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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 is 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 describes 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. 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. Most of the buildings will have a lifespan of around 40 to 60 years [1]. Hence it is important for the functionalities of the buildings to be properly considered for them to be resilient over that period. Watson [2] suggests that the benefits of adapting an existing building include an increased speed of construction by 50 percent and a lower cost compared to new build or demolition. With these benefits in mind, the value of commercial building activities in Australia as of 2025 is estimated to be approximately 43.2 Billion AUD [3]. Specifically for the fit-out market, it is forecasted to have a growth of more than 14% by 2026.

Given the economic and social disruptions due to the recent COVID-19 pandemic, there is acceleration of emerging trends such as flexible work arrangement and increasing demand for e-commerce. There are mixed views on the impact of the pandemic on the commercial building industry. In (X year), IBISWorld's analyst suggested that the growth in commercial building industry is projected to decline over the next five years due to uncertainty that emerges from the COVID-19 pandemic. On the other hand, the Australian Financial Review reported that there is a strong appetite

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for investors to purchase commercial properties in 2021. This is supported by a report from Domains Group stating that the investment in Australian commercial real estate during the first quarter of 2021 is almost two-fold of that in the first quarter of 2020.

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 [6]. Other challenges include resistance to change and low productivity, predictability and profits [7]. Sawhney, Riley [7] further describe the three types of fragmentation of the construction sector, namely vertical, horizontal and longitudinal. These fragmentations are illustrated in Figure 1. The vertical fragmentation is due to the lack of integration between the different phases of a typical construction project; the horizontal fragmentation is due to the silos between the multidisciplinary specialists; and the longitudinal fragmentation is due to the recurring of these similar from project to project

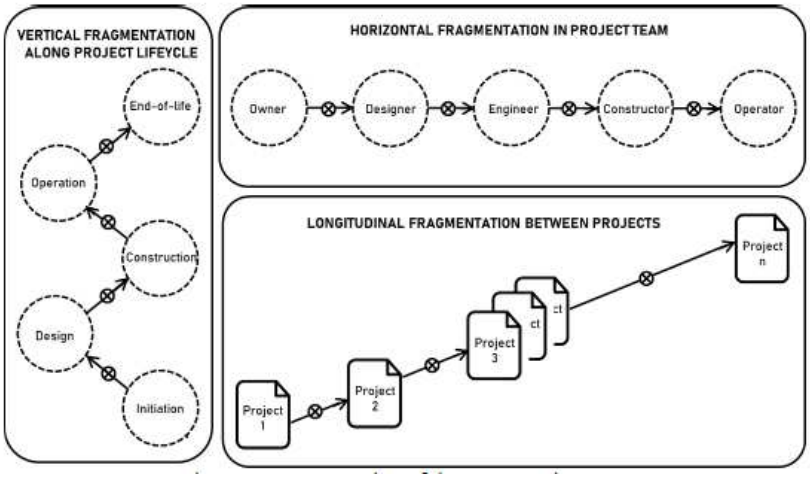

Figure 1. Fragmentations in construction projects.

These challenges and issues prompt the need to relook at the way projects are managed in the construction and building sector. Farmer [8] 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 [6]. 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. Similarly, Information Technology (IT) industry is experiencing difficulties . to cope with on-going changes, such as new and emerging technology, and dealing with communication breakdown when working across multidisciplinary teams. In attempt 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 and is proven to be effective to promote adaptation and coordination.

This research aims to define and describe the Scaled Agile framework for building adaptation projects based on a detailed literature review of the Scaled Agile concept. The study seeks to establish the role of agile practices and human-centred design in the Scaled Agile framework. The benefits of the framework and barriers to its implementation are also discussed in this study. The framework development process is based on systematic literature review to identify the key components of the framework. To achieve the aim of this research, the research question is defined as follow:

RQ: How can the concept of Agile at Scale be utilised in the buildings industry to improve adaptability, innovation and productivity?

