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Review

AgiBuild: A Scaled Agile Framework for Building Adaptation Projects †

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Abstract: Agile ways of working have garnered recognition for their capacity to drive innovation, placing a strong emphasis on adaptability to change and a user-centric approach. Inspired by these proven principles, the authors envision that applying scaled agile—an extension of agile methodologies—can serve as a catalyst for revolutionary transformations in how buildings are redesigned, refurbished, and operated, ushering in a new era of practices within the industry. This paper conducts an in-depth literature review to explore the application of agile ways of working in building adaptation projects. Drawing on insights from the literature review and expert validations, the authors propose the development of the Agile Building Adaptation (AgiBuild) framework, delineating its core components and outlining the probable implementation process. Notably, the framework's successful integration hinges on crucial factors, including effective leadership influence and comprehensive training. By embracing the AgiBuild framework, the building adaptation industry holds the potential to position itself as a highly innovative and user-centered sector, bolstering productivity and performance within the broader construction domain. By aligning with the framework's principles, the industry can cultivate a culture of adaptability and collaboration, facilitating the delivery of sustainable and customer-focused building adaptation projects that cater to the evolving needs of the built environment.

Keywords: agile ways of working; agile in construction; building adaptation; built environment; scaled agile; project management

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1. Introduction

Buildings play an important role in our built environment and our economy. The construction, operation and maintenance of a building will have 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 to ensure they are resilient over that period. Watson [2] suggests that the benefits of adapting an existing building include a 50 percent increase in the speed of construction and a lower cost compared to new builds 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, the fit-out market is forecasted to experience a growth of more than 14% by 2026.

Given the economic and social disruptions due to the recent COVID-19 pandemic, there is an 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 buildings industry. In 2021, IBISWorld's analyst suggested that the growth in commercial buildings industry is projected to decline over the next five years due to the uncertainties that emerge from the COVID-19 pandemic [4]. On the other hand, the Australian Financial Review reported a strong appetite for investors to purchase commercial buildings in 2021 [5]. 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 buildings 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 et al. [7] further describe the three types of fragmentation that are applicable to the construction of buildings, 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 building construction project; the horizontal fragmentation is due to the silos between the multidisciplinary specialists; the longitudinal fragmentation is due to the recurring of similar fragmentation from project to project.

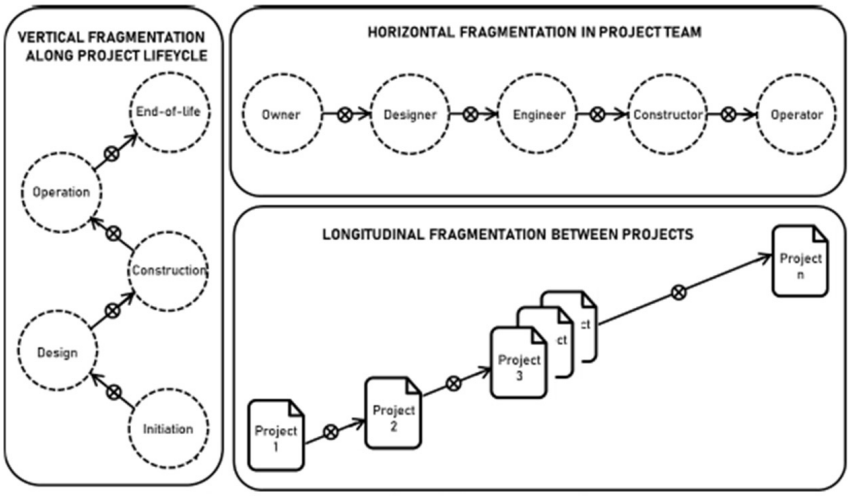


Figure 1. Fragmentations in construction projects [7].

These challenges and issues prompt the need to relook at the way projects are managed in the buildings industry. 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 make major reforms to improve the way we plan, finance, construct, maintain and operate these buildings [6]. A new way of working is required for the buildings industry to be more adaptable to change due to uncertainties, and to drive communication and coordination. The challenges associated with uncertainties and communication are not limited to the buildings industry. The information technology (IT) industry is also experiencing difficulties in coping with ongoing changes, such as new and emerging technology, and dealing with communication breakdowns when working across multidisciplinary teams. In an attempt to cope with these challenges, agile ways of working are introduced to the software industry. These agile ways of working have a strong focus on adaptation to change, flexibility and human-centred design and have proven to be effective to promote adaptation and coordination. Scaled agile is an extension of these agile ways of working that builds upon the principles and practices of the agile ways of working and adapts them to address the complexities and challenges of large-scale projects and organisations. Scholars and organisations have made significant strides in creating or adapting scaled agile frameworks for various domains, including software development, banking, manufacturing and product delivery [9–11]. These frame-

works often address the challenges of coordinating multiple agile teams and aligning them with strategic objectives. While some concepts from these existing frameworks may be transferable to the construction industry, research specific to the buildings sector remains relatively limited, and a dedicated framework explicitly designed for building adaptation projects is currently lacking.

This research aims to define and describe the scaled agile practices for building adaptation projects based on a detailed literature review of the scaled agile concept. To achieve this goal, a detailed literature review of the scaled agile concept will be conducted, emphasising the significance of agile practices and human-centered design in the context of the scaled agile. A supporting framework, known as AgiBuild, was developed, integrating these components to holistically embrace and optimise the implementation of scaled agile methodologies in building projects. Additionally, this investigation delves into the potential advantages of the framework, as well as the obstacles that may impede its successful implementation. The adoption of the AgiBuild framework offers a structured and systematic approach facilitating better collaboration, efficient resource allocation, and improved project outcomes within the dynamic and complex environment of the construction industry. To achieve the aim of this research, the research question is defined as follows:

RQ: How can the concept of scaled agile be utilised in building adaptation projects to improve adaptability, innovation and productivity?

