability to define the scope and make decisions; (C) Responsiveness of building owner
	9	Structure and nature of client organization	5			x		x			P (Sinem Korkmaz et al., 2010); B (Afshari et al., 2013; Hoffman & Henn, 2008)	(P) Owner type; (B) Lack of organisational structure effectiveness

Theme	Sr.no	Identified conditions and sub-conditions	Overall participants	Driver	Critical Success Factors	Project Delivery Attribute	Risk	Barrier	Performance criterion	Failure factor	Source	Description
				D	C	P	R	B	M	F		
Completeness and rigour of deliverables	10	Completeness of project documentation for certification	2									
	11	Completeness and rigour of project design before execution	9		x	x		x			C (B. G. Hwang et al., 2017); P (Gultekin et al., 2013; Bon Gang Hwang et al., 2016); B (Lam et al., 2009; Shi et al., 2013)	(P) Completion level of construction documents; (B) Imperfect green technological specifications; (C) Completeness and adequacy of project design and specifications
	12	Setting of a detailed sustainability charter or brief	10									
Constraints	13	Access to sustainable building materials	2		x	x	x	x			C (Kiani Mavi & Standing, 2018); P (Bon Gang Hwang et al., 2016); R (Bon Gang Hwang, Ming Shan, Helena Phua, et al., 2017; Bon Gang Hwang, Ming Shan, & Nur Nadiah Binte Supa'at, 2017; G. M. Zhang, Mosly, Setunge, & Jin, 2012); B (Ahn et al., 2013; Dalibi et al., 2017)	(R;B) Limited supply of sustainable materials and products; Lack of access to necessary spare parts; (C) Materials availability
	14	Accessibility of project funding	6		x	x	x	x			C (Bakar et al., 2009; Bond, 2010; B. G. Hwang et al., 2017; lhuah et al., 2014; Kiani Mavi & Standing, 2018; Y. Y. Li et al., 2011; Oyebanji et al., 2017; Pheng Low et al., 2014; Venkataraman & Cheng, 2018); P (Bilec, 2008); R (G. M. Zhang et al., 2012); B (Ruparathna & Hewage, 2015a; Sourani, 2011)	(B;R) Lack of funding; (B) Restrictions on expenditure and reluctance to incur higher capital; (C) Strong financial capability of client; (P;C) Adequate funding and resources
	15	Ease of logistics at project location	1		x						C (Oyebanji et al., 2017)	(C) Good accessibility and provision of adequate alternative transport modes
Cooperation and interest of stakeholders	16	Client's involvement in project development	5		x	x					C (Lam et al., 2010; Pheng Low et al., 2014; N. Wang et al., 2013); P (Elforgani et al., 2014)	(C) Client's involvement; (P) Client maintaining active participation in the green design process
	16.1	Client's facilitation of coordination among project team	1									
	17	Client's motivation to achieve sustainable outcomes	32	x	x	x		x		x	D (Ruparathna & Hewage, 2015b); C (B. Aktas & Ozorhon, 2015; Bakar et al., 2009; Banihashemi et al., 2017; Bond, 2010; B. G. Hwang et al., 2017); P (Bilec, 2008; Elforgani et al., 2014; Enache-Pommer & Horman, 2009; Gultekin et	(P;C;D) Owner's commitment towards GB project; (B;F) Lack of motivation from client/property developers

Theme	Sr.no	Identified conditions and sub-conditions	Overall participants	Driver	Critical Success Factors	Project Delivery Attribute	Risk	Barrier	Performance criterion	Failure factor	Source	Description
				D	C	P	R	B	M	F		
											al., 2013; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Molenaar et al., 2009; Olanipekun et al., 2018; Swarup et al., 2011); B (Deng, Yang, Tang, & Tang, 2018); F (Venkataraman & Cheng, 2018)	
	17.1	Client's endorsement of sustainability brief	3									
	17.2	Drivers for client to achieve sustainable outcomes	12			x					P (Sinem Korkmaz, 2007)	(P) Reason to go for "green"
	17.3	Investor's motivation to achieve sustainable outcomes	1			x					P (Elforgani et al., 2014)	(P) Commitment of client organisation to provide finances for GBs
	18	Cooperative role of building control authorities	2									
	19	End-users' operation of building in sustainable ways	12		x						C (Pheng Low et al., 2014)	(C) Tenants' cooperativeness
	19.1	End-users' motivation to achieve sustainable outcomes	1		x		x	x		x	C (Bond, 2010; Ihuah et al., 2014); R (Zou & Couani, 2012); B (Ahn et al., 2013; Chan et al., 2017; Council, 2011; Bon-Gang Hwang & Tan, 2012; Sourani, 2011; K. Williams & Dair, 2007); F (Kiani Mavi & Standing, 2018)	(B;C) End user interest in GB project; (B;R) Resistance to change from conventional to green practices and technology by occupants; (B) Occupant Behaviour; (F) End-user imposed restrictions
	19.2	End-users' understanding of building operation	5		x						C (B. Aktas & Ozorhon, 2015)	(C) Familiarity of end-users with energy-efficiency
	19.3	Tenants contractually required to consider sustainability	2									
	20	Stakeholders' approval of project	4		x		x	x			C (Bond, 2010; Robichaud & Anantatmula, 2010; L. Zhang et al., 2017); R (Qin et al., 2016; Tao & Xiang-Yuan, 2018); B (Afshari et al., 2013)	(B;R) Lack of public awareness and acceptance for GBs; (C) Supportive public cognition; (C) Broad community support; (C) Site selection based on community input
Defining project goals	21	End-users' involvement in defining project aspirations	8		x						C (Bond, 2010; Oyebanji et al., 2017; Rasekh & McCarthy, 2016; Venkataraman & Cheng, 2018; N. Wang et al., 2013)	(C) Community engagement; (C) Active stakeholder involvement; (C) Consulting meetings with tenants/end-users

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				D	C	P	R	B	M	F		
	21.1	FM team involvement in defining project aspirations	1									
	22	Project team involvement in defining project aspirations	3									
	23	Setting appropriate project targets	21		x		x				C (Bakar et al., 2009; Bilec et al., 2009; Bon Gang Hwang et al., 2015; Ihuah et al., 2014; Kiani Mavi & Standing, 2018; Robichaud & Anantatmula, 2010); R (Qin et al., 2016)	(R) Inappropriate orientation of project sustainability goals; (C) Project mission /common goal; (C) Selection of green features that naturally align with the other project goals; (C) Aligning sustainability with the business case and corporate strategy; (C) Need definition, including market conditions, physical needs, environmental goals, and green certification level
	23.1	Clarity in building's operational performance targets	1									
	23.2	Nature of GB certification aspired for project	2	x				x			D (Ahn et al., 2013; Windapo, 2014); B (L. Zhang & Zhou, 2015)	(D) Appropriateness of GB rating systems; (B) Lack of appropriate certification for GBs
	23.3	Sustainability brief aligned with project budget	3		x						C (Robichaud & Anantatmula, 2010)	(C) Ensure that the preliminary budget is aligned with project goals
	23.4	Specificity of project requirements	12		x		x				C (Banihashemi et al., 2017; Bond, 2010; Kiani Mavi & Standing, 2018; Pheng Low et al., 2014); R (Bon Gang Hwang, Ming Shan, Helena Phua, et al., 2017)	(R) Unclear requirements of owners; (C) Clear and realistic goals and objectives; (C) Clear priorities of stakeholders
	24	Stringency level of project sustainability requirements	4	x			x	x		x	D (Thorpe & Graham, 2009); R (Qin et al., 2016; Zou & Couani, 2012); B (Lam et al., 2009; Shi et al., 2013; K. Williams & Dair, 2007); F (Venkataraman & Cheng, 2018)	(B) Unachievable specification requirements; (B;R) High environmental compliance demand for sustainable materials, products and technologies; (B) Low flexibility for alternatives or substitutes; (B;R;D) Excessively complex codes and regulations on GB and sustainable construction; (F) Setting ambitious green targets
	24.1	Stringency level of GB certification requirements	2									

