Australasian Universities Building Education Association Conference

Construction Education: Live the Future

DEAKIN UNIVERSITY

44th AUBEA

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2021 Conference Themes

Theme 1: Redesigning construction education for the Fourth Industrial Revolution (Industry 4.0)

This theme focuses on defining educational contents that equip construction graduates with the required skills for the jobs of the future, and covers, but is not limited to, the following broad topics:

- curricula that prepare graduates capable of shaping the built environment for individuals and communities to thrive
- improved integration of BIM and Digital Engineering into curricula
- meeting future industry expectations of construction graduates.

Theme 2: Preparing construction graduates for the jobs of the future

This theme emphasises on pedagogical techniques that prepare construction graduates with the required skills for the jobs of the future, and covers, but is not limited to, the following broad topics:

- pedagogical strategies that nurture graduates for the jobs of the future
- construction education to enhance the digital literacy of graduates
- adopting Cloud computing, VR/AR/AI and Gamification in construction teaching and learning
- new and emerging roles in the construction industry.

Theme 3: Innovation and research that makes a difference to our industry

This theme encapsulates research and innovation that is critical to the advancement of the construction industry, and covers, but is not limited to, the following broad topics:

- cutting edge technologies for high performance construction and built environment
- innovative methodologies for enhancing sustainability, quality and resilience in construction
- remodelling processes, productivity and performance of the construction industry.

Theme 4: Value adding to stakeholders and the community

This theme concentrates on industry-focused, applied research that can add value to and enhance industry practices, processes and products, and covers, but is not limited to, the following broad topics:

- best value and best performing products, methods and processes for a sustainable industry and community
- rethinking contracts, ethics, professionalism and diversity for a thriving industry and community
- revamping policies, regulations and codes for a thriving industry and community.

Theme 5: Industry case studies, innovative methods and practices

This theme captures insights from construction industry practitioners' experiences, research and analytic findings, and exemplary case studies. The theme is quite broad and any topic of current interest to construction organisations and industry as a whole can be submitted, including aspects/topics that discuss the expectations of industry from future construction graduates and academia. Similarly, exemplary case studies of the implementation of novel technologies and approaches can be submitted, highlighting insights thereof.

Thursday 28 October

8.30 – 10.50am	**Plenary Session 1** Chair: Prof Anthony Mills		
8.30 – 8.35am	**Welcome to AUBEA** *Prof Imriyas Kamardeen, Deakin University*		
8.35 – 8.45am	**Acknowledgement of Country** *Melinda Kennedy, Wadawurrung, Deakin University*		
8.45 – 8.50	**Council Chair Address** *Prof Monty Sutrisna, Head of School, School of Built Environment, College of Sciences, Massey University*		
8.50 – 9.05am	**Opening Remarks** *Prof Karen Hapgood, Executive Dean, Faculty of Science, Engineering and Built Environment, Deakin University*		
9.05 – 9.10am	**Meet our Sponsors** *Linda Tivendale, Australian Institute of Building*		
9.10 – 9.55am	**How do Universities add value? Research, teaching, employability skills and fostering social and community values** *Hon Prof Norman Faifer, Chartered Builder, Certified Quantity Surveyor, Accredited Adjudicator, Norman A Faifer and Associates*		
9.55 – 10.40am	**Engaging with industry in times of disruption** *Prof Tony Arnel, Industry Professor, Deakin University*		
10.40 – 10.50am	Break		
10.50am – 12.35pm	**Paper Session 1** Chair: Dr Larry Xiancun Hu	**Paper Session 2** Chair: Dr Jamal Thaheem	**Paper Session 3** Chair: Assoc Prof Guillermo Aranda-Mena
10.50 – 11.05am	**Process improvement priorities for BIM related curricula in Australian Universities** *Amer Hijazi and Priyadarshini Das, Western Sydney University*	**Attitude of stakeholders towards the adoption of green building in Ghana: the perspective of construction professionals** *Florence Dadzoe, Department of Construction Technology and Management*	**Building circularity in infrastructure and commercial construction procurement** *Assoc Prof Guillermo Aranda-Mena, RMIT University*
11.05 – 11.20am	**Teaching maths not using newfangled methods –**	**Career Choice, Socio-economic Status of**	**Enhancing employability of project management**

