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AgiBuild: A Proposed Framework for Agile Building Adaptation Project Management Based on Literature Review

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Abstract
The Agile Building Adaptation (AgiBuild) framework is the adoption and adaptation of the large-scale agile framework for building adaptation projects. The agile methodology is proven to drive innovation by focusing on adaptation to change and user centricity. Similarly, the authors envision that the AgiBuild framework can fundamentally change the way that buildings are re-designed, refurbished, and operated. The AgiBuild framework is developed from the need of the building adaptation industry to manage uncertainties, overcome communication barriers, and improve innovation. In this study, a literature review of Agile and its impact on building adaptation projects was undertaken. Based on this systematic literature review, this paper defines the AgiBuilt framework and provides its benefits and barriers to implementation. A key finding of the literature review is that leadership influence, and adequate training form the key foundation for the implementation of the AgiBuild Framework. In defining the AgiBuild framework, the paper described its components and how its implementation is likely to proceed. The authors propose that by adopting the AgiBuild framework, the industry can transform itself into a highly innovative and user-centred industry to improve productivity and performance of the construction industry.

Keywords
Agile project management, Agile construction, Building adaptation, Built environment, Scaling agile

1. 1. Introduction

Commercial buildings play an important role in our built environment and our economy. The construction, operation and maintenance of a building will have both an immediate and long-term impact upon our environment as well as the occupants of the building. With that in mind, the value of commercial building activities in Australia as of 2025 is estimated to be approximately 43.2 Billion AUD (Granwal 2021). Specifically for the fit-out market, it is forecasted to have a growth of more than 14% by 2026.

At the time of writing, the world is facing the Coronavirus (COVID-19) pandemic. The COVID-19 pandemic has caused economic and social disruptions. At the same time, it was also observed that there is acceleration of emerging trends such as flexible work arrangement and increasing demand for e-commerce. In addition to the uncertainties and transformation within the macro environment of the commercial building industry, the lack of coordination and integration of planning across various stakeholder groups in the industry also exacerbate the challenges experienced in the built environment industry (Coleman 2017). Other challenges include resistance to change and low productivity, predictability and profits (Sawhney et al. 2020).

These challenges and issues prompt the need to relook at the way projects are managed in the construction and building sector. Farmer (2016) suggests that the industry needs a transformational change to overcome these challenges. Furthermore, a recent report by the Australian Infrastructure Audit claimed that key industry players need to perform major reforms to improve the way we plan, finance, construct, maintain and operate these building

(Coleman 2017). A new way of working is required for the built environment industry to be more adaptable to change due to uncertainties, and to drive communication and coordination.

The challenges experienced by the built environment industry is not unique. Similar to the built environment sector, the Information Technology (IT) industry also finds it challenging to cope with on-going changes, such as new and emerging technology, as well as dealing with communication breakdown when working across multidisciplinary teams. To cope with these challenges, the agile ways of working is introduced to the software industry. The agile ways of working has strong focus on adaptation to change, flexibility and human-centred design. It is proven to be effective to promote adaptation and coordination.

2. Research Objectives and Methodology

The objectives of this research were to define and describe the Scaled Agile framework for building adaptation projects based on a detailed literature review of the Scaled Agile concept. The framework aims to combine and bring together the synergies between agile and building adaptation, so that it can be used as a guideline for construction professionals to apply agile practices in their daily work. The first stage involves developing the framework based on systematic literature review to identify the key components of the framework. The second stage refines the initial framework through expert interviews.

2.1 Stage 1: Systematic Literature Review

To achieve the research objectives, the following thematic areas were selected for literature review and analysis: (1) Agile practices at scale; (2) Advantages, disadvantages, success factors and barriers to apply agile at scale; (3) agile project management in buildings and construction; and (4) human-centred design in buildings and construction. Systematic literature review is undertaken to review, evaluate and analyse these for thematic areas. Systematic literature review was chosen as it provides an overview of previous studies in the chosen area and allows the authors to identify areas that are yet to be explored or under-explored (Webster & Watson 2002). In fact, systematic literature review is the foundation of any research projects (Esa, Halog & Rigamonti 2017).