This paper is structured as follows: the next section describes the research methodology adopted for this study, followed by the literature review section focusing on agile ways of working and scaled agile. 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 limitations will be presented, followed by the concluding notes.

2. Literature Review

This section provides an overview of scaled agile and its application in building adaptation projects. A framework known as AgiBuild is developed based on the literature review to convey the purpose and direction of applying scaled agile practices in building adaptation projects, portray how various components interact to produce the desired outcomes, and provide a structure that industry professionals can adopt and adapt based on their projects.

2.1. Agile Ways of Working

Agile ways of working 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 negotiations; (4) responding to change when following a plan [12]. Denning [13] describes the three common features of agile management: (1) customer-obsessed; (2) small is beautiful; (3) networks. Customer-obsessed implies that organisations that apply agile ways of working focus on adding more value to users and customers; small is beautiful suggests that an agile team breaks down large, complex problems into smaller pieces that can be managed by smaller, self-organising teams; networks means that agile ways of working involve all parts of the organisation coming to an agreement to achieve the designated goals. These studies show that agile ways of working have strong focus on customer values, adaptation, iterative and incremental delivery, and 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 [14].

The concept of agile emerged due to the shortcomings experienced in traditional software development processes. The traditional approach involves sequential steps and all the requirements are defined upfront [15]. However, such practices may not be practical,

or allow for the team to be flexible and make rapid adjustments. Agile ways of working ire said to allow teams to manage changing requirements and keep up with the continually changing technology and business requirements [15,16]. Some of the fundamental differences between traditional and agile ways of working are that traditional methods assume predictability, attempt to minimise changes, and exert control over schedules [17,18].

Agile is an umbrella term 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 [19]. Most traditional project management methods involve a project scope that outlines the work that needs to be done [20]. 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 [16,19]. 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 [21]. 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 that will be used 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?; (3) Do I see any impediments? [22]. At the end of each sprint, the team will perform retrospectives to discuss options for technical or process improvements [23]. 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 [24]. Pries-Heje and Pries-Heje [25] 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 [26]. The 15th Annual State of Agile Report, which was released in 2021, shows that 94% of the respondents reported the use of agile methods within their organisations. For software development teams, agile adoption increased by 37% between the year 2020 and 2021. The report also indicates that most organisations or teams adopted agile methods to enhance their ability to manage change, accelerate delivery, and improve team productivity. The key benefits that were observed included the ability to manage changing priorities, provide visibility, and allow for alignment between business and IT stakeholders.

It is important to note that agile practices are not a method by themselves. In fact, there are many distinct agile practices 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 Rational Unified Process (RUP) [16]. Of these methods, Scrum is the more popular methodology [27]. Scrum, the most popular and widely used agile methodology, provides a specific methodology for implementing Agile principles, offering a structured framework to manage work, facilitate collaboration, and deliver value in a more predictable and transparent manner [28].

The term Scrum, in the context of product development, 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, is designed to manage uncertainties and changes in requirements. The three main roles in Scrum are the Product Owner, Scrum Master, and development team [29]. The role of a Product Owner is to act as an interface between business users and the development team. The Product Owner also ensures that the objectives of the project are met [16]. The Scrum Master is responsible for resolving any challenges at the team and organization levels. 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 programmers, business analysts, testers, and others. This cross-functional team plays an important role in delivering an end product that satisfies the needs of the customers [16,19].

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 each day to discuss the work they carried out 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 performs a sprint review and a retro. The Scrum practices and workflow are shown in Figure 2.

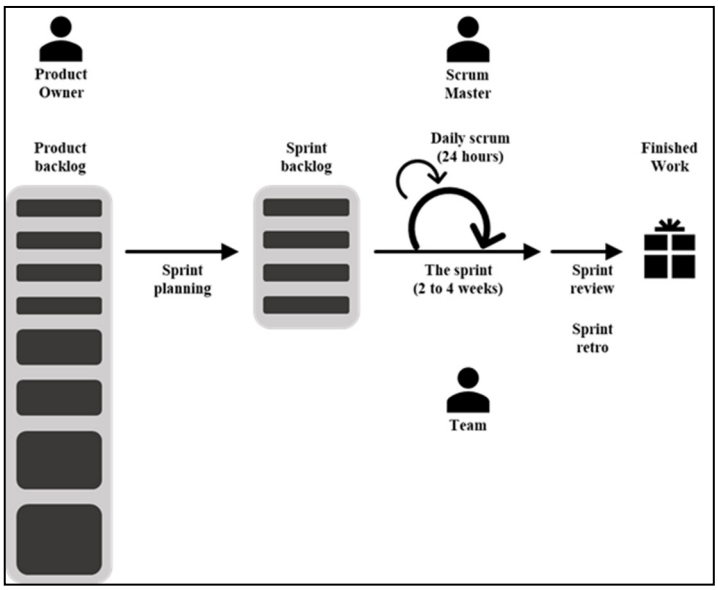


Figure 2. Scrum roles, practices and workflow.

2.2. Scaling Agile

Most agile methods, including Scrum, are catered to a small, co-located team with no more than 10 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 [30]. The idea of using agile practices on larger projects with a larger team size is known as *scaled agile*. Large programs are generally more complex due to the larger stakeholder groups and higher 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 [31]. Integration and coordination are important for large programs to be successful [16,32,33].

Xu [31] further states that agile approaches, when applied to a large program, will pose risks associated with communication and interaction. Based on the need for agile approaches to be applied to larger teams, a few frameworks that were developed to guide larger teams to apply agile approaches. Examples of these frameworks include the 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) [34]. Kalenda, Hyna [34] identified eight common scaling agile practices: Scrum of Scrums, communities of practice, scaled sprint demo, scaled requirements management, Scaled Retrospective, feature teams, and the undone department. Larson and Gray [16] also shared that a separate integration team can be formed to manage integration issues, and a central project management team can manage coordination and facilitate decision making. Some of these large-scale agile frameworks also include the scaling of roles, such as Area Product Owners (APOs) and Chief Product Owners (CPOs) [35].