Building circularity in infrastructure and commercial construction

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Abstract

This paper discusses issues, challenges and opportunities to engage with circularity and the circular economy in the property construction and infrastructure sectors. In particular when looking at procurement delivery methods in which operational expenditure (Opex) can offset higher upfront expenditure (Capex). Opportunities are here discussed for governments and the private sector to increase their environmental credentials and project performance. At the heart of this lies engaging with values for circularity through procurement. Two whole of life-cycle procurement methods are discussed in relation to opportunities including: Public-Private Partnerships (PPPs) and Build to Rent (BTR), each presents opportunities for Value for Money (VfM); increased project quality; and reduction of carbon footprint and waste in building and infrastructure projects. This paper concludes with an argument on business opportunities with circularity and whole-of-life-cycle (WoL) in mind. And reminds of the moral and ethical responsibility to all property, construction and infrastructure stakeholders.

Keywords

Procurement, Circular Economy, Infrastructure, Sustainability

1 Building Circularity in Construction

The World Economic Forum recognises the challenges that come with sustainable construction, our current practices are not sustainable. In 2019, over 92 billion tons of materials were extracted from the planed and processed, contributing to about half of the global CO2 emissions. The resulting waste – including construction related materials – is takin gits toll on the environment and human health (WEF 2016). The circular economy, which promote the elimination of waste and continual safe use of natural resources, offers an alternative that can yield up to $4.5 trillion (USD) in economic benefits to 2030. According to the Circular Gap report only 8.6% of the world is circular (2021).

But what do we mean by circular economy or circularity? “Circular development is a model of economic, social and environmental production and consumption that aims to build a sustainable society based on a circular model. The purpose is to be able to form a model that is no longer linear and transforms toward a circular economy. The aim is to enable economies and societies in general to become more autonomous, sustainable and in tune with the issue of environmental resources” (CGRi Report 2021)

The World Economic Forum identifies four key value drivers for generating asset and resource productivity. Their value creation potential results from extending the use of cycle length and count, increasing asset utilisation, while reducing the creation of new product from virgin materials and producing less waste (Intelligent Assets WEF, 2016) With over 80% of global

GDP generated in urban areas, there are multiple opportunities to optimise construction and supply chain material flow, including waste recovery and asset reutilisation.

Although there has been much R&D on circularity and closed-loop construction systems little has been implemented. The authors argue that there are various procurement contractual structures that contribute to its slow uptake including the lineal staged approach of construction contracts from schematic design, design documentation, contract administration and building operations and facilities management (FM). The transformation toward a circular construction and building operations would demand more business integrations across the engrained silos and this means to convert the prevailing lineal structures into circular loops. The construction industry is still in its early steps toward such integration. The construction sector has identified that directly and indirectly contributes for 18% of global greenhouse gas (GHG) emissions, it was the largest consumer of raw and manufactured materials in 2005 and as such it was labelled as a major emitting (polluting) industry. In other studies (Levermore 2008 and Huang et. al 2018) the construction sector is said to account for 40% of primary energy utilization. This condition rises serious concerns on the impact to GHG impact and calls for strategies for tangible CO_2 reduction at various projects stages, from design through construction and int Whole-of-Life cycle (WoL) operations and FM. The question here is on how much procurement methods could directly contribute to the reduction of CO_2 in the WoL of a building on infrastructure project?

The circular economic model is a direct response to the United Nations Global Development Goals and the Sustainable Development Goals to achieve a green economy. It aims at transforming our economy into one that is regenerative in which *waste* is dramatically reduced or become non as the result of a close-loop production model in which product such as building elements, domestic appliances, clothing or cars reutilise materials and components at the end of the life-cycle and thus land field waste is reduced to a minimum.

This paper discusses opportunities for the construction industry to increase circularity and closed-loop models as a requirement within whole-of-lifecycle (WoL) procurement in both, infrastructure, and commercial construction sector. An important component to consider in the WoL procurement in the operational and Facilities Management (FM) stage as it accounts for a majority emission, but which could be reduced at the design and construction stages. Facilities Management and behavioural programs in building occupancy is an important factor to consider when thinking on operational energy and its related carbon emissions. Also, the 'unoccupied' built environment such as roads, bridges, and other infrastructure, also accounts for embodied energy emissions for over 90% of life cycle emissions, for example, this would be the case of the use of concrete (such as Portland cement) for instance. The embodied energy would typically include 1) direct energy which is the energy required for the on-site construction operations (construction, maintenance/renovation and demolition); 2) indirect energy which is the energy required to providing products and services for the construction operations. Most of the energy used in the construction sector are mostly from non-renewable resources thus the urgency to chance our *modus-operands.*

