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RESEARCH METHODS TO INVESTIGATE OCCUPANTS' DOMESTIC ENVIRONMENTAL EXPERIENCES FOR *EXD* FRAMEWORK

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Abstract:

Occupant has holistic experiences in their domestic environments that may affect their health and wellbeing. Nowadays, various research methods are conducting to explore occupants' psychological issues in their living environments. Thus, occupants' domestic environmental experiences need to be examined into architectural design decisions to enhance their health and wellbeing. This study's primary objective is to explore the research methods to investigate occupants' environmental experiences in their domestic living. In this study, relevant literature reviews have been conducted to understand the research methods of exploring occupants' environmental experiences. A series of qualitative and quantitative methodological approaches (mixed-mode) have been considered to triangulate the correlation between occupants' subjective experiences and their wellbeing (i.e., comfortable feeling). Through these research methods, the correlation between environmental design factor (DF), spatial factor (SF) and user context (UC) have been explored in occupants' domestic settings. Structured questionnaire surveys, semi-structured interviews and photo survey techniques have been considered to explore occupants' domestic environmental experience (EXD). For the statistical data interpretations and correlational analysis, the 'Pearson' and 'Association Rules (Apriori)' algorithms have been identified for data mining using SPSS statistics. NVivo will be utilised for the content analysis and image coding to clarify the relationship between DF, SF and UC of occupants according to different domestic environments. Moreover, this methodological approach to exploring occupants' domestic environmental experiences may help develop the notion of domestic 'Environmental Experience Design (EXD)' framework.

Keywords: *Domestic Environment, Environmental Experience, Research Methods, Tools and Techniques*

1. Introduction

The literature studies identify that housing and dwelling environments have been recognised as one of the most prominent settings that may directly or indirectly affect occupants' health and wellbeing (i.e., emotions, feelings and moods) [1]. Occupants' health and wellbeing may be improved by changing or developing living conditions and behaviors related to their household daily experiences and existing physical conditions of domestic environments [1]. Although domestic indoor environmental qualities have been studied extensively before by different research methods, tools and techniques, the research on the occupants' domestic environmental experiences is still insignificant to date in the built environmental design domain [1]. Thus, occupants' domestic environmental experiences need to be examined into architectural design decisions to enhance their health and wellbeing. Therefore, there is a necessity for in-depth studies of occupants' domestic environmental experiences that may affect their wellbeing.

Although various research methods are conducting to explore occupants' psychological issues in their living environments, there is a limitation in investigating occupants' experiences in housing or domestic environments. This study's primary aim is to explore the research methods to investigate occupants' domestic environmental experiences that may contribute to developing the concept of 'Environmental Experience Design (EXD)' methodological framework to enhance occupants' health and wellbeing.

The research investigates outcome solutions to scientific and social problems through objective and systematic analysis [2]. According to the literature, research methods are the strategies or procedures applied in collecting data or evidence for analysis to discover new information and improve understanding of an issue. Different types of research methods use various tools and techniques for data collection [2, 3]. There are mainly three research approaches: (a) qualitative, (b) quantitative, and (c) mixed methods [3]. Here, inquiry procedures are called research designs and specific research methods: data collection, analysis and interpretation approaches [4]. The selection of research methods also depends on the nature of the research problems and the issues addressed. However, researchers' and audiences' personal experiences play an essential role in selecting research methods [3, 4]. The research design contributes a vital role in answering the specific research question according to the research goal. Moreover, research design and methods are closely related where researchers need to make their decisions on how to collect their expected data to answer research questions [3, 4].

2. Identification of Research Gap

From studies, it is clear that in a living condition, occupants' behavior is affected not only by the spatial environment but also by occupants' perceptions, feelings and needs as well as by users' social context [5]. Today's architectural design approaches create a gap between users' spatial needs, demands and architectural design factors along with psychological satisfaction. According to Lawrence (1990), there exists a study gap between two current theories, namely the theory of 'Environmental Deterministic' and 'Social Constructivism' that drive users' experience within space [6]. Here, The environmental deterministic theory based on environmental psychology describes the physical environment's impacts on human behavior. The scope of explanation about users' social, cultural and economic contexts is limited to some extent in this theory. On the other hand, the social constructivism theory describes cultural and social perception as challenging to measure where consideration of built environmental effects is limited [5]. According to the literature, user-centered design between the two spectra derive from the user's physical and psychological experiences and address the user's social, cultural, and environmental aspects (Fig. 1).