The 15th State of Agile report, SAFe, is the most popular framework across large enterprises, with 37% of respondents opting to use SAFe as the framework for agile scaling. 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 as follows [36]:

- 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.

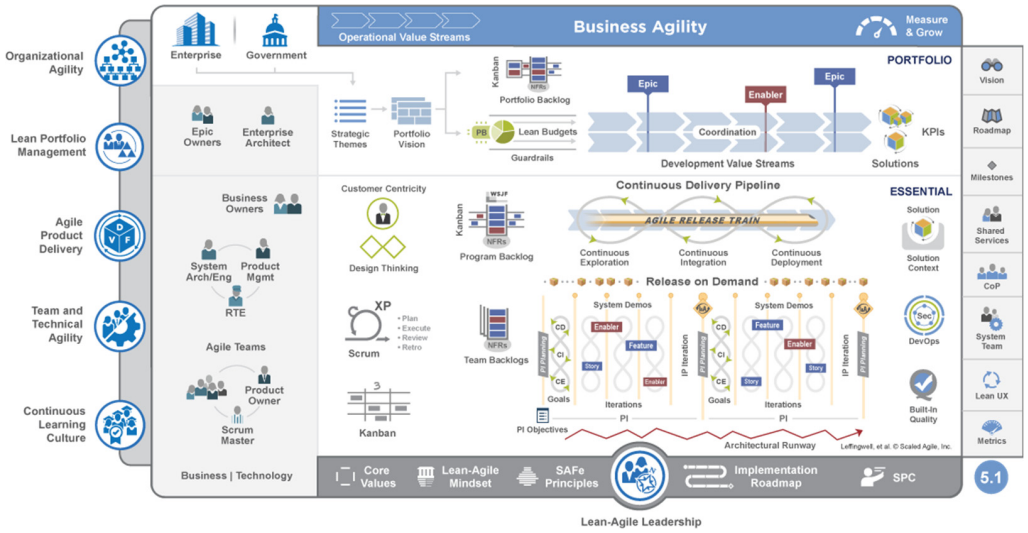


Figure 3. SAFe 5.1 Framework [36].

The benefits of agile approaches in software development have inspired the applications of APM in non-software projects. Examples of these applications include innovation management, product development, construction, real estate, education, and services. Some of the observed benefits include improved team communication and collaboration, high productivity and output quality, and ongoing feedback and continuous improvement [15]. According to the 15th State of Agile report, the adoption of agile approaches in non-software industries increased by two-fold in a year, from 2020 to 2021. Despite this increase in adoptions, the following barriers remain a challenge: (1) inconsistencies in processes and practices; (2) cultural clashes; (3) resistance to change.

Following an increase in participation in the agile movement, many studies were conducted to explore the application of agile approaches in construction in isolation. As a

result, the aim of this paper is to bring together a framework that combines the synergies between agile and building adaptation. The literature used for the development of the framework are outlined in Section 4: Discussion and Results.

2.3. Gaps Related to Analysis

Based on the literature review that was conducted, a total of three main gaps were identified:

- Integration of agile ways of working with traditional construction methods: Exploring how agile ways of working can be effectively integrated with traditional construction methods, and understanding the compatibility, challenges, and benefits of such integration.
- Scalability in large construction projects: Investigating how agile ways of working can be scaled up to accommodate large and complex construction projects, where traditional project management methods have historically dominated.
- Cultural and organisational adoption: Understanding the cultural and organisational challenges of adopting agile approaches in construction firms, including overcoming resistance to change and facilitating agile adoption at all levels of an organisation.

This research aims to address the following research gaps:

- Integration of the agile ways of working with traditional construction methods: Provide a set of principles and practices that emphasise flexibility, collaboration, and adaptability to gradually embed agile ways of working while still accommodating traditional methods.
- Scalability in large construction projects: Offer a multi-tiered framework that encompasses teams, program levels, and portfolio levels, so that it is aligned with the common structure of large construction projects for the effective management and coordination of complex initiatives.
- Cultural and organisational adoption: Include an implementation roadmap that provides guidance on change management and transformation.

3. Methodology

This study adopts a literature review to address the research question. The literature review was undertaken to review, evaluate and analyse four thematic areas: (1) scaled agile practices; (2) advantages, success factors and barriers to the application of scaled agile practices; (3) agile ways of working in buildings and construction; (4) human-centred design in buildings and construction. The literature review was chosen as it provides an overview of previous studies in the chosen area and allows for the authors to identify characteristics or relationships between key concepts from existing studies relevant to the topic [9].

The objective of the review was defined as to identify the recent developments in agile ways of working in the software and non-software industries and how are they being used. Broadly, the research was conducted in two stages, as follows: (1) the development of the theoretical components, and (2) the evaluation component, as illustrated in Figure 4. As depicted in Figure 4, the initial stage of this research involved shaping the problem statement and defining the framework requirements, as previously discussed in the 'Introduction' section. This phase assumes paramount significance in the project's progression, as it is crucial to confirm that the development of the artifact aligns seamlessly with its intended implementation environment in terms of suitability, applicability, and feasibility [37].

The following step was to review research that used the scaled agile concept within various industries, including the buildings industry. A structured and rigorous literature review was conducted using the four-step methodology, encompassing specific considerations for each step: (1) designing the review, (2) executing the review, (3) analysing the review, (4) composing the final review and developing the framework [38], and (5) conducting expert interviews and refining the framework.