2 Circularity Requirements in Procurement

Project lifecycle also referred as whole-of-life-cycle (WoL) considers the utilisation span of a service, product or building from the design stage, through construction, building operations and Facilities Management. WoL contracting can stretch up to three decades which is often the case of Public-Private Partnerships for the delivery of economic and social infrastructure (Grimsey and Mervin, 2013). In the private WoL procurement which can take the form of the

increasing popular model Build to Rent (BTR). Both methods provide an opportunity to maximise value as WoL plays a role in evaluating improved overall services (output specifications) and risk management which looks at shifting the risk from the client into private sector consortium. In the case of PPPs transferring risk to the private sector experts who can bear the cost of design, construction over-runs are a way in which PPPs can potentially add value for money in a public project. In both, PPP and BTR construction risk are not the only aspect to be addressed. There are also risks attached to site use, building quality (or standards), operations, revenue, financial conditions, service performance, obsolescence, and residual asset value, amongst other. Other WoL construction and procurement methodologies including Design-Build-Operate (DBO) had the advantage of including building operations in the design team. Grimsey and Mervin (2005) define Value for Money as 'the optimum combination of whole life cost and quality to meet the user's requirements. These scenarios present opportunities for increasing *circularity requirements* and close-loop systems (fully defined in next section) to increase project long term (1) quality, (2) operational performance and (3) waste reduction.

In defining **quality** as general term applicable to any trait or characteristic whether individual or generic. Quality is defined by the Merriam-Webster dictionary as *'how good or bad something is,'* also as a characteristic or feature that someone or something has: seeming that can be noticed (or felt) as part of a person or thing. Quality often denotes something of a high level of value or excellence (in which quality is an adjective rather than a noun). In building and architecture, quality might simply be *'fitness for purpose.'* Authors such as Cook became seminal references for the objective (technical) evaluation of design quality including areas of architecture, environment, user comfort, WoL costing operations known as Operational Expenditure (OpenX), detail design and user satisfaction. In more recent times international benchmarks of building quality such as the building occupancy survey (BUS, 2017) and WELL (2020) have become a standard or quality reference for corporate tenants. Both provide a method to benchmark buildings international as to providing keep performance indicators (KPIs) for auditing purposes. Questions of quality in high rise residential construction in mayor Australian capital cities have emerged after recent events of facades catching fire or signs of cosmetic and structural defects in new developments. Governments have also increased occupant/end-user evaluations of infrastructure services such as in transport, health, and education. Either public or private construction needs to bring quality back as a core output and better finance, procurement methods with a strong operations and service delivery need to increase uptake. The next two subheadings introduce PPP and BTR.

In defining **building operations performance,** we can simply think on energy consumption and green principles from not only from building operations and Facilities Management aspect of mechanical, electrical, plumbing and air-conditioning (MEP/AC) equipment but also from green building occupant behaviour too. This has increased to attract attention, with commercial office spaces and ways to benchmark occupant wellbeing as an indicator of operations performance. This approach brings the discussion on an early design stage the durability of equipment and materials, cleaning and maintenance costs, energy efficiency to balance as an example option for passive construction solution, that can be expensive initially versus the offset of costs in cooling and heating energy bills. Recently, the Australian government created the Clean Energy Finance Corporation (CEFC, 2021), to boost clean, green rental stock and extend the benefits of clean energy to Australian renters. Following this commitment some initiatives were taking in place to finance project in built-to-rent (BTR), like Qualitas which made available a new fund to finance the construction and management of energy efficient, low emissions build-to-rent (Qualitas, 2020) residential buildings .

Waste reduction, construction is notoriously known for being a highly wasteful sector. Building operations and FM also contribute to waste production during the lifecycle of a project. Incentives to reduce waste should make business senses. In traditional contracting incentives are next to know. This is because of the silo effect of contracting which opposes the principles of circularity, the circular economy, and close loops systems. Waste reduction must be an integral decision process vertically and horizontally such as design-construction-operations and supply chain.

2.1 Building Circularity in Public-Private Partnerships

Public Private Partnerships (PPPs) are a refinement of the private financing initiatives for infrastructure that started in the early 1990s and describe the provision of public assets and services through the participation of the government, the private sector, and the consumers (Grimsey and Lewis, 2005 and 2013).