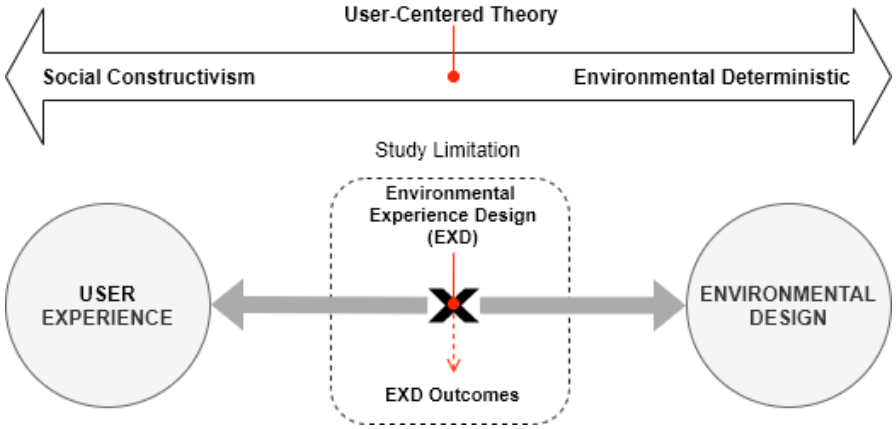

Figure 1. Research gap between '*User Experience*' and '*Environmental Design*' domain.

Architectural design encompasses multidisciplinary disciplines, including human-centered design and decision-making procedures; however, the concept of 'Experience Design' has hardly been applied to architectural design decisions before [7]. Experience design may improve the association between inhabitants' needs and physical settings in the built environment. This new application may change the design concept from a technology-driven idea to a human-centric design decision.

3. Experience Design: A User-Centered Approach

Kling (1977) coined the term 'User-centered Design (UCD),' a person-centric philosophical design approach that focused on the human cognitive interaction with objects, products or things [8]. Later, the concept of UCD became widely popular as 'User Experience (UX) Design' due to the publication entitled 'User-centered System Design: New Perspectives on Human-Computer Interaction' by Donald A. Norman in 1986 at the University of California, San Diego [9]. According to Norman,

> *Human-centered design is a design philosophy. It means starting with a good understanding of people and the needs that the design is intended to meet. This understanding comes about primarily through observation, for people themselves are often unaware of their true needs, even unaware of the difficulties they are encountering. [10]*

Additionally, in the book entitled 'The Design of Everyday Things' Norman expanded the concept of 'Experience Design' in view of the industrial design domain where the author elaborated the concept of human psychology behind design perspective and its' importance in everyday lives considering usability and usefulness [11]. According to the author, experience design is:

> "…*the practice of designing products, processes, services, events, and environments with a focus placed on the quality and enjoyment of the total experience*." [10]

The design needs to interact between people and technology where discoverability and understanding are the two most essential features of the reasonable invention [10]. However, the UX design domain is more human-centered than 'User Interface (UI)' where user thinking, feeling and behaviors are the focal point. In the book entitled 'Design for Experience: Where Technology Meets Design and Strategy', Kim stated that the user is a focal point in experience design. Meanwhile, the design incident is subjective; the humanities and social science theories may cover these issues [12]. According to him, technology innovation theory such as UX/UCD/UI may develop fundamental user experience design logic. However, it's difficult to grasp where to start when it derives from a product or service design [12]. In that case, real design features should be implemented to understand the specific experiential elements.

This term is now widely adopted and UCD/UX definition can be characterised in numerous ways focusing on the user's perspective in the design process based on their needs and demands. For instance, it resulted in difficulties in clarifying user pragmatic needs and demands [13]. In the ISO-standard 9241–210, the user-centered design process has also been endorsed for interactive systems based on people's perceptions and responses [14]. According to the authors, the user-product interrelates with socio-cultural factors in a precise context. Thus, user-centered design raised the philosophical agenda, including users' expectations and experiences. It argued about the clear perception of design usability between end-users, designers and developers, indicating a new emerging design paradigm with many disciplines. Moreover, Thüring and Mahlke draw attention to the perceived instrumental factors, non-instrumental factors and emotional responses

are the three main components of user experience to form a complete decision and regulate user behavior [14]. Finally, the authors mentioned that user experience emphasises perceptions, preferences and emotional responses while using a product or service. To consider these aspects, experience design needs an extended perspective because of human psychological needs that may correlate with the prime design objective's emotional view. In that case, human satisfaction is the core parameter within the interactive design domain.