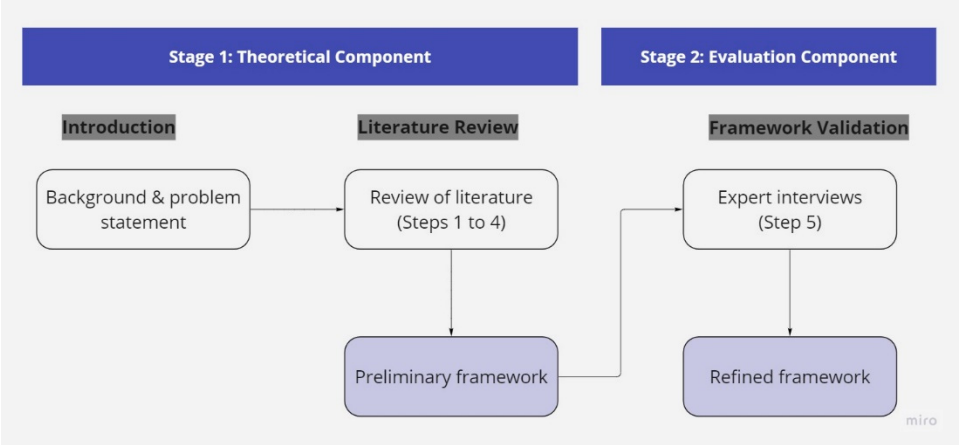


Figure 4. Research process.

3.1. Step 1: Designing the Review

The primary contribution of this paper lies in its development of a conceptual model, which applies scaled agile practices for building adaptation projects. Various constructs were carefully selected based on a rigorous literature review encompassing major topics of agile ways of working in both software and non-software industries, such as education and banking, along with scaled agile practices. Additionally, the research team conducted an analysis of potential scaled agile practices, drivers, and motivations for their adoption to form a viable theoretical model. In this context, the research team also review how these organisations effectively utilised agile methodologies to enhance their communication and coordination issues, enabling them to better manage change and achieve improved project outcomes. This is a state-of-knowledge literature review that employs a semi-systematic approach where the research team combines a historical overview of agile ways of working in small, medium, and large organizations with key themes found in the agile literature, including drivers, practices, and theories. This approach facilitates the identification of crucial components within the conceptual model, providing a clear pathway for future research opportunities [39].

3.2. Step 2: Executing the Review

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 that were defined; (3) apply a backward and forward search as required; and (4) evaluate the appropriateness of the literature subset [40].

The relevant literature was collected for review by searching the fields article title, abstract and keywords through reputable academic databases that covered construction, engineering, software development, and the project management literature, including the Scopus database, Web of Science and Google Scholar. When we conducted a literature review on the topic of agile approaches in construction, we used relevant keywords and phrases related to agile approaches and construction. These key terms include "Agile construction", "Lean construction", "Scrum in construction", "Agile project management", "Agile methodologies in construction", and "Building adaptation using Agile". Despite the authors' efforts, a specific search on "agile in building adaptations" did not yield any results. This lack of findings suggested that there might be limited or no existing literature directly addressing the application of agile practices in building adaptations. After applying the search string in the selected database, over 200 papers in the area of scaled agile approaches were found, which were relevant to the first two thematic areas. Close to 100 papers were relevant to the area of agile construction, and approximately 90 papers could be used to understand the application of human-centred design in construction. As this is a fast-emerging field, the search filters and papers were selected carefully. Noting that

there are a few "buzzwords" present in the industry, the authors also considered the use of synonyms when performing the search; for instance, Scrum is occasionally linked to agile, design thinking and user-centred design are used interchangeably with human-centred design, and large-scale agile, scaling agile and agile at scale are used interchangeably with scaled agile.

When determining the inclusion criteria, the authors specified the type of studies the authors wanted to include in the literature review. The authors focused on peer-reviewed articles, studies published in reputable journals and conferences, empirical research with data and analysis, books published by notable publishers or authors, and relevant case studies. On the other hand, the authors also established exclusion criteria to exclude certain types of studies. These exclusions are conference abstracts, any language other than English, complete simulation, and mathematical modelling papers and articles with limited relevance to the research topic. The authors also considered the geographical scope of the search. The authors chose to focus on agile practices in construction from a global perspective while also concentrating on specific regions or countries depending on our research objectives.

3.3. Step 3: Analysing the Review

Due to the diversity of the review topics, the authors chose to narrow the focus, and concentrate on specific databases and select papers that closely align with the research objectives. This approach allowed for the authors to delve into the chosen literature and analyse it thoroughly, ensuring that the selected studies were highly relevant to the scope of the review. While the authors acknowledge that other databases and papers exist, the decision to prioritise specific sources allowed for the authors to develop a more comprehensive and focused examination of the subject matter.

During this phase, the authors meticulously selected relevant papers and defined the specific information that could be abstracted from them. The most emphasis was placed on identifying the core components of scaled agile practices, which could be effectively applied in building adaptation projects. Thorough readings of the selected papers allowed for the authors to extract valuable insights, and accurately understand the authors' findings and contributions. As part of this analysis, the authors also explored the potential benefits and barriers of adopting scaled agile practices in building adaptations. This comprehensive examination provided the authors with valuable insights to advance their research and contribute to the understanding of the use of scaled agile practices in the buildings industry.

3.4. Step 4: Composing the Final Review and Developing the Framework

Building the conceptual framework involves the identification of key components that form the foundation of the conceptual framework. This process is rooted in the insights gained from the comprehensive reviews of the relevant literature. The synthesis of these components blends construction-specific insights with cross-industry agile principles. The authors identified commonalities between the software and construction industries to enrich the definition of these key components. One of the primary objectives of the conceptual framework is to map the resources and abilities necessary for the successful implementation of agile ways of working in construction projects, particularly those related to building adaptation. This involves categorising and organising the components that align with the fundamental principles of agile approaches, emphasising the importance of a strong foundation, people, process, and tools, highlighting their relevance to agility, and showing how they contribute to project success. It also serves as a bridge between agile ways of working and construction project management, and the agile ways of working can be adapted and integrated into traditional construction management processes to enhance project adaptability and responsiveness in building adaptation projects. This adaptation considers the specific needs and characteristics of construction projects, such as the involvement of multiple stakeholders, long project timelines, and the intricate nature of

building adaptation projects. Table 1 outlines the key rationales for including the selected components in the framework.