There is no single definition of a PPP. Depending on the country concerned, the term can cover a variety of transactions where the private sector is given the right to operate, for an extended period, a service traditionally the responsibility of the public sector alone, ranging from relatively short term management contracts (with little or no capital expenditure), through concession contracts (which may encompass the design and build of substantial capital assets along with the provision of a range of services and the financing of the entire construction and operation), to joint ventures where there is a sharing of ownership between the public and private sectors. PPPs fill a space between traditionally procured government projects and full privatisation (Foster, 2013).

Although many consider PPPs to be a new version of privatisation (Grimsey and Lewis, 2013), in our view PPPs are not privatisation because with privatisation the government no longer has a direct role in ongoing operations, whereas with a PPP the government retains ultimate responsibility and the asset is returned to Government at the end of the concession period. Nor do PPPs simply involve the one-off engagement of a private contractor to provide goods or services under a normal commercial arrangement. Instead, the emphasis is on long-term contracts and strict performance regimes, such as Build-Operate-Transfer (BOT) or Design-Build-Finance-Operate (DBFO) projects to design, construct, finance, manage and operate infrastructure under a concession, with revenues (either from government or users) according to services supplied. The private sector partner is paid for the delivery of the services to specified levels and must provide all the managerial, financial, and technical resources needed to achieve the required standards. Importantly, the private sector must also bear the risks of achieving the service specification (Aranda-Mena and Vaz-Serra, 2018).

There are various reasons as to why governments might undertake PPPs, although paramount is the objective of achieving improved value for money (FM), or improved services for the same amount of money, as the public sector would spend to deliver a similar project. There is a long history of publicly procured contracts being delayed and turning out to be more expensive than budgeted. Transferring these risks to the private sector under a PPP structure and having it bear the cost of design and construction over-runs is one way in which a PPP can potentially add value for money in a public project (Foster 2013; Grimsey and Lewis 2013). Circularity should be integral to risk transfer and value for money considerations.

2.2 Building Circularity in Build to Rent

Build to Rent could be the response to designing, building, and operating commercial development with whole-of-lifecycle in mind and as such tapping into the opportunities that circularity could provide. The supply of rental dwellings via emerging financial routes such as

‘build to rent’ is a promising procurement route for dwelling and commercial development (BTM, 2019).

What is ‘build to rent’? The ‘build to rent’ model focusses on increasing the supply of rental housing through improving investment options and outcomes for institutional investors. As such developers and their financiers build multi-unit buildings and, instead of selling the units, retain them to rent to tenant households. Rents may be set at market rents or, for affordable housing, an appropriate discount to market rents could be offered with appropriate government support to make up the funding gap (Dunn, 2019).

‘Build to rent’ is an established practice in both the UK and USA but it has not been taken up in Australia. Developers cite Australia’s tax settings, which were designed for a ‘build to sell’ model, as a major impediment, land taxes and the inability to defer GST costs on construction materials makes retaining dwellings unprofitable. In Australia, the experience of tenants has included developing a ‘build to rent’ and a large corporate landlord (LCL) sector (AHURI, 2019). While these two sectors may share similarities, there is a subtle difference between them.

Previous AHURI research identified several barriers for institutional investment in the Australian market, reducing the attractiveness of 'build to rent' for investment by the large banks, insurance companies and the superannuation funds. These barriers, which reflected the market conditions at the time of the published research in the early 2000s include low returns, high risk, high management costs, illiquidity, poor market, and no track record. Recent media coverage suggests these conditions have changed, and with the right policy settings, Build to Rent would become a more attractive development option (Ashurst, 2019; AHURI 2019).

Once the building phase is completed, ‘build to rent’ developers may become large corporate landlords in their own right. However, the skills and expertise in managing a tenant base are different from the skills required to obtain finance, design, and construct a large residential building.

Large Corporate Landlords (LCL) could be compared with the automotive and aerospace industries, circular production and procurement models which have continued to grow. Circularity as a model for social-technical change requires a shift in prevailing systems and although “renting” carpets and floor tiles may seem a minor change to the status quo, such changes have a direct impact on how we all collectively perceive, use, and repair good and services (2020).