The first step of this literature review was to define the problem that would be studied, that is "How can the concept of Agile at Scale be utilized in the buildings industry to improve adaptability, innovation and productivity?". The objective of the review was defined as to identify the recent developments of Agile concepts in the software industry and how are they being used. The following step was to review those research that used the concepts of Agile at scale within the non-software industries, including the building and construction industry. To conduct this literature search process, the authors performed the following search strategy steps: (1) Choose the database source; (2) Choose keywords and search criteria based on the thematic aresas defined; (3) Apply backward and forward search as required; and (4) Evaluate the appropriateness of the literature subset (Cocchia 2014).

Various search filters were applied that resulted over 200 papers in the area of agile at scale, which is relevant to the first two thematic areas; close to 100 papers in the area of agile construction; and approximately 90 papers in the area of human centered design in construction. As this is a fast-emerging field, the search filters and selection of papers were done carefully. Noting that there are a few "buzzwords" that are present in the industry, the authors also take into consideration the use synonyms when performing the search, for instance *Scrum* is occasionally being linked to *Agile*; and *design thinking* and *user-centred design* are used interchangeably with *human-centred design*. Through comprehensive reviews of relevant literatures, the different components of a Scaled Agile framework for the building adaptation projects are identified and articulated.

2.2 Stage 2: Expert interviews

The second stage of the framework development involves refining the framework by using empirical evidence collected through expert interviews. These ten experts, via their professions and professional commitments, are highly knowledgeable regarding the agile transformation, human centered design and construction management. Data were collected through ten unstructured interviews that lasted between 30 to 60 minutes. The authors started the interviews by providing a brief explanation of the various components of the framework, followed by interviews with the participants. Exploratory follow-up and non-directive probing questions were asked to ensure that the interviewees

are not directed towards the perspectives of the authors (King 2004). The notes taken during the interview were analysed to identify themes that emerged.

3. Literature Review

This paper documents the overview of scaling agile and it's application in building adaptation projects. A framework, known as AgiBuild, is developed based on literature review to convey the purpose and direction to apply scaled agile practices in building adaptation projects, portray how various elements interact to produce the desired outcomes and provide a structure in which industry professionals can adapt based on their projects. This section presents the literature review on agile project management and agile at scale. The next section i.e. the *Results* section will present the proposed AgiBuild framework. Each component of the framework is elaborated and serves as a guideline for industry professionals to manage uncertainties, drive innovation and improve collaboration.

3.1 Agile project management and practices

Agile management practices originate from the software industry. Developed in 2001, the agile manifesto advocates for four values: (1) Individuals and interactions over processes and tools; (2) Working software over comprehensive documentation; (3) Customer collaboration over contract negotiation; and (4) Responding to change over following a plan (Beck et al. 2001). Denning (2019) describes that the agile ways of working has strong focus on customer value, adaptation, iterative and incremental delivery as well as continuous improvement.

The concept of agile emerged due to the shortcomings experienced in traditional software development process. The traditional approach involves sequential steps and having all the requirements defined upfront (Ciric et al. 2018). However, such practices may not be practical to allow the team to be flexible and make rapid adjustments. The agile approach is said to allow teams to manage changing requirements to keep up with the continually changing technology and business requirements (Ciric et al. 2018; Larson & Gray 2010). Some of the fundamental difference between the traditional and agile is that the traditional methods assume predictability, attempt to minimise changes and exert control on schedules (Bergmann & Karwowski 2019; Vinekar, Slinkman & Nerur 2006).