Table 1. Summary of framework components, rationale and supporting articles.

Components	Description	Key Rationale for Inclusion	Authors
Foundation			
Agile values and principles	Foundational beliefs and guidelines on the agile ways of working.	Effectiveness, Relevance, Best Practices, Comprehensiveness	Beck et al. (2001) [12] Diepersloot (2019) [41] Iqbal (2015) [42] Mohammed and Jasim (2018) [43] Straçusser (2015) [44]
Lean-agile mindset	A way of thinking that embraces a culture of lean principles and Agile values.	Effectiveness, Relevance, Comprehensiveness	Iqbal (2015) [42] Iqbal (2016) [45]
User centricity	A focus on meeting the needs and preferences of the end users.	Effectiveness, Relevance, Best Practices	Alzaed and Boussabaine (2012) [46] Darby (2019) [47] Iskander (2018) [48] Mokhtar (2016) [49] Owen et al. (2006) [50]
Technology	The use of digital tools, platforms, and software to facilitate the application of agile ways of working.	Effectiveness, Relevance, Best Practices, Scalability, Integration	Belhadi et al. (2021) [51] Gless, Hanser and Halin (2017) [52] Lee and Lee (2021) [53] Lu et al. (2011) [54] McArthur and Bortoluzzi (2018) [55] Mrugalska and Ahmed (2021) [56] Sawhney (2020) [7] Tomek and Kalinichuk (2015) [57]
Modularity	Structuring a system or project into distinct, interchangeable modules.	Effectiveness, Relevance, Best Practices, Scalability, Integration	Lee and Lee (2021) [53]
Implementation roadmap	A strategic approach to introduce the agile ways of working in construction	Adoption, Measurement	Pareliya (2018) [58] Ribeiro and Fernandes (2010) [59]
People			
Business stakeholders, board of directors, investors, regulators	External (non-project) influencers and decisionmakers.	Compliance, Transparency, Adoption	Leybourn (2013) [60] Liang, Yu and Guo (2017) [61] Luna et al. (2010) [62]
Scrum master circle	A forum where a group of Scrum Masters come together regularly to share experiences	Effectiveness, Adoption, Integration, Consistency	Fuchs and Hess (2018) [63] Gustavsson (2017) [64] Putta (2018) [35]
Product owner circle	A forum where a group of Product Owners come together regularly to share experiences	Effectiveness, Integration, Consistency	Belling (2020) [65] Berntzen, Moe and Stray (2019) [66] Putta (2018) [35]
Scrum master	A facilitator and coach, adapting the agile ways of working to improve team efficiency and project management	Effectiveness, Adoption, Consistency	Layton (2015) [67] Ormeño Zender and García de Soto (2021) [68] Sljivar and Gunasekaran (2018) [69] Streule et al. (2016) [70]
Product owner	A single-point of accountability for defining and prioritising project requirements	Effectiveness, Consistency	Layton (2015) [67] Sljivar and Gunasekaran (2018) [69] Unger-Windeler (2020) [71]

Table 1. *Cont.*

Components	Description	Key Rationale for Inclusion	Authors
Project development team	A group of individuals with diverse skills and expertise who collaborate to complete the project	Effectiveness, Efficiency	Demir and Theis (2016) [72]
Coordination tools and systems			
Vision, mission, strategic objectives and business case	An organisation's overarching purpose, aspirations and strategic decisions	Comprehensiveness, Transparency, Measurement	Choudhury (2019) [73] Knaster and Leffingwell (2020) [36]
Program backlog (Scope)	Scope of work for a program	Effectiveness, Transparency, Consistency	Zilberova, Tomashuk and Bobkina (2019) [74]
Program backlog (WBS)	Work to be carried out in a program in the form of a Work Breakdown Structure (WBS)	Effectiveness, Scalability	Knaster and Leffingwell (2020) [36] Wirfs-Brock and Hvatum (2018) [75]
Team backlog	Specific work items, in the form of workpackages, that a development team plans to address	Effectiveness, Transparency, Measurability	Demir and Theis (2016) [72] Wirfs-Brock and Hvatum (2018) [75]
Kanban	A workflow visualisation method	Transparency, Measurability	Modrich and Cousins (2017) [76] Paul and Rahman (2018) [77]
Scrum	An iterative and incremental product development approach	Effectiveness	Demir and Theis (2016) [72] Paul and Rahman (2018) [77] Streule et al. (2016) [70]
Plan-Do-Check-Act (PDCA)	A continuous improvement approach	Effectiveness, Measurability, Integration	Lerche (2020) [78]
Last planner	A construction project planning approach with detailed short-term plans	Effectiveness, Measurability, Integration	Owen et al. (2006) [79] Poudel, Garcia de Soto and Martinez (2020) [80]
Process			
Portfolio knowledge areas	The management disciplines that align with the organisation's strategic goals	Consistency, Compliance, Comprehensiveness, Best Practices	Project Management Institute (2017) [81]
Program knowledge areas	The coordination of interrelated projects within a program	Consistency, Compliance, Comprehensiveness, Best Practices	Thiry (2004) [82]
User stories	A concise narrative that captures a specific user or stakeholder need,	Effectiveness	Streule (2016) [70]
Continuous delivery	The streamlined and ongoing process of consistently delivering products or services with minimal delays	Effectiveness	John (2018) [83] Kibler (2019) [84] Knaster and Leffingwell (2020) [36] Paul and Rahman (2018) [77]

In summary, the identification of key components in the development of the conceptual framework leverages construction-specific insights while embracing cross-industry agile principles. This approach ensures that the framework is grounded in the realities of construction projects while benefiting from the broader insights into agile practices across various domains.