Rent to lease in the property and infrastructure sector could easily consider many more examples as the above one and lessons from more mature industries such as car manufacturing. From a client perspective there is also a need in changing values and perceptions. For example, buildings will be designed with a view to be dismantle at the end of their lifecycle and reutilised with no (or reduced) waste which also means less carbon footprint and economic incentives for a highly pollutant industry. 39% of global energy-related carbon emissions are attributed to buildings and this situation needs to be addressed according to the World Green Building Council (WGBC 2020). More efficient building energy performance is needed. Better Facility Management and Building Operation services can alleviate the current situation. In such case, tenants are expected to receive quality, not only as built form but as a service. This brings economic incentive for investors and partners adding to the wider quality of life and sustainability drivers much required in our current urban environment.

LCLs are different in that they are financial institutions that acquire large numbers of dwellings and make them available to the rental market, or potentially at a discount to market rents for low-income tenants if appropriate government support is provided. LCLs do not necessarily

build new housing stock, they can purchase properties in the market or through mergers and amalgamations with other LCLs. Indeed, the largest LCL in the USA, Mid-America Apartments, (99,939 apartments in 2017) was created in 2016 through the merger of two smaller LCLS that had each been established in the 1970s. Another LCL, Blackstone's Invitation Homes, grew through purchasing 200,000 already existing single-family dwellings between 2012 and 2014 (spending $100 million per week at one stage in 2013). Even a small change or improvement in this scenario would have a substantial direct impact.

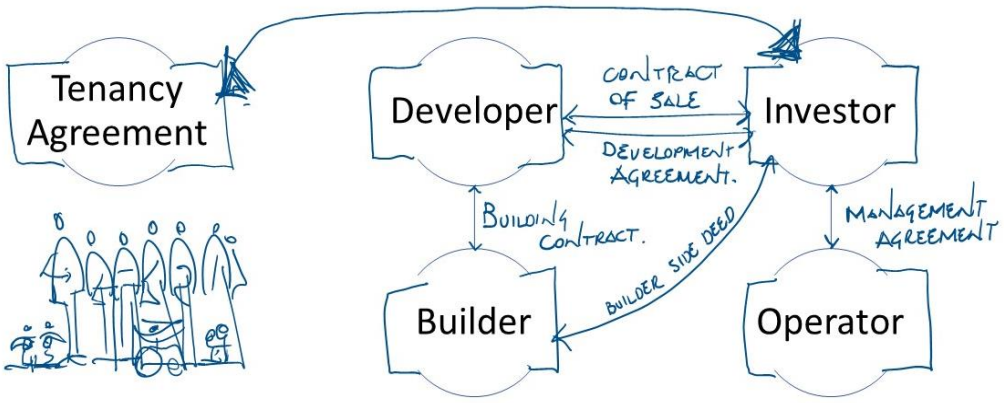

Figure 1. Circularity in Built to Rent, adapted from CBRE

Proponents claim LCLs and 'build to rent' schemes offer greater supply of rental housing, greater security of tenure for tenants, and better professionalism in tenancy management than small scale 'mum and dad' landlords, opportunities and benefits could include initiatives towards adopting circular thinking and circular practices.

Although Built to Rent suggests that successful implementation in Australia requires adequate regulation to ensure the proposed benefits an opportunity rises to built-in requirements for circularity and adding for a better housing experience by increasing materials, products and finishes standards under a tenancy agreement for instance (e.g., see above Figure 1).

2.3 Building Circularity in Design for Manufacturing and Assembly

If defining **building performance**, the appeal of DfMA concepts in the high-rise construction industry derives from the likelihood of repetition, which is often an inherent characteristic of tall buildings, and by the high stakes of economic risk and public safety, which are associated with the timely completion of speculative commercial projects. The idea of applying DfMA strategies in the conception and erection of tall buildings is, therefore, a theme of debate that has gathered interest in the CTBUH community (Vaz-Serra et.al, 2017) and idea that is not new and dates to the early 1900's with the advent of car manufacturing (Kieran and Timberlake 2004).