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This paper is structured as follow: the next section describes the research methodology adopted for this study followed by the literature review section on agile project management and agile at scale. The Results section then 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. The research limitation will be presented followed by the concluding notes.

2. Methodology

This study adopts a systematic literature review to address the research question. Systematic literature review is undertaken to review, evaluate and analyse of four thematic areas : (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 was chosen as it provides an overview of previous studies in the chosen area and allows the authors to identify characteristics or relationships between key concepts from existing studies relevant to the topic [9]. In fact, systematic review is a specific methodology that locates existing studies, analyses and synthesises data, and provides clear conclusions about what is and is not known [10]. For this study, the authors adopted the principles suggested by Briner and Denyer [11]: (1) Conduct a review systematically; (2) Exhibit a transparent method; (3) Be replicable and updatable; and (4) Summarise and analyse the key topics of this research.

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 areas defined; (3) Apply backward and forward search as required; and (4) Evaluate the appropriateness of the literature subset [12].

For the collection of the relevant literature review, the literature is collected by searching the fields article title, abstract and keywords through the commonly used resources including Scopus database, Web of Science, Google Scholar, and PubMed. After applying the search string in the selected database, over 200 papers in the area of agile at scale were found, which were relevant to the first two thematic areas and close to 100 papers in the area of agile construction; and approximately 90 papers in the area of human centred design in construction were found. 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.

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.

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 [13]. Denning [14] describes the three common features of agile management: (1) Customer-obsessed; (2) Small is beautiful; and (3) Networks. Customer-obsessed implies that organisations that apply agile management focuses on adding more value to users and customers; Small is beautiful suggests that agile team break down large complex problems into smaller pieces that can be managed by smaller, self-organising team; and Networks means that agile management involves all parts of the organisation come into an agreement to achieve the designated goals. These studies show that the agile ways of working has strong focus on customer value, adaptation, iterative and incremental delivery as well as continuous improvement. To date, there are many different viewpoints associated with the term "agile". Agile could be an approach, a method, a practice, a technique, or a framework [15].

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 [16]. 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 [16, 17]. Some of the fundamental difference between the traditional and agile is that the traditional methods assume predictability, attempt t0 minimise changes and exert control on schedules [18, 19].

The Agile project management (APM) is developed based on the principles and values stated in the Agile Manifesto [16]. Larson and Gray [17] suggested that APM is a form of project management methodology that involves continuous planning and scheduling, where the details of the final project are not fully defined and will be unfolded through a series of short, defined timeframes.

Agile is an umbrella for a vast variety of practices. Not all these practices are mandatory and some of them can be applied independently. As described in the previous section, 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 [20]. Most traditional project management methods involve a project scope that outlines the work that needs to be done [21]. 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 [17, 20]. Story mapping is another agile technique used by some agile teams. User story mapping is a method and a visual representation that aims to narrow the gap between scenarios, usability and the requirements [22]. To allow for short, iterative developments, the work items in the product backlog are distributed into multiple sprint backlogs. This will ensure the work items in the sprint backlogs can be accomplished within the defined timebox. During sprint planning (another agile technique) the team will gather to prioritise the work items and discuss the methods to complete the sprint. It is also important to note that the sprint backlog should not be changed when a sprint starts. Throughout the sprint, the team will gather daily to collaborate and share information. Each team member will share their progress and/or concerns by answering three questions: (1) What did I do yesterday?; (2) What will I do today?; and (3) Do I see any impediments? [23]. At the end of each sprint, the team will perform retrospectives to discuss options for technical or process improvements [24]. 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 [25]. Pries-Heje and Pries-Heje [26] stated that the daily meetings, product backlogs and sprint backlogs are key to facilitating coordination between team members.