Agile is an umbrella for a vast variety of practices. Not all these practices are mandatory and some of them can be applied independently. Agile advocates for iterative and incremental development. A sprint, an iteration or a cycle is a basic unit of work with a fixed timebox that lasts from around one to three weeks (Srivastava, Bhardwaj & Saraswat 2017). Most traditional project management methods involve a project scope that outlines the work that needs to be done (Fashina, Abdilahi & Ibrahim 2020). This is often represented as a product backlog when APM is implemented. The product backlog contains the requirements, features or functionalities that are useful to the end user or customers (Larson & Gray 2010; Srivastava, Bhardwaj & Saraswat 2017). Other practices worth mentioning include release planning, product road-mapping, Kanban, planning poker, team estimation, common work area, agile / lean user experience (UX) and many others. Of the agile practices, the top five practices are the daily meetings, retrospectives, sprint / iterative planning, sprint / iteration reviews and short iterations (Digital.ai 2021).

At the time of writing, agile practices have become a mainstream, cutting-edge approach applied in many industries, especially those in fast pace, competitive markets (Ciric et al. 2018). The key benefits that were observed include the ability to manage changing priorities, provide visibility and allow alignment between business and IT stakeholders.

It is important to note that APM is not a method on its own. In fact, there are many distinct APM methods that can be applied in different organisations or teams. Some of the common or popular APM methods are Scrum, Extreme Programming (XP), Crystal Clear, and other (Larson & Gray 2010). Of these methods, Scrum is the more popular methodology (Sarpiri & Gandomani 2021). Scrum, like other agile methods, are designed to manage uncertainties and changes in requirements. The three main roles in Scrum are the Product Owner, Scrum Master and development team (Gandomani et al. 2019). The Product Owner ensures that the objectives of the project are met and the Scrum Master is responsible for resolving any challenges at the team and organization level. The Development team consists of team members with distinct, specialised skills such as the programmers and others. This cross functional team plays an important role in delivering the end product that satisfies the needs of the customers (Larson & Gray 2010; Srivastava, Bhardwaj & Saraswat 2017). The Scrum development process starts with defining the

product backlog, followed by the sprint backlog. Within the Scrum framework, the Product Owner will shape the product backlog. Together with the Development team, the sprint backlog will be formulated. Once the sprint starts, the development team will gather every day to discuss about the work that they have done. At the end of the sprint, the Scrum team performs a sprint review and a retro.

3.2 Scaling agile

Most agile methods, including Scrum, are catered for small, co-located team with no more than ten team members. However, the benefits of agile methods for small teams have encouraged organisations or teams to adopt agile methods for large programs with multiple teams (Uludag et al. 2018). The idea of using agile methods on larger projects with bigger team size is known as *Scaling*. Xu (2009) further elaborates agile approaches, when applied on large program, will pose risks associated with communication and interaction. There are few frameworks that were developed to guide larger teams to apply agile. Examples of framework include Scrum of Scrums (SoS), Scaled Agile Framework (SAFe) and others (Kalenda, Hyna & Rossi 2018). The 15th State of Agile report, SAFe, is the most popular framework across large enterprises. Kalenda, Hyna and Rossi (2018) identified eight common scaling agile practices and they are Scrum of Scrums, Communities of practice, Scaled sprint demo, Scaled requirements management, Scaled Retrospective, Feature teams, and Undone department. Some of these large scale agile framework also include the scaling of roles such as Area Product Owners (APOs) and Chief Product Owners (CPOs) (Putta 2018).

The benefits of agile in software development has inspired the applications of APM in non-software projects. Examples of application include real estate, education and services. Some of the benefits observed include improve team communication and collaboration, high productivity and output quality as well as ongoing feedback and continuous improvement (Ciric et al. 2018). Following an increase of participation in the agile movement, many studies have been conducted to explore the application of agile in construction in isolation. As a result, the aim of this paper is to bring together a framework that allows agile practices to be embedded in building adaptation.