Theme	Sr.no	Identified conditions and sub-conditions	Overall participants	Driver	Critical Success Factors	Project Delivery Attribute	Risk	Barrier	Performance criterion	Failure factor	Source	Description
				D	C	P	R	B	M	F		
Design methodology	25	Market survey to identify successful building systems	1									
	26	Rigour of project design development	41		x	x		x			C (Y. Y. Li et al., 2011; Oyebanji et al., 2017); P (Gultekin et al., 2013; Bon Gang Hwang et al., 2015; Bon Gang Hwang et al., 2016); B (Worzala & Bond, 2011)	(B) Lack of efficient design; (P) Use of Quantitative metrics; (C) Strong/detailed effort in design; (C) Regular inspection of design specification and building code to prevent discrepancy; (C) Economic design and efficient use of resources; (C) Appropriate land use and development plan; (C) Check for errors and discrepancies in design documents before submission for approval to avoid deviations or corrections; (C) Performing sufficient studies and analysis on the project requirements and complexity before working on the project
	26.01	Adding adaptability and multiple layers of use in building design	1		x						C (B. G. Hwang et al., 2017)	(C) Adding flexibility in design to allow future expansion
	26.02	Use of reliable technology and solutions	2		x	x	x	x			C (Oyebanji et al., 2017); P (Bon Gang Hwang et al., 2016); R (Bon Gang Hwang, Ming Shan, & Nur Nadiah Binte Supa'at, 2017; Qin et al., 2016; G. M. Zhang et al., 2012); B (Ahn et al., 2013; Chan et al., 2017; Bon Gang Hwang & Ng, 2013; Lam et al., 2009; Shi et al., 2013; L. Zhang & Zhou, 2015)	(B;R) Uncertainty regarding durability/reliability of green materials, technology and equipment; (C) Adopting tried and tested technologies; (C) Using appropriate construction technology
	26.03	Design consideration towards future building usage	3									
	26.04	Level of complexity in project design	4		x			x			C (B. G. Hwang et al., 2017; Kiani Mavi & Standing, 2018); B (Chan et al., 2017; Kershaw & Simm, 2014)	(B) Complexity and rigid requirements involved in adopting GB technologies; (B) Complexity of building systems; (C) simplicity/low level of complexity in building design

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				D	C	P	R	B	M	F		
Theme	26.05	Life-cycle based project development approach	4		x		x	x			C (Kiani Mavi & Standing, 2018; Lam et al., 2010; Robichaud & Anantatmula, 2010; N. Wang et al., 2013); R (Qin et al., 2016); B (Sourani, 2011)	(B;R) Lack of long-term, life-cycle perspective; (C) Using whole life costing approach; (C) Whole life project management
	26.06	Maintainability considered in building design	3									
	26.07	Speculation in building design	7					x			B (Dadzie, Runeson, Ding, & Bondinuba, 2018; Bon Gang Hwang & Ng, 2013)	(B) Unreliable energy-saving projections; (B) Unforeseen circumstances in executing GB projects
	26.08	Suitability of the project design for execution	3		x		x				C (B. G. Hwang et al., 2017); R (Qin et al., 2016)	(R) Poor constructability of innovative designs; (C) Design of building to fulfil constructability
	26.09	Use of a proactive design approach	5									
	26.1	Use of balanced design approach	1									
	26.11	Use of context-oriented design approach	3				x				R (Qin et al., 2016)	(R) Design not tailored to local conditions
	26.12	Use of energy-oriented design approach	12		x	x					C (N. Wang et al., 2013); P (Enache-Pommer & Horman, 2009; Gultekin et al., 2013; S. Korkmaz et al., 2011)	(P) Use of energy and lighting simulations; (C) Focus on energy-efficiency
	26.13	Use of holistic design approach	9		x						C (Bond, 2010)	(C) Ensuring the interior fit-out matches the base building
	26.14	Use of innovative design approach	6									
	26.15	Use of integrated design approach	13		x	x					C (Bond, 2010); P (Bilec, 2008; Enache-Pommer & Horman, 2009; Gultekin et al., 2013; Hanks, 2015; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Sinem Korkmaz et al., 2011; Molenaar et al., 2009; Swarup et al., 2011)	(P) Design Integration; (C) Integrated approach to design
	27	Use of performance-based specifications	1									
	28	Educating the client about sustainability in project	6		x						C (Rasekh & McCarthy, 2016)	(C) Educating the client about the features and requirements of GB project
	29	Educating end-users and FM team about building operation	9		x						C (Bond, 2010; Rasekh & McCarthy, 2016; N. Wang et al., 2013)	(C) Having a user guide for building and educating tenants/end-users about optimally using the building; (C)
Education												

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				D	C	P	R	B	M	F		
Engraving sustainability in project development												Advising tenants on efficient use of energy
	30	Educating project team about GB development	8									
	30.1	Educating contractors about GB development	3		×	×					C (Robichaud & Anantatmula, 2010); P (Bon Gang Hwang et al., 2015)	(C) Providing sustainable education to on-site construction personnel
	30.2	Educating sub-contractors about GB development	2		×	×					C (Robichaud & Anantatmula, 2010); P (Bon Gang Hwang et al., 2015)	(C) Training workers to ensure that they operate equipment fully and efficiently
	31	Engraving sustainability in project development	8									
	32	Procurement of project site based on sustainability goals	3		×						C (B. G. Hwang et al., 2017)	(C) Selection of prime location for project
	33	Use of environmental management systems in construction	1									
Flow of project information	34	Clarity in communication of project goals	7									
	35	Communication among project team	11	×	×	×		×	×		D (Häkkinen & Belloni, 2011); C (C. B. Aktas et al., 2012; Bond, 2010; Pheng Low et al., 2014; Shen et al., 2017; Venkataraman & Cheng, 2018; N. Wang et al., 2013); P (Bilec, 2008; Gultekin et al., 2013; Hanks, 2015; Bon Gang Hwang et al., 2015; S Korkmaz et al., 2010; David Riley et al., 2005); B (Bon Gang Hwang & Ng, 2013); M (El Asmar et al., 2013)	(B) Increased meetings and coordination required with green consultants and engineers; (P;C;D) Team communication; (C) Prompt communication with client to avoid misinterpretation; (M) Communication performance
	35.1	Use of effective communication tools and strategies	5		×						C (Bakar et al., 2009; Ihuah et al., 2014; Y. Y. Li et al., 2011; Pheng Low et al., 2014; Robichaud & Anantatmula, 2010; Venkataraman & Cheng, 2018)	(C) Adequate information/communication channels; (C) Design charrettes; (C) Frequent stakeholder meetings
	36	Project team's access to robust information	5		×		×	×		×	C (Bond, 2010; Doskočil & Lacko, 2018; Lam et al., 2010); R (Zou & Couani, 2012); B (Afshari et al., 2013; Chan et al., 2017; Deng et al., 2018; Lam et al., 2009; Shi et al., 2013; Sourani, 2011); F (Venkataraman & Cheng, 2018)	(R) Poor management of green-related information; (B;F) Lack of information regarding green technologies; (B) Inadequate access to relevant knowledge and technologies; (B) Insufficient/confusing guidance, assessment tools, demonstrations and

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Inspection, monitoring, and control												best practices; (C) Knowledge management; (C) Reliability and quality of specification, guide and benchmarking systems
	36.1	Sharing of information related to project changes	1		×						C (Pheng Low et al., 2014)	(C) Effective change management
	37	Smooth transition of project from inception to operation stage	5					×			B (Deng et al., 2018)	(B) Lack of coordination between different stages of GB development
	38	Inspection of project upon construction	8									
	38.1	Execution of commissioning and fine-tuning	7		×	×					C (Robichaud & Anantatmula, 2010); P (Enache-Pommer & Horman, 2009; Kantola & Saari, 2016)	(P;C) Conducting building commissioning to ensure that the building systems function as intended
	39	Monitoring and controlling operational performance of building	5		×						C (Bond, 2010; N. Wang et al., 2013)	(C) Having a sophisticated BMS for monitoring the building to achieve peak performance; (C) Regular operational monitoring; (C) Conducting regular surveys for tenants' feedback
	40	Monitoring of project development	12		×	×					C (C. B. Aktas et al., 2012; Bakar et al., 2009; Banihashemi et al., 2017; B. G. Hwang et al., 2017; Ihuah et al., 2014; Kiani Mavi & Standing, 2018; Y. Y. Li et al., 2011; Pheng Low et al., 2014; Venkataraman & Cheng, 2018; Wai et al., 2012); P (Bon Gang Hwang et al., 2015)	(C) Performance monitoring, feedback and control; (C) Designers' involvement in construction stages; (C) Constant monitoring and feedback; (C) Commitment in monitoring the project progress and ensuring that work is according to specification and meeting quality standards
	40.1	Project reporting	2		×						C (N. Wang et al., 2013)	(C) Regular health and safety reports during construction and operational stages
	41	Review of project design by sustainability consultant	2									
	42	Thoroughness of value engineering exercise	3									
Planning approach	43	Attention towards details	5			×					P (Elforgani et al., 2014)	(P) Design team's attention to green design and construction details
	44	Rigour of project planning	19		×	×		×			C (B. Aktas & Ozorhon, 2015; C. B. Aktas et al., 2012; Bakar et al., 2009; Bond,	(B) Special planning required for non-traditional construction sequences and