3.5. Step 5: Conducting Expert Interviews and Refining the Framework

The applicability of the framework was discussed and validated with construction experts. These sessions were instrumental in gathering valuable feedback on the conceptual framework and their potential implementation. Purposive sampling, characterised by the deliberate selection of research participants based on the researcher's judgment [85], was employed in this study. This sampling method was chosen for its effectiveness in the context of framework validation, as it allows for the targeted inclusion of individuals with specialized knowledge and expertise relevant to the research objectives. By deliberately selecting construction professionals who possess unique insights into the subject matter, the study aimed to ensure that the framework's validation process benefited from their domain-specific knowledge and experience. This approach enhances the framework's robustness and applicability, as it incorporates input from key stakeholders who are well-qualified to provide informed feedback and validation. Five (5) semi-structured interviews that lasted approximately 45–60 min were conducted online to gather feedback from the following experts:

- Interviewee 1 (PM01): A highly experienced principal consultant and advisor with over 25 years of experience in strategic program management leadership roles across government and private sectors.
- Interviewee 2 (PM02): A professional with over 20 years of multi-disciplinary experience in consulting and working in the construction industry across several countries, with expertise in agile practices, who has obtained multiple agile certifications.
- Interviewee 3 (PM03): An experienced asset management principal with over 25 years of experience working in asset intensive organizations in the infrastructure, transportation, utilities and resources sectors, and is passionate about deploying innovative digital technology solutions.
- Interviewee 4 (PM04): An experienced engineer and agile coach with over 10 years of experience within the oil and energy industry.
- Interviewee 5 (PM05): An innovation, research, and development manager in an engineering consultancy with over 15 years of experience, especially in the area of agile project management and the measurement of knowledge transfers.

The interview questions asked during the validation process include:

1. How relevant does this framework appear to be for driving agility in building adaptation projects?
2. What are the major gaps or missing components in the conceptual framework?
3. What changes or modifications, if any, would you suggest to improve the framework's utility and clarity?
4. What are the potential challenges in implementing or operationalising the framework?

3.6. Summary of the Components in the Refined Framework and Rationale for Selection

Through a comprehensive literature review and discussions with experts in agile approaches to construction, the underlying components were identified and are summarised in Table 1. There are several key rationales to including the selected components in the framework:

- Alignment with Objectives: The component aligns with the overarching objectives and goals of the framework, ensuring that it directly contributes to achieving the desired outcomes. (Note—all components are in alignment with the research objectives.)
- Relevance: The component is relevant to the context in which the framework will be applied. It addresses specific challenges, needs, or opportunities within that context.
- Effectiveness: The inclusion of the component is expected to enhance the effectiveness of the framework in achieving its intended purpose or solving particular problems.
- Comprehensiveness: The component adds depth and breadth to the framework, ensuring that it covers all essential aspects of the subject matter or process.

- Best Practices: The component incorporates established best practices, lessons learned, or industry standards, ensuring that the framework is based on sound principles.
- Scalability: The component allows for the framework's scalability, ensuring that it can be applied effectively across different scales or levels of complexity.
- Consistency: The component promotes consistency in how the framework is understood, adopted, and implemented, reducing ambiguity and potential conflicts.
- Integration: The component integrates seamlessly with other components of the framework, fostering cohesion and synergy among its various parts.
- Compliance: The component ensures compliance with legal, regulatory, or industry-specific requirements, reducing the risk of non-compliance issues.
- Transparency: The component promotes transparency in decision-making, processes, or actions, enhancing trust and accountability within the framework.
- Measurability: The component allows for the measurement and evaluation of framework performance and outcomes, facilitating data-driven decision-making and continuous improvement.
- Adoption: The component enhances user adoption and acceptance of the framework by addressing specific pain points or providing clear benefits.

4. Discussion and Results

With the increase in the application of agile ways of working, the buildings industry also has the opportunity to improve innovation and become 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 outlines all possible resources related to agility and creates 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. Figure 5 shows the preliminary framework developed from the literature review, while Figure 6 is the refined framework from expert interviews.

Modelled after the concept of the Scaled Agile framework, the AgiBuild framework is also intended to be scalable to accommodate building adaptation projects that are of different sizes and complexity levels. There are three organizational levels in this framework: teams, programs and portfolios. The team level is made up of 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 a larger scope and/or size. The program level is used to align multiple agile teams with a common objective.

The framework contains the people, tools and processes involved in the application of agile approaches, as well as a foundation level. The people components involve the establishment of a portfolio-wide culture, with all units, teams, or departments having the right set of skills to embrace lean and agile values. The process components evolve around the application of lean and agile principles in the planning, development, delivery, and management of benefits and values. The process components also govern the ability to provide ongoing monitoring, feedback, and improvements. The tools components involve enablers of the easy implementation of lean and agile practices. They also enhance the ability to provide traceability and visibility across multidisciplinary teams [41]. The foundation level includes the core values, the principles, the lean-agile mindset, and guidelines to implement agile approaches in the built environment sectors.