Designs conceived with ease of manufacture and assembly in mind can contribute to more efficient tall building construction. This argument is often presented as the justification for high-rise experiments in modular construction. Case studies have been shown where strategies of "partial modularization" have brought tangible benefits of productivity for contractors. One study claimed up to 60% reduction in on-site labour and 30% reduction of program time (McFarlane and Stehle 2014). Moreover, the transfer of DfMA principles from the industrial manufacturing realm to that of construction has an even stronger appeal when applied to three-dimensional modular construction systems, also known as prefabricated prefinished volumetric construction (PPVC). The affinity between the manufacturing of products and the assembly of

PPVC modules is almost self-apparent and suggests that there are abundant opportunities for direct transfer of technologies and processes of production from vehicle manufacturing to building construction. Notwithstanding that PPVC may remain as a vital component of the high-rise innovation agenda for years to come, the construction of high-rise buildings with three-dimensional modularization also has significant limitations (Mills et al. 2015; Krulak 2017). It is often suggested that three-dimensional vertical modularization will continue to grow in the future (Wallace et al. 2015), but it is doubtful that PPVC design will be the primary conduit through which DfMA concepts can more effectively bring circularity in the construction industry.

Building circularity through DfMA in the built environment such as efficient processes of innovation with flat-pack systems, rather than three-dimensional modularization, although an small component it can act as an effective catalyst for circularity by volume or repetition such as the utilisation in tall building projects. The validity and possible repercussions of DfMA for tall buildings are discussed by using the case study of a wall-integrated plumbing system that was developed for the bathrooms of a high-rise apartment tower in Australia one small change like this one could provide a high impact or at least a steady step in the right direction.

2.4 To summarise

The selection process for the best procurement route, when the decision to build with circularity in mid is to have a commitment between investor and final user, is paramount. Measure properly unbalanced risk aversion or preventions rather than partial outcomes, thus identifying best value for money solution for overall project lifecycle (McCann et. al, 2014a and 2014b). A call for a level of leadership in integrating circularity and lifecycle procurement. The comfort-zone in selecting known procurement methods is pervasive and at time not much seems to have changed since those utilised in the mid-1990's (Turner's 1997 Pg.81). Circularity must come into the previous and other similar multicriteria analyses tools applied for the selection of procurement methods including build to rent/lease or Public-Private Partnerships in social infrastructure.

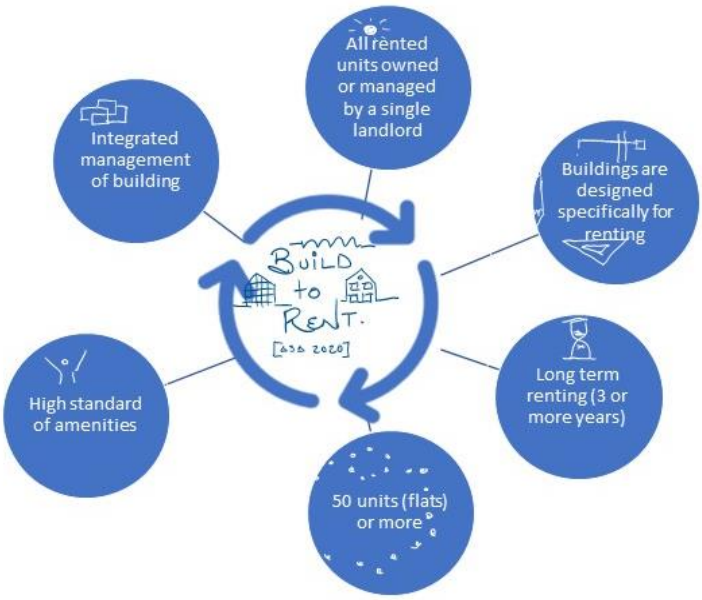

Figure 2 Circularity in Built to rent report for Australia (Adapted from Ashut, 2019).

In construction build to rent (or to lease) presents a clear opportunity to bring commercial incentives to uptake circularity in private sector development, need to have a specific procurement due to the nature of the asset. Integrated management systems of the building in

a design stage are essential for the success of the projects (see Figure 2). According to Scheule (2020) the Australian market can benefit largely from the BTR model like attractive solutions for those unwilling or unable to buy their own homes, allowing people to live near the job, and less volatility for long term investors. The procurement method should cover the long-term operational costs, promoting the increase of quality in building environment high more sustainable solutions, high standard of amenities and reducing long term energy costs. BTR for residential buildings is supported by the Clean Energy Finance Corporation (CEFC), looking at the construction and management of its energy efficiency and low emissions (Qualitas, 2020) and with the potential for engaging with the supply chain of products and services.