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				D	C	P	R	B	M	F		
											2010; B. G. Hwang et al., 2017; Ihuah et al., 2014; Kiani Mavi & Standing, 2018; Pheng Low et al., 2014); P (Bon Gang Hwang et al., 2015; Bon Gang Hwang et al., 2016); B (Bon Gang Hwang & Ng, 2013)	different construction techniques; (C) Adequate planning and sequencing of work; (C) Proper allocation of resources; (C) Ensuring that the plan of work matches with the resources and time to develop the work
	44.1	Adequate budget allocation for project development	13		x		x				C (Bakar et al., 2009; Ihuah et al., 2014; Pheng Low et al., 2014); R (Bon Gang Hwang, Ming Shan, Helena Phua, et al., 2017)	(C) Realistic cost estimate; (R) Overlooking capital cost; (C) Cost management
	44.2	Adequate time allocation for commissioning and testing	1		x						C (Bond, 2010)	(C) Longer commissioning and tuning periods
	44.3	Adequate time allocation for project development	11		x		x	x		x	C (Bakar et al., 2009; B. G. Hwang et al., 2017; Ihuah et al., 2014; Kiani Mavi & Standing, 2018; Pheng Low et al., 2014; Wai et al., 2012); R (Qin et al., 2016); B (Ahn et al., 2013; Bon-Gang Hwang & Tan, 2012; Lam et al., 2009; Shi et al., 2013; Sourani, 2011); F (Venkataraman & Cheng, 2018)	(B;R;F) Lack of enough time to address sustainability issues, and possible delays; (C) Realistic schedule estimate; (C) Time management
	45	Rigour of risk management	4		x						C (Bakar et al., 2009; Bond, 2010; Doskočil & Lacko, 2018; B. G. Hwang et al., 2017; Ihuah et al., 2014; Kiani Mavi & Standing, 2018; Lam et al., 2010)	(C) Incorporating effective risk management
Team authorities, responsibilities, and contractual relationships	46	Control of project design by Design and Sustainability Consultant	2			x					P (Elforгани et al., 2014)	(P) Design team's effectiveness in controlling and monitoring design development
	47	Empowerment of sustainability consultant by client	3									
	48	Project team's involvement in decision-making	2									
	49	Using appropriate project delivery method	3		x	x					C (Bond, 2010); P (Bilec, 2008; Carpenter, 2005; Dahl et al., 2005; El Asmar et al., 2013; Gard, 2004; Gultekin et al., 2013; Hanks, 2015; Kantola & Saari, 2016; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Sinem Korkmaz et al.,	(P;C) Project Delivery System

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Team characteristics											2011; Lei, 2005; Molenaar et al., 2009; David Riley et al., 2005; Swarup et al., 2011; Zhou & Smith, 2013)	
	49.1	Contractual interrelationships between client and project team	2			x					P (Gultekin et al., 2013; S. Korkmaz et al., 2011; Swarup et al., 2011)	(P) Contractual relations for core team members
	50	Like-mindedness of project team members	2									
	51	Proficiency of FM team	3		x		x				C (Bond, 2010; B. G. Hwang et al., 2017; Pheng Low et al., 2014); R (Qin et al., 2016; Tao & Xiang-Yuan, 2018)	(R) Lack of experienced property company and experienced managers to operate the building; (C) Skilled facilities management team; (C) Knowledge of maintenance staff to operate facilities fully and efficiently; (C) Competency of FM team to satisfy end-users' requirements
	52	Proficiency of project team	32		x	x	x	x		x	C (C. B. Aktas et al., 2012; Bakar et al., 2009; Bilec et al., 2009; Bond, 2010; B. G. Hwang et al., 2017; Ihuah et al., 2014; Pheng Low et al., 2014; Shen et al., 2017; Venkataraman & Cheng, 2018); P (Bilec, 2008; Enache-Pommer & Horman, 2009; Gultekin et al., 2013; Hanks, 2015; Bon Gang Hwang et al., 2015; Bon Gang Hwang et al., 2016; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Sinem Korkmaz et al., 2011; Molenaar et al., 2009; Swarup et al., 2011); R (Qin et al., 2016; G. M. Zhang et al., 2012; Zou & Couani, 2012); B (Afshari et al., 2013; Ahn et al., 2013; Chan et al., 2017; Council, 2011; Häkkinen & Belloni, 2011; Lam et al., 2009; B. Li & Yao, 2012; Masrom, Rahim, Ann, Mohamed, & Goh, 2017; Ruparathna & Hewage, 2015a; Shi et al., 2013; Sourani, 2011;	(B;R;F) Lack of expertise and experience in GB development; (B;R) Lack of awareness, understanding, shared information, socio-technical knowledge; (D) Familiarity with sustainable materials, technology and products; (D) Knowledge and training on green technology and materials; (C) Ability to develop good relationships and continuous communications between team members and stakeholders; (C) Education, training and knowledge of project team; (C;P) Team member's experience in GBs; (C) Competence and skills of project team

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				D	C	P	R	B	M	F		
											K. Williams & Dair, 2007); F (Venkataraman & Cheng, 2018)	
	52.1	Leadership qualities among project team members	2			x					P (Elforgani et al., 2014)	(P) Design team's leadership effectiveness
	52.2	Proficiency of contractor	12		x		x				C (B. G. Hwang et al., 2017; Shen et al., 2017); R (Zou & Couani, 2012)	(R) Lack of constructor's/ subcontractor's familiarity with GB-related responsibilities; (C) Competence of contractor; (C) Skilful workers with adequate training in GBs
	52.3	Proficiency of Design Consultant	12		x	x	x	x			C (B. Aktas & Ozorhon, 2015; Bond, 2010; B. G. Hwang et al., 2017; Y. Y. Li et al., 2011; Shen et al., 2017; N. Wang et al., 2013); P (Elforgani et al., 2014); R (Qin et al., 2016; Zou & Couani, 2012); B (K. Williams & Dair, 2007)	(C) Competence of design consultant; (B;C;R) Lack of design consultant's experience and knowledge in GBs; (C) Mix-experienced design team; (P) Design team's experience in construction industry; Design team's experience in similar type and size of project; Design team's decision-making effectiveness; Design team's effectiveness in controlling and monitoring an economic design; Design team's communication effectiveness; Design team's effectiveness of managing conflicts; Design team's knowledge relevant to green design; Design team's knowledge of green design assessment tools; Design team's skills of using design programs; Design team's ability to interpret client needs into an efficient green design; Design team's speed in producing green design drawings; Design team's ability in overcoming green design difficulties
	52.4	Proficiency of MEP Consultant	6									
	52.5	Proficiency of PM team	4		x	x					C (Banihashemi et al., 2017; Bond, 2010; B. G. Hwang et al., 2017; Kiani Mavi & Standing, 2018; Y. Y. Li et al., 2011; Pheng Low et al., 2014; Robichaud & Anantatmula, 2010; Shen	(C) Competence and skilfulness of the Project Manager; (C) Experience and awareness of Project Manager regarding GB development

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											et al., 2017); P (Bon Gang Hwang et al., 2016)	
	52.6	Proficiency of sub-contractor	5		×	×					C (B. Aktas & Ozorhon, 2015); P (Gultekin et al., 2013)	(P) Subcontractor's "green" education; (C) Effectiveness of subcontractor
	52.7	Proficiency of sustainability consultant	5		×						C (B. Aktas & Ozorhon, 2015; Robichaud & Anantatmula, 2010; Shen et al., 2017)	(C) Competence of GB consultant; (C) Experience and awareness of sustainability consultant regarding GB development; (C) Effectiveness of consultant in terms of documentation and material supply
	53	Project team's understanding of project goals and aspirations	3		×						C (Bakar et al., 2009; Ihuah et al., 2014; Wai et al., 2012)	(C) Understanding of project and project objectives
	54	Size of design team	2									
Team collaboration	55	Conflicts among project team	1									
	56	Project team collaboration	29		×		×	×		×	C (Bond, 2010; B. G. Hwang et al., 2017; Y. Y. Li et al., 2011; Venkataraman & Cheng, 2018); R (Qin et al., 2016); B (Afshari et al., 2013; Häkkinen & Belloni, 2011; Bon-Gang Hwang & Tan, 2012); F (Venkataraman & Cheng, 2018)	(B;R;F) Lack of communication and collaboration among project team members; (C) Cooperation among project team; (C) Cooperation between architects and engineers
	56.1	Liaison between design team and client	5			×					P (Elforgani et al., 2014)	(P) Communication effectiveness among client and design team
	56.2	Liaison between FM team and project development team	2		×						C (Rasekh & McCarthy, 2016)	(C) Group meetings of the project team and end-users
	56.3	Liaison between sustainability consultant and client	1									
	56.4	Liaison between sustainability consultant and contractor team	3									
	56.5	Liaison between sustainability consultant and design consultant	4									
	56.6	Liaison between sustainability consultant and project team	5									