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, as well as technology and innovation driven organisations [16]. The 15th Annual State of Agile Report which was released in 2021 shows that 94% of the respondents reporting the use of agile methods within their organisations. Particularly for software development teams, agile adoption has increased by 37% between the year 2020 and 2021. The report also indicates that most organisations or teams adopted agile to enhance

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their abilities to managing change, accelerate delivery and improve team productivity. 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, Agile Modeling, Dynamic Systems Development

Method (DSDM), Lean Development, Rapid Product Development (RPD) and RUP (Rational Unified Process) [17]. Of these methods, Scrum is the more popular methodology [27]. This is supported by the evidence collected from the 15th State of Agile Report where 66% of the respondents selected Scrum as their preferred agile methods.

The term Scrum in the context of product developments was introduced in 1986 through the work of Hirotaka Takeuchi and Ikujiro Nonaka. In their Harvard Business Review article, The New New Product Development Guide, Takeuchi and Nonaka adapted the Scrum concept from rugby as a new holistic approach to develop new commercialised products. 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 [28]. The role of a Product Owner is to act as the interface between the business users and the development team. The Product Owner also ensures that the objectives of the project are met [17]. The Scrum Master is responsible for resolving any challenges at the team and organization level. The Scrum Mater's role is often described to be similar to the role of a project manager in a waterfall or traditional setting. The Development team consists of team members with distinct, specialised skills such as the programmers, business analysts, testers, and others. This cross functional team plays an important role in delivering the end product that satisfies the needs of the customers [17, 20].

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 everyday to discuss about the work that they have done as part of the daily Scrum event. The daily Scrum is facilitated by the Scrum Master. At the end of the sprint, the Scrum team to perform a sprint review and a retro. The Scrum practices and workflow are shown in Figure 2..

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 [29]. The idea of using agile methods on larger projects with bigger team size is known as Scaling. Large programs are generally more complex due to the larger stakeholder groups and number of team members. They also tend to have more requirements and are technically more challenging to implement. The interdependencies between tasks and teams are also relatively more complex in larger programs [30]. Integration and coordination are important for large programs to be successful [17, 31, 32]

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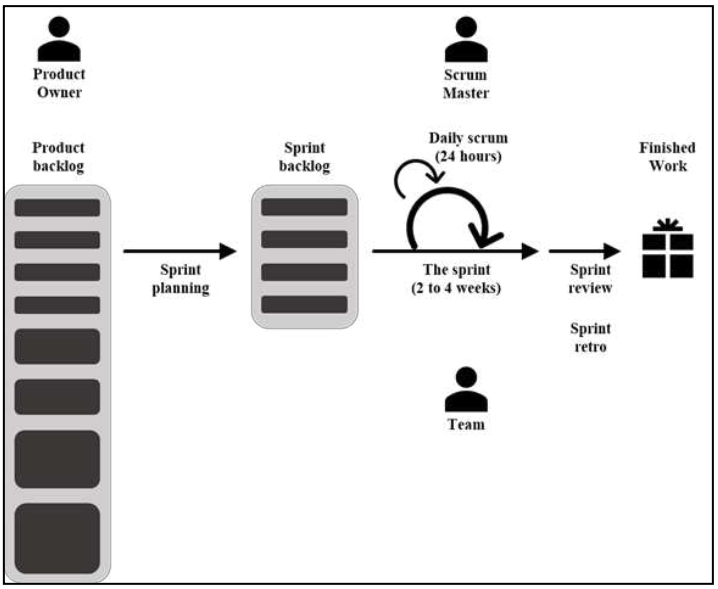

Figure 2. Scrum roles, practices and workflow.

Xu [30] further elaborates agile approaches, when applied on large program, will pose risks associated with communication and interaction. Based on the needs for agile to be applied for larger teams, 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), LeSS, Disciplined Agile Delivery (DAD), Lean scalable Agility for Engineering (LeanSAFE), and Recipes for Agile Governance in the Enterprise (RAGE) [33]. Kalenda, Hyna [33] 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. Larson and Gray [17] also shared that a separate integration team can be formed to manage integration issues, and a central project management team who manages coordination and facilitates decision making. Some of these large scale agile framework also include the scaling of roles such as Area Product Owners (APOs) and Chief Product Owners (CPOs) [34].

