Article

Practices Driving the Adoption of Agile Project Management Methodologies in the Design Stage of Building Construction Projects

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Abstract: The aim of this study is to identify practices that would enable building construction companies to adopt agile project management methodologies during the design stage of projects that use building information modelling (BIM) solutions in the designing process. Due to the benefits of agile project management methodologies, a considerable amount of research has been conducted regarding the adoption of this methodology for building construction projects. However, waterfall project management is still more widely used in the building construction industry than agile project management is. Several recent studies claim that firms could focus on adopting agile methodologies during the design stage of a building construction project because due to the advent of BIM software solutions, the design stage can be carried out in a manner such as a software development project. Since software development industry is experiencing a widespread adoption of agile methods, if the design stage of a building construction project can be carried out such as a software development project, then there is a possibility to drive agile adoption in the design stage. Based on this information, researchers found an architectural consultancy firm that has been using a BIM solution to adopt agile project management methodologies in the design stage. The authors carried out a systematic literature review and identified 10 possible practices that might drive the adoption of agile practices. Those practices were presented to the architectural consultancy firm to identify practices that they are using to successfully adopt agile methods. The findings suggest that maintaining a backlog, running sprints, engaging a cross-functional team, continuous integration, and iterative/incremental development of the design are practices that have enabled the firm to adopt agile methods. Practical and theoretical implications were derived from the findings, and suggestions for future research and limitations of the study are discussed in the discussion. Concluding remarks are provided in final section of the paper.

Keywords: agile methods; building information modeling systems; BIM; construction project management; building construction industry

1. Introduction

The adoption of agile project management practices for building construction projects is a highly researched topic because of the benefits these practices offer as compared to those of traditional project management methods. Over the years, researchers have proposed different frameworks for the adoption of agile methodologies in building construction projects

(e.g., [1–4]). However, thus far, the scale of adoption has been extremely limited [5,6]. For example, in the construction industry in the United States, waterfall project management remains far more popular than agile project management is [1].

In contrast, in the software industry, agile project management methodologies are quite popular [5]. That is quite normal because the concept of agile project management was introduced to the world by the software industry [7]. Moreover, the software industry has the capability to facilitate easy implementation of agile characteristics such as implementing continuous design, maintaining a flexible scope, living with uncertainty, and interacting with customers on a constant basis [8–10]. If these characteristics could be facilitated in the building construction industry, there is a higher chance of increasing the adoption of agile methodologies in building construction projects. However, it is extremely hard to facilitate continuous changes in the building construction industry because changing an ongoing construction project could cost a lot. It is not the case in the software industry since their projects are carried out in a virtual environment. Thus, they have the luxury of continuously changing features of an outcome. When one is considering the building construction industry, there is a phase that can be carried out in a virtual environment without the involvement of physical constructions. That is the design stage of a building construction project.

The design phase of any building construction project is extremely critical, since it defines the scope of the construction phase [6,8]. At present, leading construction companies in the world use building information modelling (BIM) solutions to design buildings. Through digital simulation of building design, BIM solutions can enable all stakeholders involved in a project to view a digital representation of the building and demonstrate how it will function before the actual construction phase commences [6,11]. Moreover, BIM solutions could enable the design phase of a construction project to be carried out in a manner that is similar to a software development project [1,6]. That is because a BIM solution has advanced features that can facilitate continuous design, flexible scope, living with uncertainty, and constant customer interaction [1]. For example, Autodesk Construction Cloud has a BIM module that can be accessed by anyone from anywhere in the world over the internet. Hence, even a customer could follow the progress of a design project remotely and provide real-time feedback.

Previous studies such as [6,12] have investigated how BIM solutions could be used to implement agile methodologies in the construction industry. However, hardly any past research has investigated practices that would enable construction firms to adopt agile methodologies for building construction projects that incorporate BIM solutions. Thus, the research problem of this study can be formulated as follows.

Research problem—a lack of understanding of building construction firms regarding the practices that would enable them to adopt agile project management methodologies in the design stage of projects that uses BIM solutions.

This lack of understanding has created a gap in the field of construction project management. Hence, this study aims to fill this gap in the construction project management literature. Thus, the main aim of this study is as follows.

Aim of the research: this study aims to investigate practices that would enable building construction companies to adopt agile project management methodologies in the design stage of a building construction project with the assistance of BIM solutions.