Referring to Merleau-Pontian than Heideggerian, Pallasmaa believes that an architect's design needs to incorporate with basic human needs of feelings where phenomenological analysis of emotions and feelings is a prominent part of the design. According to Pallasmaa, architectural phenomenology is a purely theoretical approach that captures the essence or interprets human-environmental perception [15]. According to McLellan, functionality, engagement, stimulation, enjoyment and memory are the experience design goals [16]. The book 'The Handbook of Interior Design' also highlights that reflection of human experiences is domineering in indoor living environmental design [17]. A study by Noguchi also projected the concept of 'Environmental Experience Design (EXD)' for aged care facilities in the Australian context [7].

4. Research Hypothetical Construct

An EXD theoretical concept has been developed based on this 'User-centered Design' thematical framework. In this theoretical concept, the user experience's core aspects are concised in three separate components: design factor (DF), spatial factor (SF) and user context (UC). Without understanding occupants' experiences, it may be difficult to identify environmental design solutions to enhance occupants' mental wellbeing or satisfaction. The first component, which concerns environmental design and qualities, deals with the user's needs and demands with existing environmental design aspects. It encompasses indoor environmental elements but also the psychological part of occupants' comfortable feelings. The second component, considering perceived spatial factor focuses on users' spatial experiences and may be linked to user physical, psychological and social needs and demands into their domestic living environments. The last component deals with user contextual factors related to their preferences and restrictions in their living environment that may shape the interaction between design and spatial factors. Thus, this theoretical concept may be applied to extract the 'Environmental Experience Design (EXD)' methodological framework for the domestic environment, as suggested in Fig. 2.

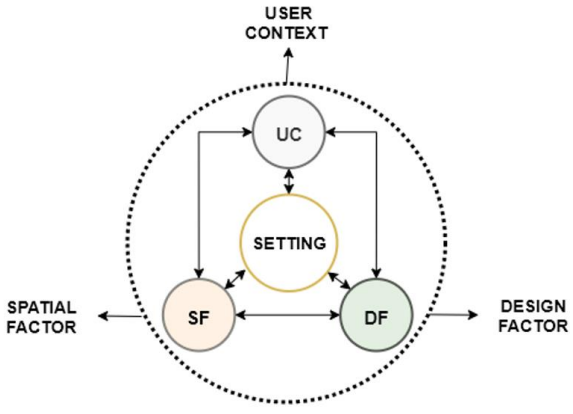

Figure 2. Research hypothetical construct.

5. Research Questions Formulation

Formulating a significant research question (RQ) is essential to exploring an existing ambiguity in specific circumstances or deliberate inquiry areas [2-4]. After narrowing the research subject's

scope and identifying what types of studies have been conducted in the past based on occupants' domestic experiences, primary and sub-research questions will be formulated for further analyses (Fig. 3). In this study, the research question is the following:

What research methods to investigate occupants' domestic experiences (DF, SF and UC) in their living environments to enhance wellbeing?

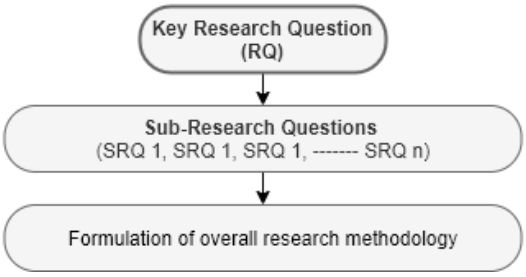

Figure 3. Primary and sub research question formulation.

Based on the research questions, suitable research methodological approaches have been discussed in the following section while considering the study's purpose.