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Team commitment to the project	56.7	Willingness of project team to work together	4									
	57	Alignment of team interest with project interest	9		x						C (Bilec et al., 2009; Bon Gang Hwang et al., 2015)	(C) Alignment of team member goals with project goals
	57.1	Rewards for achieving performance targets	2		x	x				x	C (Robichaud & Anantatmula, 2010); P (Sinem Korkmaz, 2007); F (Venkataraman & Cheng, 2018)	(F) Lack of financial incentives; (C) Contracts including incentives for implementing sustainable practices and exceeding sustainability goals; (P) Contract incentives/penalties
	58	Contractor's proactive role in project development	2									
	59	FM team motivation to achieve sustainable outcomes	1									
	60	Project team motivation to achieve sustainable outcomes	20		x	x		x		x	C (B. Aktas & Ozorhon, 2015; Banihashemi et al., 2017; Bond, 2010; B. G. Hwang et al., 2017; Kiani Mavi & Standing, 2018; Y. Y. Li et al., 2011; Shen et al., 2017; Venkataraman & Cheng, 2018); P (Elforgani et al., 2014; Enache-Pommer & Horman, 2009); B (Bon-Gang Hwang & Tan, 2012; Ruparathna & Hewage, 2015a; Sourani, 2011); F (Venkataraman & Cheng, 2018)	(B;F) Lack of interest and commitment among project team members; (C;P) Team commitment to sustainable development; (P) Commitment of Quantity Surveyor to select green materials
	60.1	Contractor team motivation to achieve sustainable outcomes	8									
	60.2	Design Consultant's motivation to achieve sustainable outcomes	10		x	x					C (Murtagh et al., 2016); P (Elforgani et al., 2014)	(C) Motivations of design consultants; (P) Commitment level of the architect to produce green design; Design team's Interest in green design assignments
	60.3	MEP Consultant's motivation to achieve sustainable outcomes	3			x					P (Elforgani et al., 2014)	(P) Commitment of M&E engineers to implement green energy
	60.4	PM team motivation to achieve sustainable outcomes	3		x						C (Robichaud & Anantatmula, 2010)	(C) Efforts of the project manager to achieve project outcomes
	60.5	Sustainability Consultant's motivation to achieve sustainable outcomes	2									

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Team mindset and priorities	61	Establishing and promoting synergies	2		x	x					C (C. B. Aktas et al., 2012; Banihashemi et al., 2017; Bond, 2010; Ihuah et al., 2014; Kiani Mavi & Standing, 2018); P (Enache-Pommer & Horman, 2009; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Sinem Korkmaz et al., 2011; Swarup et al., 2011)	(C) Project team composition and cohesiveness; (P) Team chemistry; (P) Team's prior experience as a unit; (C) Good working relationships among team members; (C) Trust among stakeholders; (C) Well-integrated project team
	62	Focus of sustainability consultant on project goals	1									
	63	Open-mindedness and flexibility of project team	3									
	64	Priority of sustainability in project development	9			x					P (Gultekin et al., 2013; S Korkmaz et al., 2010; Swarup et al., 2011)	(P) Importance of "green" for the project
	65	Team working on project with innovative mindset	1	x	x		x	x			D (Häkkinen & Belloni, 2011); C (B. G. Hwang et al., 2017; Lam et al., 2010; Y. Y. Li et al., 2011; Venkataraman & Cheng, 2018); R (Qin et al., 2016; Zou & Couani, 2012); B (Ahn et al., 2013)	(R) Lack of creativity and innovation; (B;R) Constructor/subcontractor/supplier to use unfamiliar technologies to build green; (C) Use of innovative technological approaches; (C) Innovative management approaches; (D) Development and adoption of innovative methods for GB requirement management; (C) Contractor using advanced technology and automation for construction work
	66	Team working on project with value management mindset	5		x						C (Kiani Mavi & Standing, 2018; Robichaud & Anantatmula, 2010)	(C) Ensuring cost-effectiveness of work; (C) Finalising economic and ecological goals based on cost/benefit analysis
Team procurement methodology	67	Involvement of sustainability consultant in contractor's selection	1									
	68	Preferences in project team selection	12		x	x					C (Bond, 2010; Venkataraman & Cheng, 2018); P (Gultekin et al., 2013; Kantola & Saari, 2016; Sinem Korkmaz, 2007; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; S. Korkmaz et al., 2011; Molenaar et al., 2009; Swarup et al., 2011)	(P) Process for team selection; (P) Team procurement method; (C) Selection of companies relative to the size of the project

Theme	Sr.no	Identified conditions and sub-conditions	Overall participants	Driver	Critical Success Factors	Project Delivery Attribute	Risk	Barrier	Performance criterion	Failure factor	Source	Description
				D	C	P	R	B	M	F		
	68.1	Long-term engagement of sustainability consultant	2		x	x					C (Bond, 2010; B. G. Hwang et al., 2017; Venkataraman & Cheng, 2018; N. Wang et al., 2013); P (Enache-Pommer & Horman, 2009; Gultekin et al., 2013; Sinem Korkmaz et al., 2010)	(P) Involvement of a “green” consultant; (C) Involvement of green professional throughout the project lifecycle; (C) Dedicated department for sustainability
	68.2	Preferences in consultant's engagement	5									
	68.3	Preferences in contractor's engagement	5		x	x					C (Banihashemi et al., 2017; B. G. Hwang et al., 2017; Robichaud & Anantatmula, 2010); P (Bon Gang Hwang et al., 2015)	(C) Emphasis on high-quality workmanship; (C) Comprehensive contractors' portfolio investigation in terms of their level of awareness of the sustainability concept and their previous records of sustainable project implementation; (C) Check contractors' resources and capabilities before awarding the contract; (C) Using open-book subcontracting process which allows the owner to have access to the estimates and pricing submitted by subcontractors
	68.4	Pre-qualification of contractors and sub-contractors	1									
	68.5	Requirement for contractor to engage a sustainability advisor	1									
Timeliness of project activities	69	Early engagement of project team	30		x	x					C (Bilec et al., 2009; Bon Gang Hwang et al., 2015; Shen et al., 2017; Venkataraman & Cheng, 2018); P (Enache-Pommer & Horman, 2009; Hanks, 2015; S. Korkmaz et al., 2011)	(P) Timing of participants' involvement; (C) Early involvement of team members
	69.1	Early engagement of commissioning professionals	3		x						C (Robichaud & Anantatmula, 2010)	(C) Involvement of commissioning professional from the project onset
	69.2	Early engagement of contractor	6		x	x					C (Y. Y. Li et al., 2011); P (Gultekin et al., 2013; S Korkmaz et al., 2010; Sinem Korkmaz et al., 2010; Sinem Korkmaz et al., 2011; Swarup et al., 2011)	(C) Timing of contractors' involvement; (P) Contractors' involvement in design stages
	69.3	Early engagement of design consultants	1									

Theme	Sr.no	Identified conditions and sub-conditions	Overall participants	Driver	Critical Success Factors	Project Delivery Attribute	Risk	Barrier	Performance criterion	Failure factor	Source	Description
				D	C	P	R	B	M	F		
	69.4	Early engagement of FM team	6		x						C (Rasekh & McCarthy, 2016)	(C) Involvement of building operators in the design stage
	69.5	Early engagement of sub-contractor	1									
	69.6	Early engagement of suppliers	2									
	69.7	Early engagement of sustainability consultant	22									
	70	Early introduction of project targets	22									
	70.1	Client's early decision-making regarding sustainability goals	4									
	70.2	Early incorporation of sustainability in project	17		x	x					C (Bilec et al., 2009; Bon Gang Hwang et al., 2015); P (Enache-Pommer & Horman, 2009; Gultekin et al., 2013; S Korkmaz et al., 2010; Swarup et al., 2011)	(P) Timing of introducing "green"; (C) Early evaluation and adoption of environmental considerations
	71	Timeliness of building approval	2			x	x				P (Bon Gang Hwang et al., 2015); R (Bon Gang Hwang, Ming Shan, Helena Phua, et al., 2017)	(R) Complex procedures to obtain approvals; (C) Avoiding setback in review and approval of documents
	72	Timeliness of feedback on sustainability documentation	1									
	73	Timely submission of GB certification documentation for review	2		x						C (Robichaud & Anantatmula, 2010)	(C) Efficient compilation and submission of documentation for certification

D.5. Analysis of Success conditions based on the viewpoints of interview participants

Three viewpoints are used by interview participants to discuss the conditions associated with GB project success. The three viewpoints (which are, '*Findings from successful/failed projects*', '*Findings from participants' overall experience*', and '*Suggestions for clients*') shown in Table 8-3 are exclusively visualised in Figure D.5 which depicts the overlap of identified conditions and sub-conditions across the three viewpoints.