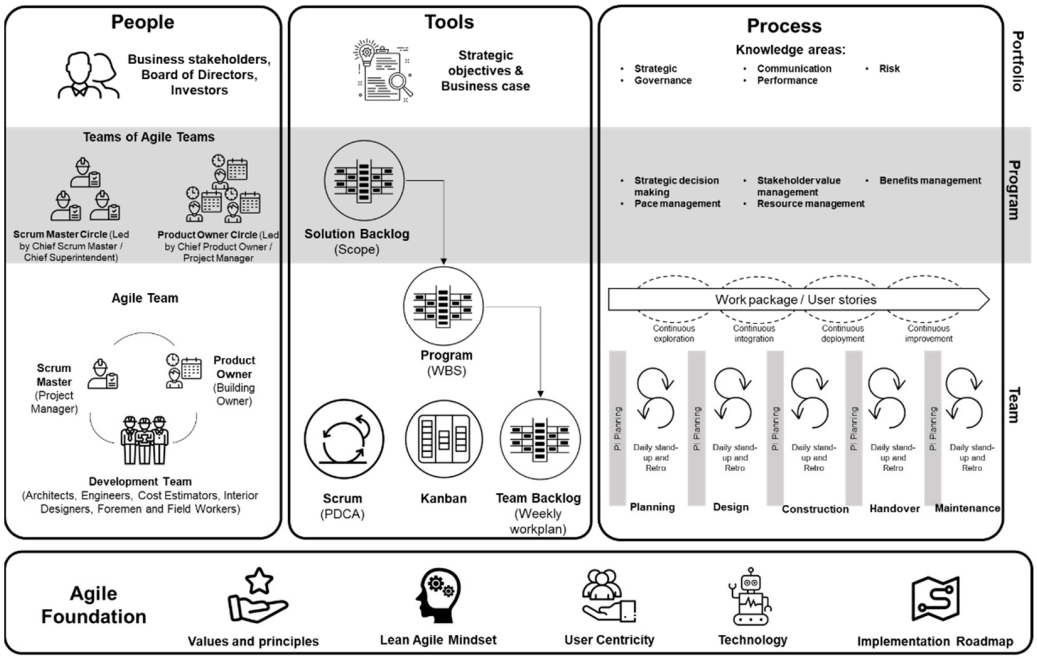


Figure 5. The AgiBuild framework (preliminary).

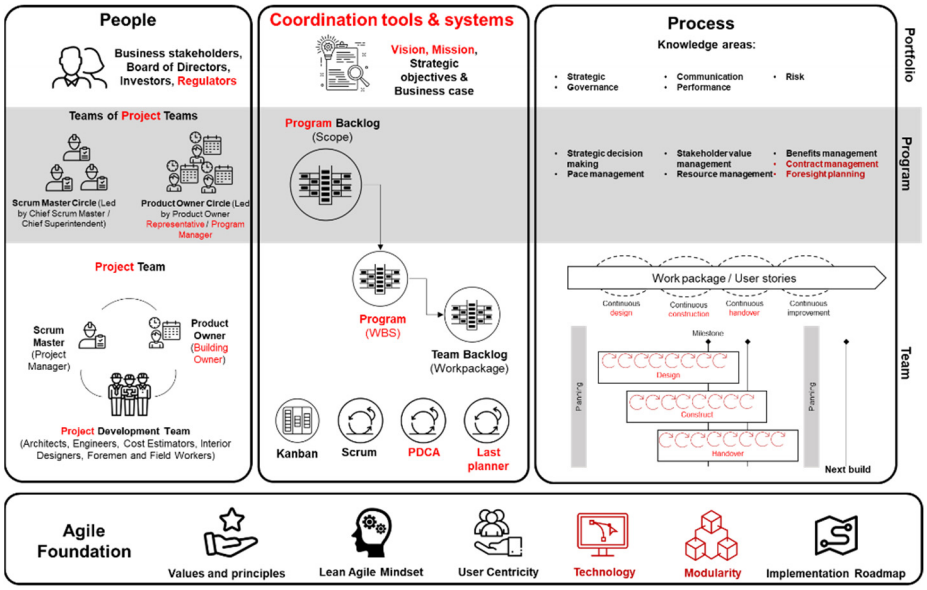


Figure 6. The AgiBuild framework (refined).

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 agile values and principles in various construction projects. These values were found to be beneficial to different parties in a construction project [43,44]. Diepersloot [86] suggested that, while these values are relevant, a slight change in terminology 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 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;
- Responding to change over following a plan.

The above values use 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 used in construction, a stakeholder collaboration, including customer, regulators, contractors, and others, need to be considered.

Other core components for the largescale application of agile approaches include having a lean-agile mindset. The following lean-agile mindsets are important for construction professionals [42,45]:

- Maximise value and minimise 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 approaches 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 [47]. The integration of digital tools such as the Building Information Model (BIM) and industrial production such as 3D printing play a key role in agile methods to improve collaboration and efficiency [7,52,55,57]. The Implementation Roadmap is another key component for the application of agile approaches in the built environment sector. The implementation roadmap considers common success factors and barriers to implementation. The main success factors include an executive leadership buy-in and having proper training and education. The barriers include resistance to change, lack of skills and knowledge, and cultural misalignment. Pareliya [58] recommended educating building and construction professionals with an agile methodology to drive adoption and allow for the methodology to be applied effectively.

The interviewees agreed that the current components at the foundation level are appropriate and relevant. PM01 suggested the inclusion of modularity at the foundation level, as modularity promotes the decomposition of complex systems or projects into smaller, independent, and interchangeable modules or components. The researchers agreed that this allows for greater flexibility and adaptability, enabling teams to respond effectively to changing requirements and customer feedback, which are fundamental principles of the agile ways of working.

4.2.2. People

Stakeholder management is crucial for the success of a project, more so in retrofit projects. Retrofit projects involve a wider group of stakeholders, such as tenants and facility managers, who have a contractual relationship such as a lease contract and split incentives [61]. 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 [67] 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 that the Product Owner is 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 by helping the team to remove any impediments.

The agile development team is made up of skilled team members such as architects, interior designers, and engineers. When the team gets larger, one consideration is the inclusion roles such as Scrum of Scrum Master and Chief of Product Owners. The Chief of Product Owners will be responsible for facilitating coordination between different Product Owners and ensure their contribution towards a common goal by aligning backlog priorities with stakeholder needs [65,66].

Similarly, the Scrum of Scrum Master role is also to align inter-team collaboration and coordination [63,64]. They will take a lead role in coordinating multiple agile teams. At the portfolio level, the key roles are played by the portfolio executives who assume responsibility for exercising authority over the organisation. The decisions made by the executives will impact the project management organisation that is adopted [61].