The 15th State of Agile report, SAFe is the most popular framework across large enterprises with 37% of respondents opted SAFe as the framework for scaling agile. SAFe contains the best practices for agile development for large organisations. It is also designed to support organisations of different sizes, from small to large. The SAFe framework is illustrated in Figure 3 and the seven core competencies of the SAFe framework are [35]:

- Lean-agile leadership: Practise the leadership skills that empower team members and promote sustainable change.
- Team and technical agility: Encourage agile behaviours and technical practices.
- Agile product delivery: Use design thinking and customer-centricity to create valuable products.
- Enterprise solution delivery: Create and sustain large-scale solutions
- Lean portfolio management: Execute portfolio vision and strategy, and prioritise the portfolio and roadmap.
- Organisation agility: Apply lean and systems thinking to strategic execution.
- Continuous learning culture: Commit to continuous improvement and innovation.

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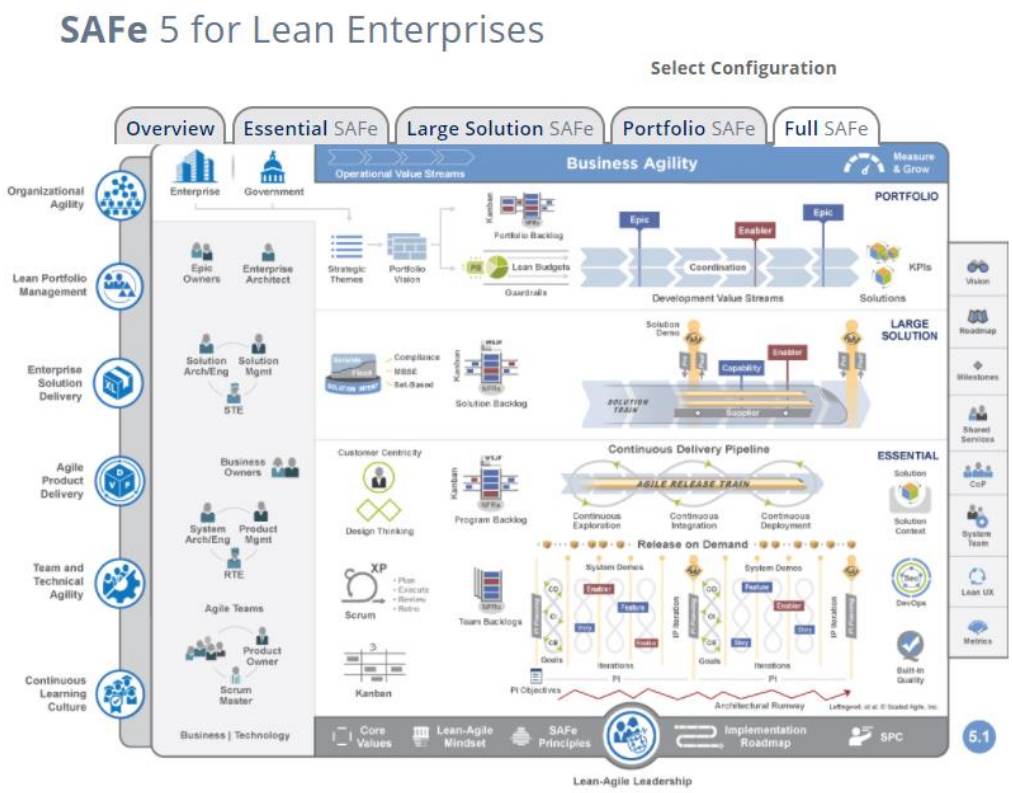

Figure 3. SAFe 5.1 Framework.