From Part-1 of Figure D.5, it can be seen that the viewpoint of 'successful/failed projects' has conditions with three paradigms, that is (1) they are success-leading, (2) failure-leading, and (3) challenge-leading. Within this viewpoint, 35 conditions and 33 sub-conditions belong to only one out of the three paradigms; 19 conditions and 11 sub-conditions belong to at least two out of the three paradigms; and 8 conditions and 2 sub-conditions concurrently belong to all the three paradigms.

From the Part-2 of Figure D.5, the viewpoint of 'overall experience' has conditions belonging to two paradigms. There are two types of conditions within the success paradigm, that is conditions leading to overall project success and conditions leading to operational success. Similarly, there are two types of conditions within Failure paradigm, that is conditions leading to overall project failure and conditions leading to operational failure. In Figure D.5 (Part-2) the overlap of the four types of conditions (that is conditions for operational success, operational failure, overall success, and overall failure) is shown.

Part-3 of Figure D.5 shows an overlap among the conditions identified within the three viewpoints (that is '*Findings from successful/failed projects*', '*Findings from participants' overall experience*', and '*Suggestions for clients*'). Overall, the highest number of conditions (57) and sub-conditions (72) are identified within the viewpoint of 'overall experience'. Least number of conditions (23) and sub-conditions (24) are identified within the viewpoint of '*Suggestions for clients*'. This may be owing to the fact that in response to this viewpoint the interview participants were mainly limited to the conditions controllable by a project client. In the case of '*Suggestions for clients*' viewpoint, other than 2 sub-conditions, all the rest of 23 conditions and 22 sub-conditions also concurrently occur within the other two viewpoints. This points out that in case the other two viewpoints are used in interviews for identifying the success factors, the '*Suggestions for clients*' viewpoint has a little contribution in developing an exhaustive dataset of conditions. However, the considerable overlap of this viewpoint with the other two viewpoints do not undermine the importance of this viewpoint for a qualitative inquiry since such an investigation is more than the mere identification of conditions. Overall, 45 conditions and 46 sub-conditions are identified in at least two out of the three viewpoints; and 28 conditions and 36 sub-conditions are exclusively identified in one of the three viewpoints. This highlights the importance of using multiple viewpoints in developing an exhaustive dataset of Success conditions.

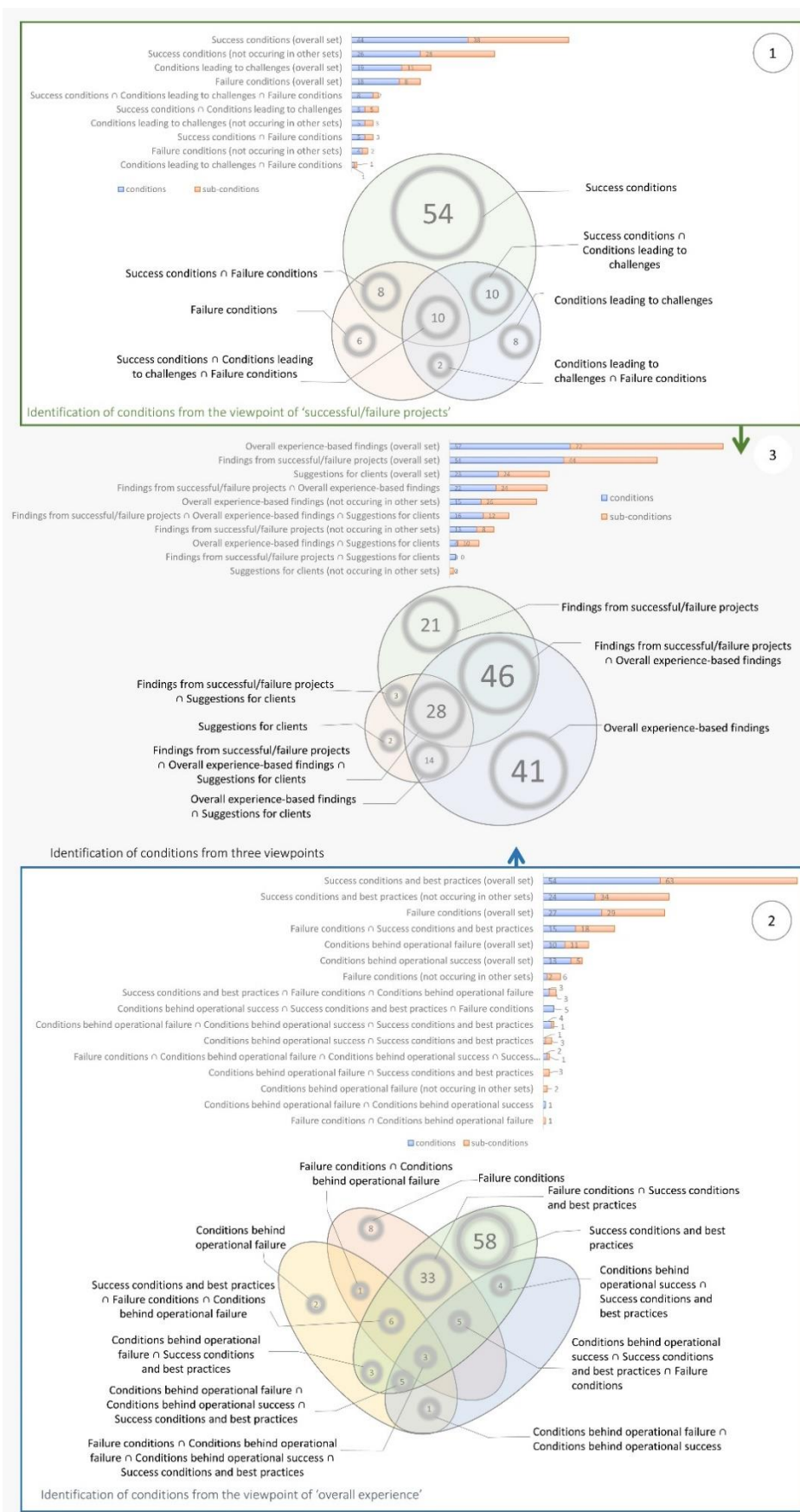


Figure D.5: Overlap of conditions responding to the viewpoint of 'Successful/failed projects', 'Overall experience', and 'Suggestions for clients'

D.5.1. Viewpoint-1: Findings from the overall experience of interview participants

From the viewpoint of their overall experience of GB projects, interview participants have identified conditions and sub-conditions leading to success and failure of GB project development as well as operation.

Up to 55 interview participants associated 106 conditions with the success of GB project development (shown in Column H of Table 8-3). Among these conditions, 72 (68%) are highlighted by multiple interview participants. Some of the conditions discussed by more than 11 participants include 'Rigour of project design development' (n=21), 'Proficiency of project team' (n=21), 'Project team collaboration' (n=15), 'Early engagement of project team' (n=14), and 'Client's motivation to achieve sustainable outcomes' (n=12).

Up to 30 interview participants associated 56 conditions with the failure of GB project development (shown in Column D of Table 8-3). Among these conditions, 29 (52%) are highlighted by multiple interview participants. Some of the conditions discussed by more than 5 participants include 'Rigour of project design development' (n=11), 'Proficiency of project team' (n=7), 'Rigour of project planning' (n=6), and 'Early introduction of project targets' (n=6),

Up to 8 interview participants associated 18 conditions with the operational success of GB projects (shown in Column F of Table 8-3). Some of these conditions discussed by multiple interview participants include 'Educating end-users and FM team about building operation' (n=5), 'End-users' operation of building in sustainable ways' (n=2), 'Smooth transition of project from inception to operation stage' (n=2), 'Inspection of project upon construction' (n=2), 'Early engagement of project team' (n=2),

Up to 10 interview participants associated 21 conditions with the operational failure of GB projects (shown in Column E of Table 8-3). Some of these conditions discussed by multiple interview participants include 'Rigour of project design development' (n=6), 'End-users' operation of building in sustainable ways' (n=2), 'Educating end-users and FM team about building operation' (n=2), 'Smooth transition of project from inception to operation stage' (n=2), 'Monitoring and controlling operational performance of building' (n=2), and 'Proficiency of FM team' (n=2).

D.5.2. Viewpoint-2: Findings from successful/failed projects

The interview participants recalled some challenging, failed, and successful GB projects they have been involved in and highlighted the conditions and sub-conditions resulting in challenges (Column-B), failure (Column-C) and success (Column-G) in those projects. For instance, 2 interview participants associated 'Project team's access to robust information' with challenges (Column-B), 3 interview participants associated 'Scope changes during project execution' with GB project failure (Column-C), and one interview participant associated 'Client's motivation to achieve original project intent' with project success (Column-G).