The remainder of this paper is organized into five sections. The literature review is presented in the Section 2. This study conducted a systematic literature review to identify and understand the possible practices that a building construction firm could adopt. Since software industry is the industry that has successfully adopted agile methodologies around the globe, most studies that were reviewed during the systematic literature review related to the software industry. By reviewing those studies in the literature, the authors were able to identify possible practices that would drive building construction companies to adopt agile project management methodologies in the design stage of a building construction project. Section 3 presents the methodology adopted to derive possible practices that

could enable construction firms to adopt agile methodologies for building construction projects that incorporate BIM solutions. The researchers came across an architectural consultancy company in Sri Lanka that has successfully adopted agile project management practices in the design stages of certain building construction projects with the aid of a BIM software package. This study received the support of the firm to execute the methodology. By executing the methodology, the actual practices that are adopted by the architectural consultancy firm were identified. The practices are presented in Section 4 as the findings of the research. Section 5 presents implications and recommendations based on the findings of the study, as well as the limitations of the study and suggestions for future research. Concluding remarks are presented in Section 6.

2. Literature Review

A literature review was conducted to identify and understand possible practices that would drive the adoption of agile methodologies with the assistance of BIM solutions. Since it was required to conduct a comprehensive review of the literature, this study decided to conduct a systematic literature review to identify possible practices. Thus, authors adopted the six-step procedure suggested by the authors of [13] to carry out the systematic literature review: (1) formulate a question to guide the literature review, (2) determine what criteria should be used to decide which articles to include in the review, (3) conduct a systematic search of the literature and unpublished studies, (4) select articles of sufficient quality that fulfill the criteria from Step 2, (5) extract the relevant results from the selected studies, and (6) create a summary of the best available results.

The review question that guided the literature search in this study is: *What are the possible practices that would drive the adoption of agile methodologies with the assistance of BIM solutions?* Once this review question was finalized, the authors determined the article inclusion criteria and search criteria. A summary of the inclusion criteria is presented in Table 1.

Table 1. Criteria for inclusion.

Characteristic	Inclusion Criteria
Type of publication	Peer-reviewed journal articles, conference papers, book chapters indexed in Scopus
Language(s)	English
Time period	From 2006 to 2022 (inclusive)
Research design	Conceptual and empirical
Content	Studies on various agile project management methodologies
Source	Scopus databases

In this study, the authors limited the search to articles written in English, since this language is commonly understood by all six authors and is widely understood by researchers across the globe. Only peer-reviewed journal articles, book chapters, and conference papers were included based on the inclusion criteria mentioned in other review articles published in reputable journals (e.g., [14,15]). Moreover, the search was limited to articles included in the Scopus database, as indicted in other studies (e.g., [16]). Additionally, the study only considered articles on agile project management that were published between 2006 and 2022.

Once the article inclusion criteria were finalized, the search process was conducted in three steps (i.e., identification, screening, and inclusion), as mentioned in previous studies (e.g., [17]). The specific search terms used in each stage are shown in Figure 1. During the identification stage, the authors searched for articles with the phrase, *agile project management*, based on a preliminary literature review in which the authors found that for studies indexed on Scopus, the two most popular keywords in studies related to agile project management in the construction industry are *project management* and *agile project management*. As *project management* is an overly broad subject area, the article search process