This portion of the framework was revised based on mixed opinions from different experts. In general, the interviewees were comfortable with the components in the preliminary framework, with additional refinements being required due to the distinct stakeholder ecosystem and terminologies used in the building adaptation industry. PM01, PM02, and PM03 suggested that *regulators* be added as a key stakeholder. They mentioned that compliance with regulatory standards and requirements is crucial in building adaptation projects due to safety and legal considerations. The authors agreed with this addition, as regulatory bodies play a pivotal role in enforcing these standards, especially if this is to be applied to a public sector project. PM01 and PM04 also commented that the term *agile team* is not commonly known in the building adaptation industry, and may lead to the misconception that the agile team is a separate entity or team within the project. The authors modified the term to *project team*, as this is more commonly used and recognized, and using industry-specific terminology helps to bridge the gap and facilitates communication between stakeholders. The authors also agreed with PM03, that *Representative* or *Program Manager* should be included as the Product Owner at the program level because these roles often have a comprehensive view of the program and understand the overarching goals, priorities, and stakeholder needs. PM04 further added that it is important to focus more on the roles and responsibilities, rather than the *Product Owner* and *Scrum Master* titles.

4.2.3. Coordination Tools and Systems

The strategic objectives and business cases are established by the portfolio executives and stakeholders. They will impact the development backlogs at the subsequent levels [36]. The program backlog contains the upcoming work orders that are required to address user needs and deliver business values [36]. A visualised version of the program backlog allows for organisations to assess the gaps in achieving the organisation's goals and the effort required to achieve the targets. Zilberova, Tomashuk and Bobkina [74] 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 [36,75]. The use of a Kanban board allows for team members to assess the tasks assigned to them, and allows for stakeholders to view the statuses of the current and future activities [76]. The Plan-Do-Check-Act (PDCA) practice can also be used to support the project workflow. This encourages proactive learning and continuous improvements through on-going planning and control [78]. These backlogs are designed to support the teams by helping them to be efficient [75].

The heading of this section was initially *Tools* and was updated to *Coordination tools and systems* as PM04 suggested that the term "tools" alone might be perceived as limiting, as it can imply a narrower scope of physical tools or software applications. "Coordination tools & systems" conveys a more precise meaning. The tools and systems that are used often extend beyond simple hand tools or software. PM03 said that vision and mission statements are essential in the context of agile portfolio management in a building adaptation project, as incorporating vision and mission statements into portfolio tools serves as a constant reminder of the organisation's strategic direction, helping portfolio managers

make decisions that are in harmony with these goals. Another change that was made to the preliminary framework is the replacement of *Solution backlog* with *Program backlog (scope)* and *Program backlog (WBS)*. This was based on the feedback made by PM03, suggesting the a need for the term *Program backlog scope* to explicitly convey that it represents the scope of work at the program level, and a team-level work breakdown structure (WBS) that provides a clear breakdown of the scope of work for a specific team. PM02 also added that Scrum and PDCA are two different concepts and should be separated, while PM01 further suggested the term last planner system (LPS), as LPS uses visual planning techniques, such as pull planning and weekly work plans, to enhance project visibility. The authors acknowledged that the integration of LPS complements the agile ways of visual planning, providing a holistic view of project progress and potential bottlenecks.

4.2.4. Processes

At the portfolio level, the components are incorporated based on the PMBOK's portfolio and program knowledge areas to support and/or deliver solutions. Some of the portfolio management knowledge areas are as follows [81]:

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

At the program level, these will be translated to the following knowledge areas [82]:

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

At the team level, the framework proposed that the team conducts 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 stand-up meeting where the Scrum Master, or Project Manager will gather the team members to identify their daily work plans and challenges [36,83].

All interviewees are comfortable for the components to align with the PMBOK knowledge areas to facilitate integration between agile and traditional methods. PM01 suggested that *Contract Management* is specifically called out at the *program* level to ensure that contractual changes are addressed systematically, and adaptations are made in a coordinated manner across projects. In construction, changes to the project scope or specifications can impact contracts. PM05 also mentioned that *foresight planning* at the program level helps the project teams to make informed decisions that align with the building's future needs and sustainability goals. This ensures that the agile ways of working consider potential changes in the building's purpose, regulations, or technology. Foresight planning involves anticipating future trends, challenges, and opportunities. In building adaptation, considering the long-term impact of changes and renovations is essential. PM03 also suggested that, in agile ways of working, there should be an integration between the different project phases, where each phase is executed continuously in an agile fashion. The phases should be working together cohesively, with less rigid separation, to achieve the benefits of agile practices without compromising the project structure or control.

5. Implications of the Framework

The development of the proposed scaled agile framework for building adaptation projects has significant implications for various stakeholders, including researchers and industry practitioners. For researchers, the proposed framework serves as a valuable reference and starting point for further investigations into the application of scaled agile methodologies in the construction domain. It provides a comprehensive analysis of agile practices and human-centered design within the context of building adaptations, paving the way for future studies that will explore additional aspects or conduct an empirical validation. For industry practitioners, the proposed scaled agile framework offers a practical and structured approach to managing building adaptation projects. It provides guidance on how to effectively apply agile practices and human-centered design principles, enabling teams to collaborate more seamlessly, adapt to changing requirements, and deliver customer-centric solutions. Industry practitioners can integrate the framework into their project management processes, align teams with strategic objectives, and enhance overall project outcomes through continuous improvement and iterative development. Industry practitioners can tailor this to their specific project requirements, team dynamics, and organisational context to optimise project success.

6. Limitations and Future Works

Due to the limited time and scope of work, the agile framework proposed in this paper is developed based solely on the previous literature and validated with five subject matter experts. A follow-up case study is required for the refined framework to be validated via practical implementation. 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.

7. Conclusions

The construction and built environment sector are pivotal for the advancement of civilization. While there are many developments and evolution processes within the industries, the built environment sector faces major challenges, such as a lack of growth and innovation. In addition, building adaptation projects often experience poor coordination, fragmentation and inefficiencies. Agility, a concept that originates from the software industry, has the potential to facilitate a flexible, responsive process, especially when dealing with fragmented activity changes.

In this paper, the authors identified a link between agile project management and building adaptation project management. Using the literature review approach, the AgiBuild framework and its key components are identified and validated.

While agile principles and practices were partially applied to some construction projects, the application of agile approaches 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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