While referring to the successful/failed projects in their professional careers, the interview participants associated the conditions and sub-conditions with success, failure, as well as challenging circumstances in GB projects. As shown in Figure D.5.1 these conditions have originated from 73 GB projects having a variety of functions (such as office, mix-use, and retail) and spread across 6 regions, that is the UAE (number of projects=7), Australia (n=22), the UK (n=34), Hong Kong (n=4), Pakistan (n=2), and Singapore (n=4). Most of the mentioned projects are office building projects (n=42, 58%), while the rest of the projects (n=31, 42%) have many different functional categories as shown in Figure D.5.1. Further details regarding individual projects are provided in Appendix B (Section B.7).

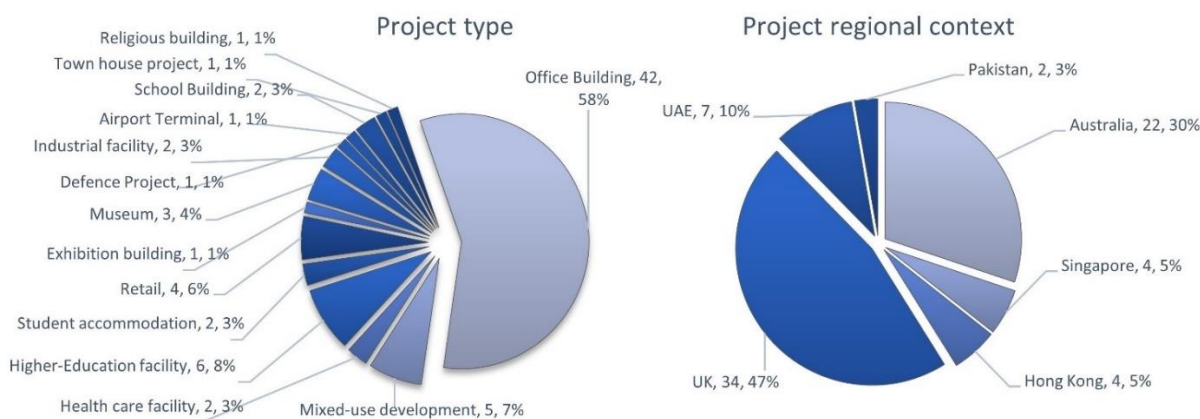


Figure D.5.1: Functional use and regional context of successful/failed Green Building projects discussed in interviews

In the case of the successful/failed projects discussed in interviews 19 conditions and 11 sub-conditions (shown in Column B of Table 8-3) are associated with challenging circumstances by 15 interview participants. The conditions associated with challenges by more than 2 interview participants are 'Rigour of project planning' (n=4) and 'Stringency level of project sustainability requirements' (n=3).

While discussing the successful/failed GB projects in their professional careers, 9 interview participants associated 18 conditions and 8 sub-conditions with project failure (shown in Column C of Table 8-3). The conditions associated with GB failure by more than 1 interview participant are 'Scope changes during project execution' (n=3), 'Priority of sustainability in project development' (n=2), 'Setting appropriate project targets' (n=2), and 'Proficiency of project client' (n=2).

While discussing the GB projects 32 interview participants associated 44 conditions and 38 sub-conditions with project success (shown in Column G of Table 8-3). The conditions associated with GB project success by more than 7 interview participants are 'Client's motivation to achieve sustainable outcomes' (n=20), 'Project team collaboration' (n=13), 'Rigour of project design development' (n=11), and 'Project team motivation to achieve sustainable outcomes' (n=8).

D.5.3. Viewpoint-3: Suggestions for clients

A client is the most influential project team member. Different actions enabled by the project client or through the client's representatives (for instance, Project Manager or architect), can make a substantial difference in the project performance. The interview participants were requested to provide their suggestions from the standpoints of sustainability experts to a fictional client for the development of a GB project.

While discussing the '*Suggestions for clients*', 19 interview participants associated 23 conditions and 24 sub-conditions with project success (shown in Column I of Table 8-3). Up to 22 of these conditions and sub-conditions are highlighted by multiple interview participants. Some of these conditions highlighted by more than 3 participants include 'Early engagement of project team' (n=9), 'Early introduction of project targets' (n=5), and 'Proficiency of project client' (n=4).

The suggestions for a client, are not merely applicable in parts. Instead, it is important that the client observes these suggestions collectively and in a timely manner.

According to an Australia-based interview participant (AU-F-5),

“The client needs to finalise the level of the certification; the project will strive for. Afterwards, the client needs to discuss with a sustainability consultant the credits in the certification system which are the target for the new development. Once the intention of credit is decided, it needs to be documented. This is because on knowing the credits to target, the design consultant is able to design a building accordingly. In case the client adds something in the program of development after tendering is done, then it starts costing money.”

D.6. Analysis of Success conditions based on the attributes of interview participants

The identified Success conditions are analysed based on participants' role in GBs, region of belonging, and experience of working on GBs.

D.6.1. Success conditions according to the role of interview participants in Green Building projects

Professionals belonging to different disciplines of the construction industry may associate different conditions with project success. Considering this, the semi-structured interviews in this study are conducted with professionals having different roles in GBs. The key findings of analysis with respect to two prominent roles of GB professionals (that is Design Consultants and Sustainability Consultants) are as follows,

- Up to 19 interview participants having the role of Design Consultants in GBs discussed 53 conditions and 52 sub-conditions (Column J in Table 8-3). Up to 60 of these conditions and sub-conditions are identified by multiple interview participants. Some of the key conditions identified by more than 6 design consultants include 'Rigour of project design development' (n=12), 'Client's motivation to achieve sustainable outcomes' (n=11), 'Setting appropriate project targets' (n=7), 'Proficiency of project team' (n=7), 'Early introduction of project targets' (n=7),
- Up to 21 interview participants having the role of Sustainability Consultants in GBs discussed 53 conditions and 56 sub-conditions (Column K in Table 8-3). Up to 55 of these conditions and sub-conditions are identified by multiple interview participants. Some of the key conditions identified by more than 9 Sustainability consultants include 'Early engagement of project team' (n=12), 'Rigour of project design development' (n=11), 'Proficiency of project team' (n=11), 'Project team collaboration' (n=10), and 'Early introduction of project targets' (n=10),

D.6.2. Success conditions according to the regional belonging of interview participants

The identified Success conditions are analysed in terms of the 6 regions where the participants' experience of GB projects is mainly based. Following are the key findings of this analysis.

- Up to 5 interview participants having their experience of GBs in the UAE discussed 25 conditions and 17 sub-conditions (Column L in Table 8-3). Around 11 (26%) of these conditions are identified by multiple interview participants. Within the identified conditions, 2 conditions are unique for the UAE-based participants as they are not identified by participants from other regions. Some of the key conditions identified by more than 2 participants include 'Client's motivation to achieve sustainable outcomes' (n=3), 'Rigour of project design development' (n=3), 'Project team collaboration' (n=3), and 'Early engagement of project team' (n=3).
- Up to 30 interview participants having their experience of GBs in Australia discussed 62 conditions and 56 sub-conditions (Column M in Table 8-3). From among the conditions identified by Australia-based participants, 8 conditions and 11 sub-conditions are not identified by participants based in other regions. Up to 76 conditions and sub-conditions are identified by

multiple Australia-based participants. Some of the key conditions identified by more than 9 participants include 'Rigour of project design development' (n=16), 'Proficiency of project team' (n=13), 'Client's motivation to achieve sustainable outcomes' (n=11), 'Project team motivation to achieve sustainable outcomes' (n=10), and 'Early introduction of project targets' (n=10).

- Up to 13 interview participants having their experience of GBs in the UK discussed 50 conditions and 54 sub-conditions (Column N of Table 8-3), including 3 conditions and 8 sub-conditions unique in terms of regional context. Up to 56 of these conditions and sub-conditions are identified by multiple interview participants. Some of the key conditions identified by more than 6 participants include 'Client's motivation to achieve sustainable outcomes' (n=9), 'Project team collaboration' (n=9), 'Proficiency of project team' (n=8), and 'Rigour of project design development' (n=7).
- Up to 8 interview participants having their experience of GBs in Hong Kong discussed 32 conditions and 29 sub-conditions (Column O of Table 8-3), including 2 sub-conditions unique in terms of regional context. Up to 22 of these conditions and sub-conditions are identified by multiple interview participants. Some of the key conditions identified by more than 3 participants include 'Rigour of project design development' (n=5), 'Early engagement of project team' (n=5), and 'Client's motivation to achieve sustainable outcomes' (n=4).
- 2 interview participants having their experience of GBs in Pakistan discussed 14 conditions and 11 sub-conditions (Column P of Table 8-3), including 1 sub-condition unique in terms of regional context. Up to 3 of these conditions are identified by multiple interview participants. These conditions include 'Client's motivation to achieve sustainable outcomes' (n=2), 'Proficiency of project team' (n=2), and 'Project team collaboration' (n=2).
- 14 interview participants having their experience of GBs in Singapore discussed 39 conditions and 36 sub-conditions (Column Q of Table 8-3), including 2 conditions and 1 sub-condition unique in terms of regional context. Up to 35 of these conditions and sub-conditions are identified by multiple interview participants. Some of the key conditions identified by more than 4 participants include 'Rigour of project design development' (n=10), 'Setting appropriate project targets' (n=6), 'Early engagement of project team' (n=6), 'Proficiency of project team' (n=5), and 'Project team collaboration' (n=5).