6. Trend of User Experience (UX) and Built Environmental Research Methods

The term 'user experience (UX) design' was developed in the industrial design domain [1]. Here UX that focuses on improving user-product interfaces for usability. The user experience research method indicates creating data and user perceptions [7, 10, 11]. This section identifies the various research methods commonly used in the UX design domain that may influence developing the research methods to investigate occupants' environmental experiences in their domestic environments. The most-frequent research methods used by UX professionals have been illustrated here from the source of UX careers survey reports (Fig. 4).

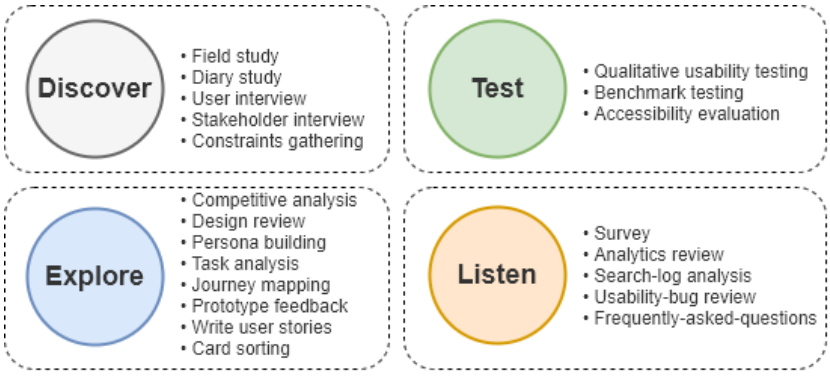

Figure 4. The most-frequent UX research methods.

Figure 5. The most systematic research methods applied in the built environmental researches.

The built environment is a relatively new term and most spatial design settings created by humans are elements of the built environments [18]. The most frequent of the built environmental research consists of cognitive, behavioral, components and emotional aspects. The present trend of existing built environmental research methods is either robust qualitative or quantitative. Nowadays, mixed mode (combined) methods are utilising by researchers in the domain of built environmental researches (Fig. 5).

7. Mixed-mode Research Approach

The term 'mixed-mode' states to develop a research methodology that integrates both quantitative and qualitative data within a single investigation or inquiry. This research integration explores a more comprehensive and interactive data analysis application than the data collected separately by quantitative and qualitative approaches [3, 4].

Mixed methods research initiated in the social sciences research and has recently expanded into the built environmental studies and others [3]. Research methods depend on the functions of research situations where each strategy has its specific approach to collect and analyse empirical data [3]. In this study, to understand research methods of exploring occupants' domestic environmental experiences, a series of qualitative and quantitative methodological approaches (mixed-mode) have been considered to triangulate the correlation between occupants' subjective experiences and their mental wellbeing (i.e., emotions) in existing domestic environments (Fig. 6) [3, 19].

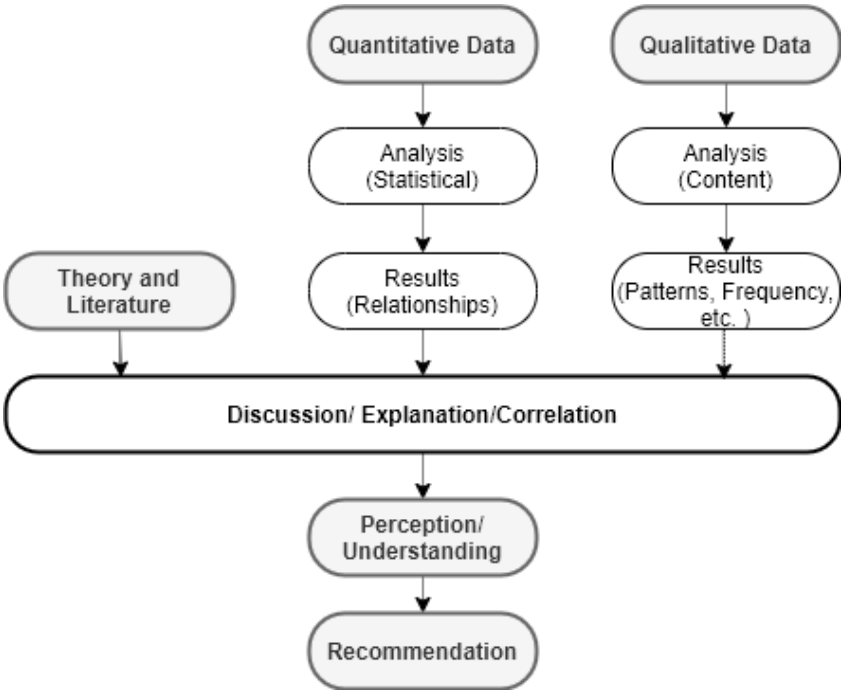

Figure 6. Triangulation of mixed-mode research approach.