4 Results

4.1 Framework overview

With the increase application of APM, the built environment sector also has the opportunity to improve innovation and be more efficient (Owen & Koskela 2006). The AgiBuild framework is a conceptual framework which serves as an intermediate theory that outline all possible resources related to agility and create a logical connection between APM and building adaptation projects. It can be used as a guideline for construction professionals to plan, design and deliver built environment projects more effectively and efficiently, especially in a market environment that is constantly changing. Modelled after the concept of Scaled Agile framework, the AgiBuild framework is also intended to be scalable to accommodate building adaptation projects that are of different sizes and complexity. There are three organisational levels in this framework: Teams, Programs and Portfolios. The framework contains the people, tools and processes on the application of agile. With reference to the expert feedback on the framework, all the experts agreed that this framework is relevant and could be applied in building adaptations in general, but one expert argues that this may not be relevant due to the unique nature of the industry.

4.2 Component analysis

4.2.1 Agile foundation

The core values and principles of the AgiBuild framework will be adapted from the Agile Manifesto to suit the built environment sector. Studies were performed to examine the relevancy of the agile values and principles in various construction projects. Diepersloot (2019) suggested that while these values are relevant, slight change in terminologies should be considered to better suit the building and construction industry. The authors suggest using the adapted version found in the Disciplined Agile Delivery (DAD) in the AgiBuild, where the terms in *italic* are the modified terms: (1) Individuals and interactions over processes and tools; (2) Working *solution* over comprehensive documentation; (3) *Stakeholders* collaboration over contract negotiation; and (4) Responding to change over following a plan.

The values above take a holistic lens where the solutions could be defined as a functional system (e.g. electrical, piping), a deliverable (e.g. a P&ID diagram) or a work package. Given the complex stakeholder ecosystem

in construction, stakeholders collaboration, including customer, regulators, contractors and others, need to be considered. Another important concept in scaled agile is user centricity. In the context of building adaptation projects, this includes anyone who will be using the building such as the staff, a visitor, or a service provider. The project teams need to have a multidisciplinary approach involving psychology, physiology, engineering, building physics and health to understand the complex interactions between humans, buildings, and their environment (Darby et al. 2019). Interviews with industry experts suggest this this is an important component of the framework and should be applied in projects where necessary.

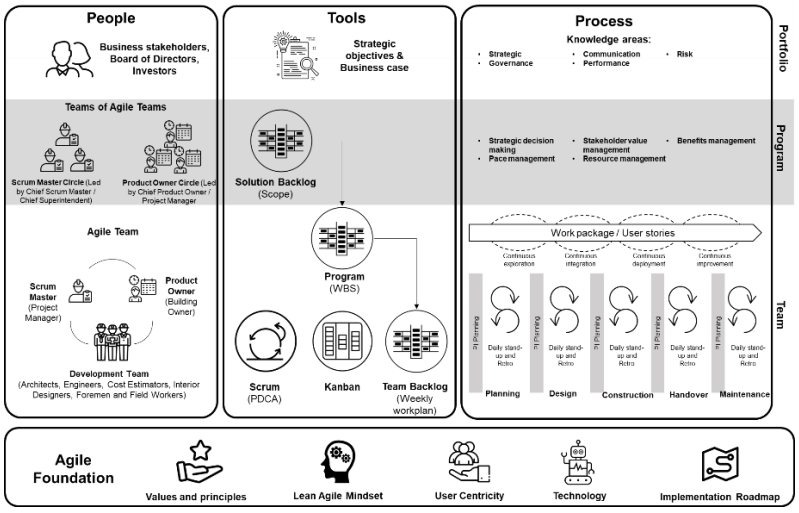

Fig 13: The AgiBuild Framework

The technology component was newly added to the framework after the interviews with industry experts. The industry experts suggested that digital transformation and digital tools such as Building Information Model (BIM) are changing the way building and construction organisations execute their projects, and the availability to technology tools is a potential enabler for this framework (Gless, Hanser & Halin 2017; McArthur & Bortoluzzi 2018; Sawhney et al. 2020; Tomek & Kalinichuk 2015). The Implementation Roadmap is another key element for agile to be applied in the built environment sector. Pareliya (2018) recommended to educate building and construction professionals with agile methodology to drive adoption.