D.6.3. Success conditions according to the professional experience of interview participants

Three groups are created to analyse the identified Success conditions in terms of the interview participants' professional experience of GB projects (that is in number of years they have worked on GBs). This analysis can help see the effect of participants' professional experience on the identification of Success conditions. There are 22 participants with low to medium-level experience (that is less than 10 years), 32 participants with high-level experience (that is more than 10 but less than 15 years), and 18 participants with very high-level experience (that is 15 years or more). Following are the key findings of this analysis.

- Participants with low to medium-level experience discussed 54 conditions and 58 sub-conditions (Column R in Table 8-3). Up to 56 of these conditions and sub-conditions are identified by multiple interview participants. Some of the key conditions identified by more than 9 participants include 'Project team collaboration' (n=14), 'Proficiency of project team' (n=11), 'Client's motivation to achieve sustainable outcomes' (n=10), 'Rigour of project design development' (n=10), and 'Early engagement of project team' (n=10).
- Participants with high-level experience discussed 61 conditions and 67 sub-conditions (Column S in Table 8-3). Up to 80 of these conditions and sub-conditions are identified by multiple interview

participants. Some of the key conditions identified by more than 11 participants include 'Rigour of project design development' (n=19), 'Client's motivation to achieve sustainable outcomes' (n=14), 'Early engagement of project team' (n=14), 'Proficiency of project team' (n=12), and 'Project team collaboration' (n=12).

- Participants with very high-level experience discussed 55 conditions and 49 sub-conditions (Column T in Table 8-3). Up to 52 of these conditions and sub-conditions are identified by multiple interview participants. Some of the key conditions identified by more than 5 participants include 'Rigour of project design development' (n=12), 'Proficiency of project team' (n=9), 'Client's motivation to achieve sustainable outcomes' (n=7), and 'Early engagement of project team' (n=6).

It is important to notice that 'Client's motivation to achieve sustainable outcomes' is among the top 3 conditions highlighted by all three groups. Moreover, 'Early engagement of project team' is among the top 5 conditions highlighted by all three groups (that is participants with low to medium, high, and very high experience of GB development).

Appendix E

E.1. Overlap among conditions

Appendix E.1 contains the table showing the overlap among Success conditions, Differentiating conditions, and Underlying conditions identified in this study. It provides the basis for comparison of these three types of conditions in Chapter 9.

Table E.1: Overlap among Differentiating, Underlying, and Success conditions of Green Building projects

Conditions	Success conditions	Underlying conditions	Differentiating conditions
Setting of a detailed sustainability charter or brief	x	x	x
Level of complexity in project design	x	x	x
Life-cycle based project development approach	x	x	x
Use of energy-oriented design approach	x	x	x
Use of integrated design approach	x	x	x
Monitoring and controlling operational performance of building	x	x	x
Execution of commissioning and fine-tuning	x	x	x
Preferences in contractor's engagement	x	x	x
Design consideration towards future building usage	x	x	x
Diligence in building system, material and technology selection		x	x
Execution of sustainable design during construction	x	x	
Client's motivation to achieve sustainable outcomes	x	x	
Access to sustainable building materials	x	x	
Using appropriate project delivery method	x	x	
Sustainability brief aligned with project budget	x	x	
Project team involvement in defining project aspirations	x	x	
Rigour of project design development	x	x	
Suitability of the project design for execution	x	x	
Use of clearly defined and standardised approaches for GB development	x	x	
Thoroughness of value engineering exercise	x	x	
Monitoring of project development	x	x	
Adequate budget allocation for project development	x	x	
Adequate time allocation for project development	x	x	
Proficiency of PM team	x	x	
Attention towards details	x	x	
Team working on project with value management mindset	x	x	
Project team's understanding of project goals and aspirations	x	x	
Early incorporation of sustainability in project	x	x	
Use of effective communication tools and strategies	x		x
End-users' involvement in defining project aspirations	x		x
Use of context-oriented design approach	x		x
Use of holistic design approach	x		x
Use of innovative design approach	x		x
Market survey to identify successful building systems	x		x
Project team collaboration	x		x
Liaison between sustainability consultant and project team	x		x
Pre-qualification of contractors and sub-contractors	x		x
Involvement of sustainability consultant in contractor's selection	x		x
Early engagement of project team	x		x
Early engagement of design consultants	x		x
Early engagement of sustainability consultant	x		x
Quality of maintenance		x	
Focus on the capital cost of the project		x	
Focus on reducing operational costs		x	
High consultation requirements		x	
Innovation in building industry		x	
Material delivery time		x	
Regional climate		x	
Rework because of poor workmanship		x	
Use of buffers and contingencies in project planning		x	
Increased budget and delivery time requirement			x

Conditions	Success conditions	Underlying conditions	Differentiating conditions
Intense design activity			x
Higher documentation activity			x
Engagement of sustainability consultant			x
Engagement of an independent commissioning agent			x
Complexity in project development			x
Priority of sustainability in project development	x		
Change in project team members	x		
Scope changes during project execution	x		
Permanence in client's requirements during project delivery	x		
Client's motivation to achieve original project intent	x		
Clarity in process of developing project	x		
Delegating clear responsibilities to project team	x		
Project team contractually required to deliver sustainable outcomes	x		
Provision of sustainability specifications and other related information in tender	x		
Specificity of deliverables from Design Consultants	x		
Client's leadership in project	x		
Consensus within client organisation	x		
Proficiency of project client	x		
Client understanding the need of sustainable outcomes	x		
Client's understanding of GB requirements	x		
Client's understanding of sustainable building operation	x		
Client's rational decision-making	x		
Structure and nature of client organisation	x		
Completeness of project documentation for certification	x		
Completeness and rigour of project design before execution	x		
Accessibility of project funding	x		
Ease of logistics at project location	x		
Client's involvement in project development	x		
Client's facilitation of coordination among project team	x		
Client's endorsement of sustainability brief	x		
Drivers for client to achieve sustainable outcomes	x		
Investor's motivation to achieve sustainable outcomes	x		
Cooperative role of building control authorities	x		
End-users' operation of building in sustainable ways	x		
End-users' motivation to achieve sustainable outcomes	x		
End-users' understanding of building operation	x		
Tenants contractually required to consider sustainability	x		
Stakeholders' approval of project	x		
FM team involvement in defining project aspirations	x		
Setting appropriate project targets	x		
Clarity in building's operational performance targets	x		
Nature of GB certification aspired for project	x		
Specificity of project requirements	x		
Stringency level of project sustainability requirements	x		
Stringency level of GB certification requirements	x		
Adding adaptability and multiple layers of use in building design	x		
Use of reliable technology and solutions	x		
Maintainability considered in building design	x		
Speculation in building design	x		
Use of a proactive design approach	x		
Use of balanced design approach	x		
Use of performance-based specifications	x		
Educating client about sustainability in project	x		
Educating end-users and FM team about building operation	x		
Educating project team about GB development	x		
Educating contractors about GB development	x		
Educating sub-contractors about GB development	x		
Engraving sustainability in project development	x		
Procurement of project site based on sustainability goals	x		
Use of environmental management systems in construction	x		
Clarity in communication of project goals	x		
Communication among project team	x		
Project team's access to robust information	x		
Sharing of information related to project changes	x		
Smooth transition of project from inception to operation stage	x		