Through this research method, the correlational matrix between environmental design factor (DF), spatial factor (SF) and user context (UC) will be explored that may contribute to developing a methodological framework of 'Environmental Experience Design (EXD). In this study, qualitative methods, especially field observations and semi-structured interviews have been allowed the researcher to develop the overall scenario of the occupants' environmental experiences in their existing domestic settings. On the other hand, quantitative analysis using structured questionnaire

survey data will identify the DF and SF's descriptive complements concerning comfortable feeling as occupants' wellbeing.

8. Data Collections Methods

Data collection is one of the most significant phases in directing research that collects information on different variables of research interests [3, 4]. In this study of occupants' domestic environmental experiences, the main research variables are environmental design factor (DF), spatial factor (SF) and user context (UC). Based on these factors, the following methods have been considered to collect data.

a. Literature Review

A literature review is a scholarly survey that is connected to a particular theme or research question [3]. The literature reviews concerning theories related to this research thematic study areas are essential to developing a benchmark and correlational matrix between DF and SF within the built environments. This desk research will help to clarify the notion of occupants' domestic environmental experiences as described above. PubMed, Scopus, Science-Direct, Google Scholar databases and other sources (such as books, journal articles and theses) may be explored to identify the relevant literature based on the thematic study areas.

b. Structured Questionnaire Survey

A structured questionnaire survey is a document with standardized questions for extracting specific information from the respondents [3]. There will be two sections addressing domestic environmental design factors and spatial factors in these structured questionnaire surveys. The participants will be asked straightforward questions based on their existing domestic environments' present conditions, comfortable feeling and future preferences in each section. From the question sheet, participants can understand the specific problem/question. The interviewer put a tick mark or binary (0, 1) or 'yes/no' on the 'Low, Medium, or High' boxes beside each item in the answer sheet according to occupants' responses. The participant will be asked about their experiences on that particular design and spatial factors considering different spaces (i.e., bedrooms, living room, dining room, drawing room, kitchen, toilets, multipurpose, corridor, balcony) in their domestic settings (Fig. 7).

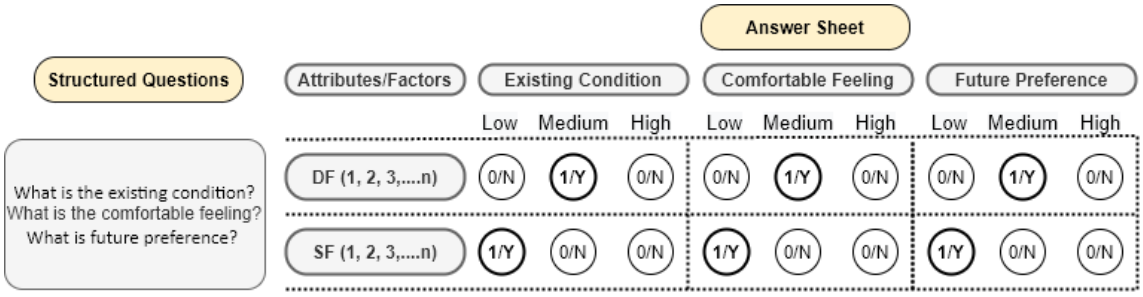

Figure 7. Methods of the structured questionnaire survey.

c. Semi-structured Interview

Here, semi-structured interviews do not strictly follow a formalized list of questions and answers format [3]. The strategy is to listen to the occupants (as interviewees) tell their domestic living experiences using open-ended questions, allowing for a discussion with the interviewee to achieve the goal (Fig. 8). The duration of each interview will be no longer than 30 to 40 minutes for an occupant. In this interview, occupants need to ask their background information,

preferences, restrictions and requests to record their interviews. Occupants may express their daily experiences regarding their emotional responses (positive and negative) in domestic environmental settings. The interviewer encourages interviewees to explain their mental wellbeing status related to different spaces in their daily domestic environments. Occupants may discuss the most recent space-related experiences in their domestic settings and describe their adaptive behaviors. The interviewer is also warming up the interviewee to think about future preferences (needs and wants) and their restrictions on their existing living conditions. Lastly, the interviewee may seek permission to take some photos in their domestic living environments.