The benefits of agile in software development has inspired the applications of APM in non-software projects. Examples of application include innovation management, product development, construction, 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 [16]. According to the 15th State of Agile report, the adoption of agile in non-software industries has increased by two-fold in a year, from 2020 to 2021. Despite an increase in adoptions, the following barriers remain a challenge: (1) inconsistencies in processes and practices; (2) cultural clashes; and (3) resistance to change.

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 o this paper is to bring together a framework that combines the synergies between agile and building adaptation..

4. Results

With the increase application of APM, the built environment sector also has the opportunity to improve innovation and be more efficient [36]. This transformation is achievable through the convergence of existing and agile project management methods in building adaptation projects. This transformative framework is represented by the AgiBuild framework presented in this paper.

4.1. Framework overview

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.

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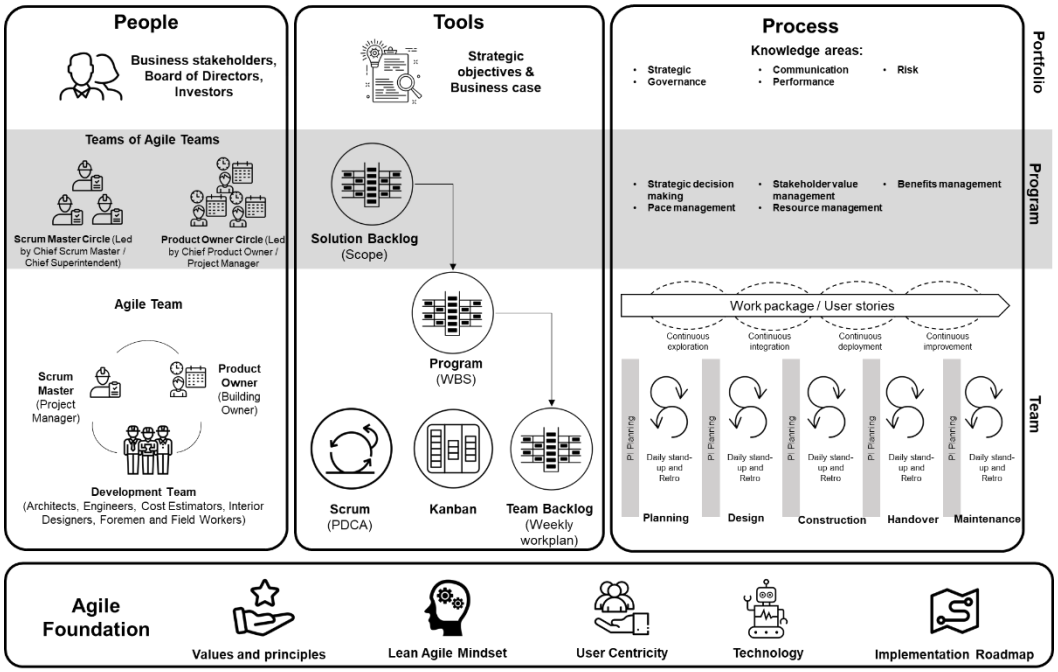

Figure 4. The AgiBuild Framework.

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 team level is made up of the basic agile teams where the team will apply basic agile practices such as Kanban and daily sprint. The program level is for larger projects with larger scope and / or size. The program level is used to align the multiple agile teams to a common objective.

The framework contains the people, tools and processes on the application of agile, as well as a foundation level. The people elements involve establishing a portfolio-wide culture with all units, teams or departments having the right set of skills to embrace the lean and agile values. The process elements evolve around the application of lean and agile principles in the planning, development, delivery and management of benefits and values. The process elements also govern the ability to provide ongoing monitoring, feedback and improvements. The tools elements involve the enablers for easy implementation of lean and agile practices. They also enhance the ability to provide traceability and visibility across multidisciplinary teams [37]. The foundation level includes the core values, the principles, the lean-agile mindset, and guidelines to implement agile in the built environment sectors.