was focused on the phrase, *agile project management*. In the identification stage, a total of 4439 articles were compiled.
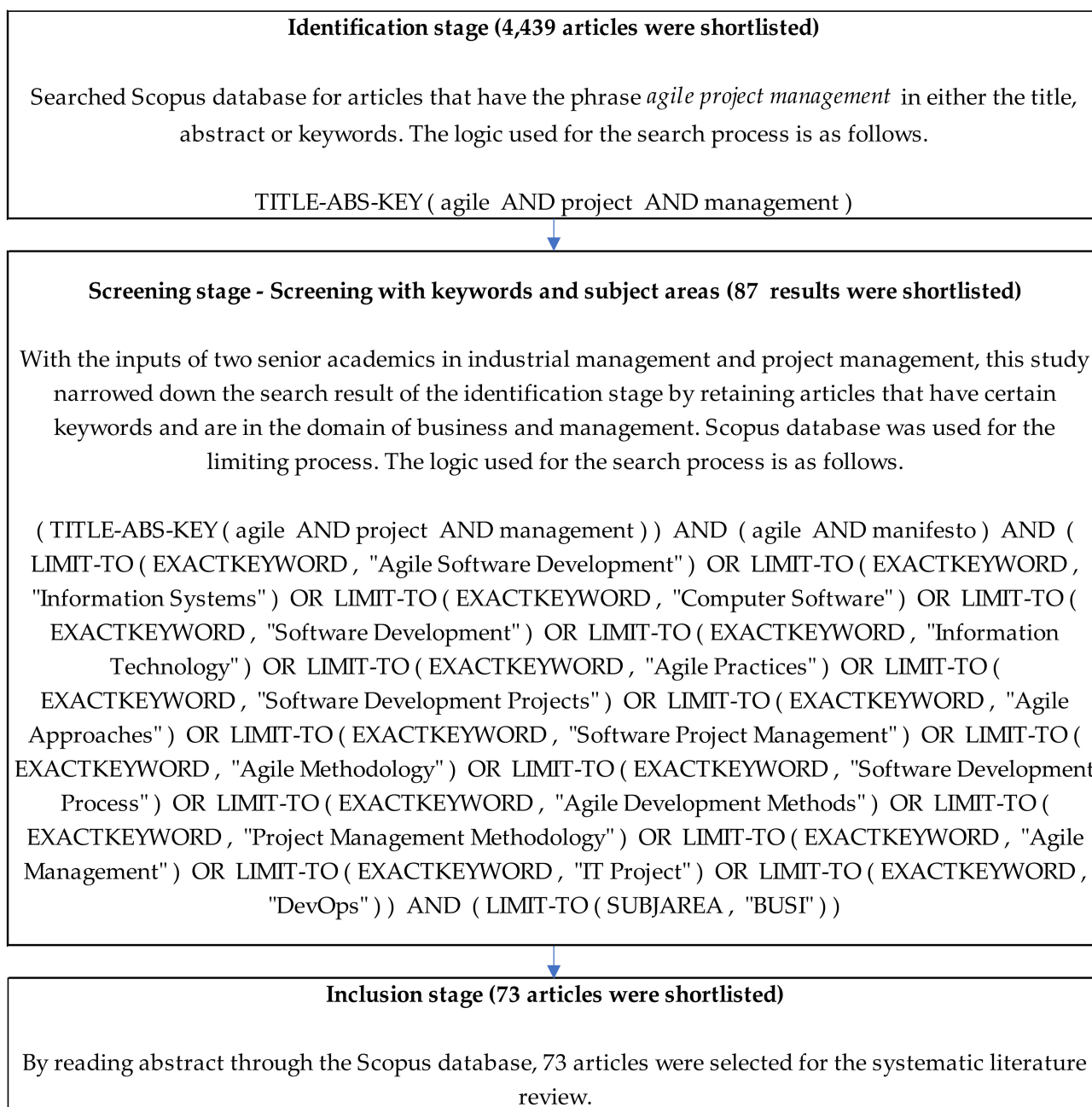

Identification stage (4,439 articles were shortlisted)

Searched Scopus database for articles that have the phrase *agile project management* in either the title, abstract or keywords. The logic used for the search process is as follows.

TITLE-ABS-KEY (agile AND project AND management)

Screening stage - Screening with keywords and subject areas (87 results were shortlisted)

With the inputs of two senior academics in industrial management and project management, this study narrowed down the search result of the identification stage by retaining articles that have certain keywords and are in the domain of business and management. Scopus database was used for the limiting process. The logic used for the search process is as follows.

(TITLE-ABS-KEY (agile AND project AND management)) AND (agile AND manifesto) AND (LIMIT-TO (EXACTKEYWORD , "Agile Software Development") OR LIMIT-TO (EXACTKEYWORD , "Information Systems") OR LIMIT-TO (EXACTKEYWORD , "Computer Software") OR LIMIT-TO (EXACTKEYWORD , "Software Development") OR LIMIT-TO (EXACTKEYWORD , "Information Technology") OR LIMIT-TO (EXACTKEYWORD , "Agile Practices") OR LIMIT-TO (EXACTKEYWORD , "Software Development Projects") OR LIMIT-TO (EXACTKEYWORD , "Agile Approaches") OR LIMIT-TO (EXACTKEYWORD , "Software Project Management") OR LIMIT-TO (EXACTKEYWORD , "Agile Methodology") OR LIMIT-TO (EXACTKEYWORD , "Software Development Process") OR LIMIT-TO (EXACTKEYWORD , "Agile Development Methods") OR LIMIT-TO (EXACTKEYWORD , "Project Management Methodology") OR LIMIT-TO (EXACTKEYWORD , "Agile Management") OR LIMIT-TO (EXACTKEYWORD , "IT Project") OR LIMIT-TO (EXACTKEYWORD , "DevOps")) AND (LIMIT-TO (SUBJAREA , "BUSI"))

Inclusion stage (73 articles were shortlisted)

By reading abstract through the Scopus database, 73 articles were selected for the systematic literature review.