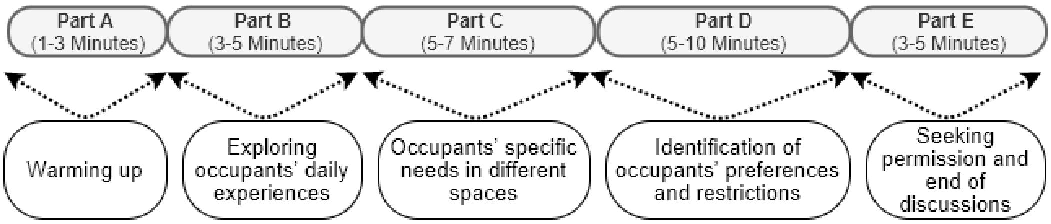

Figure 8. Segmentation of the semi-structured interview.

d. Photographic Survey

The photographic survey is a visual data collection qualitative research method used as a research tool throughout diverse individuals and communities [3, 20]. This research method can filter to explore human-environmental relationships and experiences [3, 4, 20]. Photographic surveys will be carried out to convey information about the occupants' living environments, lifestyle, behaviors and space use patterns or sequences within their existing domestic environments. Photographs will be taken in the different high-density urban dwellings in each case study area, depending on the users' behaviors, space usability and functionality in their residences. This photographic survey's primary purpose is to explore the existing compact living scenarios and occupants' patterns in high-density urban apartments. The photographic survey will be implemented anytime on weekdays or weekends to easily understand occupants' living style in different circumstances in their domestic spaces.

9. Analytical Algorithms:

a. Pearson Correlation Coefficient

Pearson's correlation coefficient (Pearson's *r*) is generally used in statistical analysis (linear regression) to measure how strong a relationship is between two variables [21, 22]. Pearson correlation coefficient (PCC) is a symmetrical algorithm developed by Karl Pearson, which means calculating the similarity of item X to item Y is the same as figuring the similarity of item Y to item X [21, 22]. The initial measures of linear correlation and significance between two variables DF and SF will be extracted from the binary data obtained from a structured questionnaire survey of occupants' present and future domestic environmental conditions and emotional responses by using the 'Pearson' algorithm.

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{[n\Sigma x^2 - (\Sigma x)^2][n\Sigma y^2 - (\Sigma y)^2]}} \qquad \text{.......................................} (1)$$

Where, n = Total number of respondents, x (Target) = SF/EM (1, 2, 3, ….n) and y (Input) = DF (1, 2, 3, ….n)

It has a value range between +1 and −1. A value of +1 is total positive linear correlation, 0 is no linear correlation, and −1 is an absolute negative linear correlation [21, 22]. The correlation and significance between DF, SF and EM factors of occupants' domestic experiences will be identified from this statistical analysis (Fig. 9).

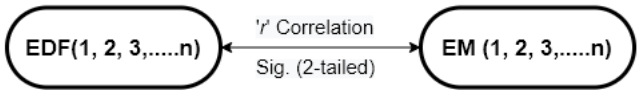

Figure 9. Pearson Correlation Coefficient between EDF and SF/EM.

b. Apriori

Apriori is a statistical algorithm for extracting association rules from data that was developed by Agrawal and Srikant in 1994 [21, 22]. This algorithm discovers frequent item sets from the data and then generates rules from frequent item sets (Fig. 10 and 11). After analysing the correlation by 'Pearson' coefficient (*r*)' and significance, 'Association Rules' can develop the relationship between DF and SF by discovering the most interesting frequent item sets or combinations for 'Mass Customisation' for the occupants to their present scenarios and future preferences. The analytical adjustment will be considered based on confidence (min. 50%), support (80-100%) and lift (+1). Variables in this analysis can be either categorical or continuous. Occupants' emotional (comfortable feeling) and design priority lists of specific spaces in their domestic environment according to their future preferences will help to develop a methodological framework of EXD for the domestic environment that may have a societal impact.