Conditions	Success conditions	Underlying conditions	Differentiating conditions
Inspection of project upon construction	x		
Project reporting	x		
Review of project design by sustainability consultant	x		
Rigour of project planning	x		
Adequate time allocation for commissioning and testing	x		
Rigour of risk management	x		
Control of project design by Design and Sustainability Consultant	x		
Empowerment of sustainability consultant by client	x		
Project team's involvement in decision-making	x		
Contractual interrelationships between client and project team	x		
Like-mindedness of project team members	x		
Proficiency of FM team	x		
Proficiency of project team	x		
Leadership qualities among project team members	x		
Proficiency of contractor	x		
Proficiency of Design Consultant	x		
Proficiency of MEP Consultant	x		
Proficiency of sub-contractor	x		
Proficiency of sustainability consultant	x		
Size of design team	x		
Conflicts among project team	x		
Liaison between design team and client	x		
Liaison between FM team and project development team	x		
Liaison between sustainability consultant and client	x		
Liaison between sustainability consultant and contractor team	x		
Liaison between sustainability consultant and design consultant	x		
Willingness of project team to work together	x		
Alignment of team interest with project interest	x		
Rewards for achieving performance targets	x		
Contractor's proactive role in project development	x		
FM team motivation to achieve sustainable outcomes	x		
Project team motivation to achieve sustainable outcomes	x		
Contractor team motivation to achieve sustainable outcomes	x		
Design Consultant's motivation to achieve sustainable outcomes	x		
MEP Consultant's motivation to achieve sustainable outcomes	x		
PM team motivation to achieve sustainable outcomes	x		
Sustainability Consultant's motivation to achieve sustainable outcomes	x		
Establishing and promoting synergies	x		
Focus of sustainability consultant on project goals	x		
Open-mindedness and flexibility of project team	x		
Team working on project with innovative mindset	x		
Preferences in project team selection	x		
Long-term engagement of sustainability consultant	x		
Preferences in consultant's engagement	x		
Requirement for contractor to engage a sustainability advisor	x		
Early engagement of commissioning professionals	x		
Early engagement of contractor	x		
Early engagement of FM team	x		
Early engagement of sub-contractor	x		
Early engagement of suppliers	x		
Early introduction of project targets	x		
Client's early decision-making regarding sustainability goals	x		
Timeliness of building approval	x		
Timeliness of feedback on sustainability documentation	x		
Timely submission of GB certification documentation for review	x		

E.2. Interpretation of research findings in terms of Green Building certification systems

Appendix E.2 contains the tables (Table E.2.1 and E.2.2) showing the associations of identified Success conditions and criteria with credits occurring in Green Building certification systems. Associations shown in these tables are used to discuss Success conditions and criteria in Chapter 7 and 8.

Table E.2.1: Associations of identified Success criteria with credits occurring in Green Building certification systems

ID	Criteria identified in this study	Design & As Built	performance	Green Star	Living Building Challenge- (Buildings)	Design + Construction	Operations and Maintenance	LEED
				Credit	Credit			Credit
C-1	Building acting as a human-oriented and occupant-centric development	x	x	Light Pollution	Human-powered living	x	x	Light Pollution Reduction
					Civilised environment	x		Surrounding Density and Diverse Uses
					Human scale + humane places	x		Access to Quality Transit
C-1.01	Users satisfied from building performance		x	Occupant Satisfaction			x	Occupant Comfort Survey
C-1.02	Users' health and well-being ensured in building		x	Hazardous Materials	Red list		x	Green Cleaning- Products and Materials
		x	x	Microbial Control		x		Low-Emitting Materials
C-1.03	Users' comfort ensured in building					x		Building Product Disclosure and Optimisation
		x	x	Acoustic Comfort		x		Acoustic Performance
		x	x	Lighting Comfort		x	x	Thermal Comfort
		x	x	Thermal Comfort			x	Daylight and Quality Views
		x		Visual Comfort				
C-1.04	Good Indoor Environment Quality ensured in building		x	Daylight & Views				
		x	x	Indoor Air Quality	Healthy interior environment	x	x	Minimum Indoor Air Quality Performance
C-1.11	Building making public happy			Indoor Pollutants				
					Universal access to nature + place			
C-1.12	Building adding value to users' life				Beauty + spirit			
C-1.15	Building bringing people's life close to environment				Biophilic environment			
C-3	Realising sustainable and efficient building operations							
C-3.1	Reduction in energy consumption	x	x	Peak Electricity Demand Reduction	Net positive energy	x	x	Minimum Energy Performance
C-3.4	Transparency in building efficiencies	x	x	Metering and Monitoring		x	x	Water Metering
						x	x	Building-Level Energy Metering
C-5	Building having the minimum impact on environment		x	Groundskeeping	Limits to growth		x	Renewable Energy and Carbon Offsets
		x	x	Ecological Value	Urban agriculture	x	x	Fundamental Refrigerant Management
		x		Heat Island Effect	Habitat exchange	x		Sensitive Land Protection
		x		Sustainable Sites	Net positive energy	x		Building Life-Cycle Impact Reduction
		x		Responsible Building Practices	Red list	x		Building Product Disclosure and Optimisation

ID	Criteria identified in this study	Design & As Built	Performance	Green Star		Living Building Challenge- (Buildings)		Design + Construction	Operations and Maintenance	LEED	
				Credit		Credit				Credit	
			x	Environmental Management		Responsible industry		x	x	Heat Island Reduction	
			x	Green Cleaning		Embodied carbon footprint			x	Site Development-Protect or Restore Habitat	
		x	x	Light Pollution				x	x	Light Pollution Reduction	
		x		Life-cycle Impacts							
			x	Procurement and Purchasing							
		x	x	Refrigerant Impacts							
		x	x	Stormwater							
C-5.1	Reduction in water consumption		x	Fire Protection Testing Water		Net positive water		x	x	Rainwater Management	
		x	x	Potable Water				x	x	Outdoor Water Use Reduction	
								x	x	Indoor Water Use Reduction	
C-5.2	Reduction in greenhouse gas emissions		x	greenhouse Gas Emissions							
C-5.4	Reduction in waste		x	Operational Waste		Net positive waste		x		Construction and Demolition Waste Management	
		x		Construction and Demolition Waste					x	Solid Waste Management	
			x	Waste from Refurbishments							
C-7	Building project acting as a source of learning					Inspiration + education					
C-7.2	Building project supporting industry through innovation	x	x	Market Transformation							
C-12	Building responding to its surroundings					Limits to growth		x	x	Regional Priority	
C-12.1	Building integrated well within community					Universal access to nature + place		x		Surrounding Density and Diverse Uses	
C-13	Building to act as a benchmark	x	x	Improving on Green Star Benchmarks							
C-15	Sustainability considered during building construction	x		Responsible Building Practices				x		Construction Activity Pollution Prevention	
C-17	Innovation involved in building design	x	x	Innovative Technology or Process				x	x	Innovation	

Table E.2.2: Associations of identified Success conditions with credits occurring in Green Building certification systems

Theme	Sr.no	Identified Success conditions and sub-conditions	Green Star		Credit	Criteria (LBC)	LEED		Criteria
			Design & As Built	Performance			Design + Construction	Operations & Maintenance	
Cooperation and interest of stakeholders	17	Client's motivation to achieve sustainable outcomes	x	x	Commitment to Performance				
	19.1	End-users' motivation to achieve sustainable outcomes	x	x	Commitment to Performance				
Design methodology	26.05	Life-cycle based project development approach	x		Life-cycle Impacts		x		Building Life-Cycle Impact Reduction
	26.06	Maintainability considered in building design						x	Facility Maintenance and Renovations Policy
	26.11	Use of context-oriented design approach					x	x	Site Development - Protect or Restore Habitat
							x	x	Regional Priority: Specific Credit
							x		Site Assessment
	26.12	Use of energy-oriented design approach	x	x	Peak Electricity Demand Reduction	Net positive energy	x	x	Demand Response
							x	x	Green Power and Carbon Offsets
							x	x	Minimum Energy Performance
							x	x	Optimise Energy Performance
							x		Renewable Energy Production
	26.14	Use of innovative design approach	x	x	Innovative Technology or Process		x	x	Innovation
	26.15	Use of integrated design approach					x		Integrative Process
Education	28	Educating client about sustainability in project	x	x	Building Information				
	29	Educating end-users and FM team about building operation	x	x	Building Information				
Engraving sustainability in project development	32	Procurement of project site based on sustainability goals	x		Sustainable Sites	Limits to growth	x		High Priority Site
							x		Sensitive Land Protection
							x		Surrounding Density and Diverse Uses
	33	Use of environmental management systems in construction	x		Responsible Building Practices		x		Construction Activity Pollution Prevention
Inspection, monitoring, and control	38.1	Execution of commissioning and fine-tuning	x	x	Commissioning and Tuning		x		Enhanced Commissioning
							x		Fundamental Commissioning and Verification
								x	Ongoing Commissioning
	39		x	x	Metering and Monitoring		x	x	Building-Level Water Metering

Theme	Sr.no	Identified Success conditions and sub-conditions	Green Star			LEED		
			Design & As Built	Performance	Credit	Criteria (LBC)	Design + Construction	Operations & Maintenance
		Monitoring and controlling operational performance of building					x	x
							x	x
							x	x
Team commitment to the project	59	FM team motivation to achieve sustainable outcomes	x	x	Commitment to Performance			
Team mindset and priorities	65	Team working on project with innovative mindset	x	x	Innovation Challenge			
Team procurement methodology	68.1	Long-term engagement of sustainability consultant	x	x	Green Star Accredited Professional		x	x