Figure 1. Summary of the article search process.

Next, the authors initiated the screening stage. To aid in the screening process, expert opinions from two senior professors in industrial management and project management were solicited. The experts inspected the identified studies and suggested several keywords and a subject area that the authors could use to screen the compiled articles. The keywords and the subject area that were proposed by experts are shown in Figure 1. A majority of the keywords suggested by the experts are related to the information technology (IT) industry, as the experts mentioned that agile practices have been more successfully adopted by the information technology industry as compared to the adoption of other industries, and they believed that a comprehensive list of practices could be extracted from studies related to the information technology industry. Furthermore, the two experts suggested using the phrase

agile manifesto and searching for this term in the articles identified in the initial screening process. Based on the screening, a total of 87 articles were shortlisted.

During the inclusion stage, authors reviewed the abstracts of 87 shortlisted articles. A total of 14 articles were eliminated because they did not include any discussion of practices that drive the adoption of agile methodologies. The remaining 73 articles were selected for further investigation. Because 73 articles were peer-reviewed studies that were indexed in Scopus, it was deemed that they were of sufficient quality to be included in the review. Another notable aspect of the 73 shortlisted articles is that almost all the articles are related to the information technology industry. That is because most of the companies that have adopted agile project management methodologies are from the information technology industry.

Next, data were extracted to aid in developing an answer to the review question for the systematic literature review. The authors carefully examined each paper that was shortlisted from the article search process. By the end of this process, the authors became quite convinced that all the agile practices used in the information technology industry evolved from the agile manifesto. Thus, it is important to gain an understanding of the agile manifesto before discussing the specific agile practices that could be adopted by firms in the construction industry.

2.1. The Agile Manifesto

The agile manifesto was developed by a group of 17 software practitioners in 2001 as an alternative approach for developing of software systems at the early stage of the development life cycle [7]. Thus far, this alternative method has given rise to multiple revolutionary agile methods such as Extreme Programming, Scrum, and Lean [7,18].

As per the agile manifesto, agile methodologies give more prominence to the following four principles "individuals and interaction over processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation, and responding to change over following a plan" [7] (p. 10).

When greater prominence is given to individuals and interaction, project teams focus more on enabling each participant to comprehend the development process, become a part of it, contribute to it, and collaborate with all other project stake holders rather than merely focus on state-of-the-art, hard-to-use tools [7]. It is obvious that tools are important. However, if the members of the project team do not feel that they are part of the team, the chances of the project team being successful are lower, regardless of the quality of the tools they possess. Thus, the agile manifesto highlights the significance of nurturing individuals and promoting interaction among them.

When more attention is given to working software, the project teams can experience three benefits. First, project teams can focus on the development process and the documentation necessary to carry out the process. Second, agile project management encourages an early start for the coding process to enable the project team and the customer to quickly gain an understanding of the product to be developed. When traditional project management methodologies are used, it is not possible to do any of these things, as the focus is on gathering the entire list of requirements at the start of the project, documenting them comprehensively, and getting all the relevant stakeholders to sign off. Thus, the focus on working software is very minimal for a considerable period. Third, in most cases, agile project management processes have the capability to provide bug-free, high-quality working software that can meet the expectations of the customer [7] because the customer has been engaged with the project throughout the entire life cycle.

However, this is not the case when traditional project management methodologies are used. Customer engagement is intensive at the start due to activities such as requirement gathering and the preparation of various documents. However, during the execution stage, the level of customer engagement is very minimal (or could even be non-existent). At the end of the execution stage, customer engagement becomes high because the company will be conducting product demonstrations. During these product demonstrations, customers

who are seeing the product for the first time may request extensive changes. However, in contrast to traditional project management methods, the customer witnesses the evolution of the product when agile methodologies are used. Hence, agile methodologies are more often able to help project teams develop bug-free software that can meet customers' expectations.

When greater prominence is given to customer collaboration, project teams are allowed to interact with customers on a frequent basis. In fact, some agile project teams can interact with customers on a daily basis. This direct client interaction makes it possible to properly manage numerous changes that are typical of software projects [7]. In the meantime, as mentioned before, customers can see the evolution of the product from start to finish.

Finally, when more prominence is given to responding to change, project teams are able to successfully respond to changes requested by customers without compromising the quality of the product or the customer experience [7]. According to the agile manifesto, responding to change is very important from a customer's perspective because the customer might not be able to predict requirements that might arise in the future. If a project team shows that they are ready to respond to change, the customer will know that the service provider will be ready to accommodate changes at any point of the project if the changes can be justified.