$$\textbf{Apriori} = \begin{cases} Support\ (x) = \dfrac{N_x}{N} \\ Confidence\ (x \rightarrow y) = \dfrac{\text{Support (x, y)}}{\text{Support (x)}} \\ Lift\ (x \rightarrow y) = \dfrac{\text{Support (x, y)}}{\text{Support (x)} \times \text{Support (y)}} \end{cases}$$

Consideration, support (80-100%), confidence (min. 50%), lift (+1)
N = Number of Records

Figure 10. Mathematical modeling of '*Apriori*' algorithm.

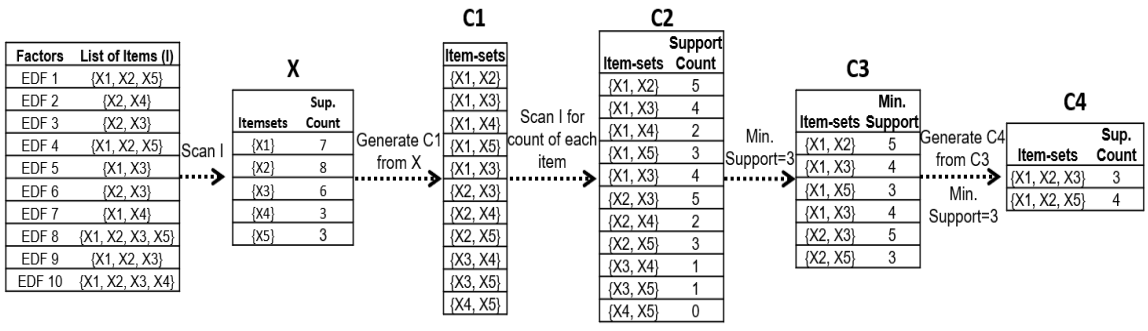

Figure 11. Demonstration of support count in association rules.

c. *Text Mining*

Text and image analysis methods are generally used to extract useful information from many narrative documents. In the text mining methods, word frequency allows to detect trends in the incidence and consider contextual information about the words commonly used in narrations [23]. Tree mapping of text/word frequency can classify and visualise the relationship between different variables. Coding means highlighting sections of text, phrases, sentences or images to describe qualitative data content. Coding helps to bring all types of sources and references together in a single 'node'. In the coding section, 'node' can gather all the responses and information in one place by thematic categorisation. Using a coding chart for a percentage of coverage, visualisation, identifying and developing content becomes easy (Fig. 12) [3, 23].

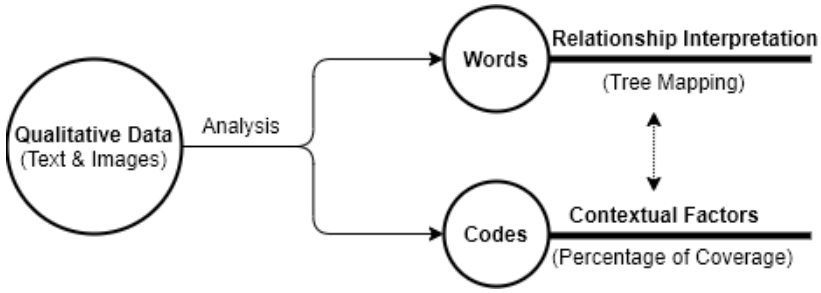

Figure 12. Text and images analysis approach.

10. Quantitative and Qualitative Analytical Tools

a. *Quantitative Data Analysis*

Statistical Package for the Social Sciences (SPSS):

SPSS is a widely used program for statistical analysis in social science. Market, health, education and government researchers also practice statistical data collection, data analysis, data mining, text analysis and data documentation by SPSS. Statistics such as descriptive, bivariate, prediction, correlation and regression analysis are included in the base software. SPSS was developed by Norman H. Nie, Dale H. Bent, C. Hadlai Hull and was initially released in 1968 [21].