4.2.2 People

Stakeholder management is crucial for the success of a project, more so in retrofit projects. Retrofit project involves a wider group of stakeholders, such as tenants and facility managers, who have contractual relationship such as lease contract, split incentives and others (Liang, Yu & Guo 2017). At the Teams level, Layton (2015) suggested that the Scrum roles can be adapted for the construction ecosystem. The Product Owner role can be represented by the Building Owner, who will be responsible for making decisions on behalf of the end users and occupants. The Superintendents or Project Managers can occupy the role of the Scrum Master by not only facilitating the daily coordination of resources and tasks, but also helping the team to remove any impediments. The agile development team is made up of skilled team members such as architects, interior designers, engineers, and others. When the team gets larger, a consideration is to include roles such as Scrum of Scrum Master and Chief of Product Owners. They will take a lead role in coordinating the multiple agile teams (Belling 2020; Berntzen, Moe & Stray 2019). At the Portfolio level, the key roles would be the portfolio executives who assume the responsibilities in exercising authority over the organization (Liang, Yu & Guo 2017). One of the experts also suggested the portfolio executives to play a role in organising the contractual agreements that will empower team members to undertake agile roles.

4.2.3 Tools

The strategic objectives and business cases are established by the portfolio executives and stakeholders. They will impact the development backlogs at the subsequent levels (Knaster & Leffingwell 2020). The program backlog contains the upcoming work orders that are required to address the user needs and deliver business values (Knaster &

Leffingwell 2020). A visualised version of the program backlog allows organisations to assess the gaps in achieving the organisation goals and the effort required to achieve the targets. Zilberova, Tomashuk and Bobkina (2019) suggested that the program backlog needs to take into account resource workload and customers' requirements to achieve the highest possible efficiency. Overall, in terms of the tool, all experts agreed that having a simplified Kanban board allows the team to visualise responsibilities and drives communication.

4.2.4 Processes

This portion of the framework was revised based on the mix opinions from different experts. One of the experts suggested to keep the processes flexible to allow this framework to be scalable. He also suggested to incorporate elements from the PMBOK's portfolio and program knowledge areas as part of the framework. At a team level, the framework proposed the team to have a planning session, with agile practices embedded, prior to starting any work. Another recommended agile practice is the daily Scrum meeting where the team gathers to identify their daily work plans and challenges (John 2018; Knaster & Leffingwell 2020). Most of the experts pointed out that the daily scrum is encouraged for most construction projects, and in fact, has taken place in the execution phase in most of the construction or building adaptation projects today.

5 Limitations and Future Work

Due to limited time and scope of work, this agile framework proposed in this paper is developed solely based on previous literatures and expert interviews. A follow-up study is required for the proposed framework to be validated. One possible direction of future work is also to prototype the framework on a building adaptation project and gather feedback from research participants. In addition, it would be advantageous to quantify the effectiveness of the framework in reducing delay, enhancing coordination, and managing risks. As this is an emerging field, it is also essential to consider the skills required within the future workforce for this framework to be applied successfully.

6 Conclusion

The construction and built environment sector are pivotal for the advancement of civilization. While there are a lot of developments and evolution processes within the industries, the built environment sector faces major challenges such as lack of growth and innovation. In addition, building adaptation projects often experiences poor coordination, fragmentation and inefficiencies. Agility, a concept that originates from the software industry, has the potential to facilitate a flexible, responsive process, especially dealing with fragmented activity changes. In this paper, the authors have identified the linkages between agile project management and building adaptation project management. Using the systematic literature review and expert interview approaches, the AgiBuild framework and its key components are identified. While agile principles and practices have been partially applied on some construction projects, the application of agile in building adaptation is still an emerging field. Partnerships between various entities such as academic institutions and industries are required for the future workforce to be well-equipped for the implementation of the AgiBuild framework.

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