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. They values were found to be beneficial to different parties in a construction project [38, 39]. Diepersloot [40] 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

- Individuals and interactions over processes and tools
- Working solution over comprehensive documentation
- Stakeholders collaboration over contract negotiation

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- 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 core elements for agile to be applied at scale is having the lean-agile mindset. The following lean-agile mindsets are important for construction professionals [41, 42]:

- Maximize value and minimize waste
- Manage time as an asset
- Establish a culture of continuous improvement
- Enable safe failures
- Increase predictability
- Proactively adapt to change
- Strive to achieve measurable results early and often

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 that works in the building, a visitor, or a service provider. The project teams need to have a holistic and multidisciplinary approach involving psychology, physiology, engineering, building physics and health to understand the complex interactions between humans, buildings, and their environment [43]. The technology component was newly added to the framework after the interviews with industry experts. The industry experts suggested that digital transformation is changing the way building and construction organisations execute their projects, and the availability to technology tools is a potential enabler for this framework. The integration of digital tools such as Building Information Model (BIM), and industrial production such as 3D printing play a key role in agile methods to improve collaboration and efficiency [7, 44-46]. The Implementation Roadmap is another key element for agile to be applied in the built environment sector. Pareliya [47] recommended to educate building and construction professionals with agile methodology to drive adoption and allow the methodology to be applied effectively.

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 [48]. One of the industry experts pointed out that coordination has always been an issue in the constructions sector and having clear roles and accountabilities are crucial for projects to be successful.

At the Teams level, Layton [49] 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. One of the industry experts also recommended for the Product Owner to be responsible in the whole-of-life performance of the building, from refurbishment, or retrofit, to maintenance. 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. The Chief of Product Owners will be responsible to facilitate the coordination between different Product Owners and ensure contribution towards a common goal by aligning backlog priorities with stakeholder needs [50, 51].

Similarly, the Scrum of Scrum Master role is also to align inter-team collaboration and coordination [52, 53]. They will take a lead role in coordinating the multiple agile teams. At a portfolio level, the key roles would be the portfolio executives who assume the responsibilities in exercising

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authority over the organisation. The decisions made by the executives will impact the project management organisation adopted [48].

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 [35]. The program backlog contains the upcoming work orders that are required to address the user needs and deliver business values [35]. 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 [54] suggested that the program backlog needs to take into account resource workload and customers' requirements to achieve the highest possible efficiency.

The next level is the project or team backlog that contains the to-do list that originates from the program backlog [35, 55]. The use of a Kanban board allows team members to assess the tasks assigned to them and allows stakeholders to view the statuses of the current and future activities [56]. The Plan-Do-Check-Act (PDCA) practice can also be used to support the project workflow. It encourages proactive learning and continuous improvement through on-going planning and control [57]. These backlogs are designed to support the teams by helping them to be efficient [55].

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 portfolio level, these are the processes that will support and/or deliver the solutions. Some of the portfolio management knowledge areas are [58]:

- Portfolio strategic management
- Portfolio governance management
- Portfolio performance management
- Portfolio communication management
- Portfolio risk management.

At a program level, these will be translated to the following knowledge areas [59]:

- Strategic decision making
- Stakeholder value management
- Pace management
- Resource management
- Benefits management
- Stakeholder relationship management
- Communication / marketing management
- Uncertainty management
- Partnership management.

At a team level, the framework proposed the team to have a planning session prior to starting any work. The planning session aims to integrate agile principles such as short-term planning, client involvement, reflection and adaptation, and business representatives and team members working together. Another recommended agile practice is the daily Scrum meeting where the Scrum Master, or Project Manager, will gather the team members to identify their daily work plans and challenges [35, 60].

5. Limitations and Future Works

Due to limited time and scope of work, this agile framework proposed in this paper is developed solely based on previous literatures. 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 on the practicality of the

framework. 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.

5. 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 approach, 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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