Several construction companies, developers and real estate agents in Australia are looking and using BTR concept to start new business models and adapt their strategic plan in a long-term commitment with property investors which are likely to be owner-occupier.

2.5 Worked scenarios

The method is that of Schon's Reflective Practitioner in which the authors think, reflect and critically discus industry cases publicly available through government and business reports:

Icon's experience in South Yarra, where it is currently delivering the Iglu student accommodation project primes it for the contract. Hickory could also be expected to bid for the development, given its current pipeline of residential developments including the Aspire tower on King Street in the CBD and Galleria in Glen Waverley. Multiplex is another strong contender with potential to compete, with the Tier-1 builder soon to reach completion on several high-profile projects including Southbank's Australia 108 tower. Probuild, another Australian tier one contractor has indicated interest. Grocon, whose pipeline houses several build-to-rent projects, is not likely to compete, given its partnership with Singaporean investor GIC. Kane, Watpac and Citta are all currently competing for the tender to deliver the state government's build-to-rent projects in Prahran, Brighton, and Flemington, and following announcement of a preferred builder, are expected to express interest in Greystar's development (Love 2020).

Mirvac created a concept based on their rental revolution (Mirvac 2020) for the strategic BTR brand called LIV. CBRE developed the concept of designing a lifestyle, expecting to have continuity in the 2020 BTR gaining momentum in Australia and to have 1800 units completed by 2021. This presents clear opportunities to build circularity in the WoL of high-rise construction, especially due economies of scale. BRE experts advocated that BTR demonstrated resilience through the current COVID-19 pandemic offering a safe haven for investors (BTR 2020).

Figure 3 – Integrating circularity in Built to Rent Adapted from CBRE 2020.

Trends of change in the Australian construction industry suggest that the long-term implications could change the sustainable landscape of an entire industry. The subcontracting market may take a decisive turn in the future, moving towards circular scenarios in which the

actors most able to integrate different green production and circular possess in the production of technological systems may emerge as market leaders. The case of prefabrication with integrated plumbing is, in fact, a global phenomenon on the rise, of which very sophisticated examples can be witnessed in prominent recent buildings under construction worldwide, such as at 100 Bishopsgate in London. Such example may have seemed unthinkable in the context of traditional schemes of procurement only a few years ago. However, processes of innovation that depend on the concentration of know-how have occurred long before in other subsectors of the high-rise industry, such as unitized curtain walls (Vaz-Serra et. al. 2019).

As a final statement and if considering the reduction of upfront risk in WoL procurement shifting major project risk to building operations, here lies the opportunity for higher upfront commitment to circularity in a way that makes a *'business sense'* in reducing the operational cost as increasing the building quality. There are also clear opportunities to reducing risk because of a more integrated supply chain of products and services. Infrastructure projects most provide a well justified evaluation of Value for Money (VfM), circularity could be a key assessment criterion. It is our hope that this paper is a first step toward government and private sector engagement with concepts of circularity across design, build and operational stages of commercial and public sector procurement.

3 Final remarks

To conclude, this paper has promoted the concept of circularity in WoL procurement, in particular Public-Private Partnerships (PPPs) and Build to Rent (BTR). The aim was to provide insights into opportunities to engage with close-loop systems integrated across design, construction and building operations as a contractual *service* obligation. The opportunity rises as the popularity of leased over ownership model is on the rise. The benefits that come with the model have been discussed, the most obvious is the long-term contract duration as concession period which can stretch for up to 30 years. In the public sector PPPs have demonstrated Value for Money for Governments and Risk Transfer to private sector means that projects are financed, executed, and operated efficiently by teams of expert specialists and as such a circularity benchmark assessment should be an integral part of VfM in PPPs. In the case of private sector, residential and commercial development, there is also a business case to engage with the circular economy. Circularity on return on investment (RoI) outcomes under the 'Build to Rent' procurement method is plausible. Current cases in the Built to Rent scenario were discussed and future scenarios illustrated. Finally, Design for Manufacture and Assembly (DfMA) clearly provides incentives for circularity a close loop could provide technical efficiencies and component performance such as the example of BMW (2020). The above three scenarios have direct implications to increase building performance during life cycle operations and Facilities Management. Ultimately, *circularity* is about the environment and improving a highly wasteful industry sector, it did not get a single mention in two of the most influential construction industry surveys (KPMG 2021 and Deloitte 2021), nor recycling and not even waste. What a shame!

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