IBM SPSS Modular:

IBM SPSS Modeler is a data mining and text analytics software application from IBM. It is used to shape predictive models and conduct other analytic tasks. It has a visual interface that permits users to influence statistical and data mining algorithms and machine learning software without programming. One of its main aims from the outset was to eliminate unnecessary complexity in data transformations and make complex predictive models very easy to use [21].

b. *Qualitative data analysis*

NVivo for Content Analysis:

NVivo is a qualitative data analysis computer software package used across various fields. QSR International produces this software. Australian social scientist Lyn Richards and computer scientist Tom Richards developed this software [23, 24]. NVivo supports qualitative researchers to organize and analyze qualitative data perceptions like interviews, open-ended survey responses, journal articles, social media, photo coding, and web content. NVivo also helps deep levels of analysis on small or large volumes of data are required in research.

11. Overall Research Structure

According to the above discussions, the investigation of occupants' experiences in their domestic settings, this overall research methodological approach may explore the EXD framework for the domestic environment to enhance occupants' health and wellbeing that has been illustrated in Fig. 13. However, this draft proposal of the methodological approach may help explore EXD research and be tested for further application. Hereafter, this method may need to be modified or adjusted after multiple evaluations of occupants' experiences during the study timeline.

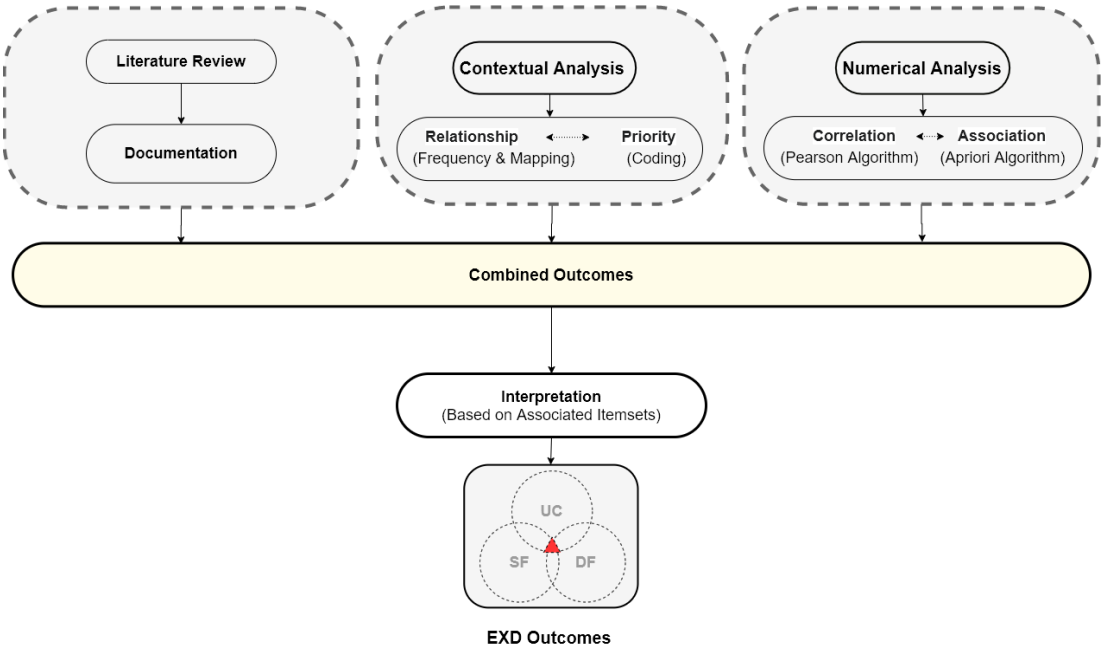

Figure 13. Summary of the overall research methods.

12. Conclusion

Structuring the EXD research methods entails systematising the architectural design decision-making process and selection prioritised of environmental design components that may improve occupants' mental wellbeing. This study aims to develop research methods to investigate occupants' environmental experiences to explore correlations between DF, SF and UC in their existing domestic environments. This overall research approach can help develop the 'Environmental Experience Design (EXD)' methodological framework of domestic environments for rural and urban housing to enhance occupants' health and wellbeing by investigating their living experiences. Subsequently, rethinking architectural design approaches to compact domestic environments into consideration not only housing or dwelling but also other built environmental scenarios that affect occupants' wellbeing before and after COVID-19 will be another concern of this research.

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