Through their understanding obtained by examining the agile manifesto, the authors realized that it is important to check whether each practice extracted from the systematic literature review will adhere with at least one of the four principles highlighted in the agile manifesto.

2.2. Possible Practices That Could Be Adopted by Building Construction Firms

During the review process, the authors identified 10 major agile practices that have been adopted by the information technology industry. Descriptions of these practices, along with the sources for each practice, are provided in Table 2.

Table 2. Agile practices that could be adopted by building construction firms.

Practice	Description of the Practice	Sources
Maintaining backlogs	The features and functions that will be included in the completed project are listed in the backlog. A backlog consists of a sizable collection of scope items that have been explained in terms of what the end users will receive from them. These scope items will be assigned to various team members with matching skills to perform each scope item. Once assigned, scope items are executed during a very short period known as a sprint. At the start of a project, a backlog might not contain detailed scope items. However, when a project progresses, it is the responsibility of the project team to maintain the backlog properly by grooming it appropriately.	[19–41]
Running sprints	As mentioned above, a sprint is a brief micro project that lasts only a few days or weeks. It is anticipated that every scope item from the backlog included in the sprint will be finished within its time frame.	[22–24,26,27,29–49]
Encouraging cross-functional teams	In certain projects, teams tend to work independently within their designated departments and only collaborate with other teams during specific periods. This approach poses a challenge for software developers as they often discover that their work contradicts the thinking of other teams or that some work has been duplicated unnecessarily. To address this issue, creating a cross-functional team can be beneficial as it removes the barriers between departments and eliminates the inefficiencies that arise from having multiple functional experts working in isolation.	[20,26,33,34,36,37,41,49–55]

Table 2. *Cont.*

Practice	Description of the Practice	Sources
Continuous integration	Continuous integration refers to the practice of regularly merging components of a project developed by different groups to prevent any individual component from becoming isolated. In a software development project that practices an agile methodology, developers integrate different pieces of codes on continuous basis to increase efficiency of the delivery process and prevent conflicts in the latter part of the project.	[27–29,31,33,36,42,45,46,53,56–59]
Establish information radiators	Information radiators are visual displays used in agile project management to provide real-time updates on the project's status, progress, and performance metrics to stakeholders. Examples of information radiators include task boards, burndown charts, and team dashboards. These displays are designed to be easily visible and understandable by all stakeholders, including team members, customers, and management. The goal is to keep everyone informed and aligned with project objectives and to facilitate communication and collaboration within the team. In software projects, dashboards, and features in software such as Jira, Asana, Monday.com are used to display key information.	[26,43,48,60–62]
Iterative and incremental development	Iterative and incremental development is a key aspect of agile project management, where development is broken down into small, manageable parts called iterations or sprints. Each iteration involves the delivery of a working piece of software, which is then incrementally improved in subsequent iterations. This approach allows for feedback to be received early and often from stakeholders, leading to more effective and efficient development. The iterative and incremental approach emphasizes collaboration, flexibility, and adaptability, enabling teams to respond quickly to changing requirements and deliver high-quality software products that meet the needs of stakeholders.	[20,22–24,27,29–34,36–38,40,41,48,49,54–58,63–68]
Stand-up meetings	Stand-up meetings, also known as daily scrums, are a key component of agile project management. These short, daily meetings are typically held while attendees are stood up to encourage brevity and focus on progress, goals, and any obstacles that may be hindering progress. During the meeting, each team member answers three questions: What have they accomplished since the last meeting? What are they planning to accomplish by the next meeting? Are there any obstacles or issues that need to be addressed? The goal of the stand-up meeting is to keep the team aligned, informed, and engaged, while also identifying and resolving any issues that may arise. By meeting daily, the team can adjust their plans and quickly adapt to changes, resulting in more effective and efficient development.	[30–34,36–39,41,43,49,51,59,65,67,69]
Timeboxing	Timeboxing is a technique used in agile project management to ensure that work is completed within a fixed time period, known as a timebox or iteration. Timeboxes are typically short, usually lasting between one and four weeks, and are used to set a clear deadline for completing a specific set of tasks. During the timebox, the team focuses on completing the highest-priority work items, and at the end of the timebox, they deliver a working product increment.	[23,36,46,58,70,71]

Table 2. *Cont.*

Practice	Description of the Practice	Sources
Development of use cases and user stories	Use cases and user stories are two techniques used in agile project management to capture and describe requirements from the perspective of end users. Use cases are a more formal and structured technique used to define the interactions between users and the software system. They typically include a detailed description of the user's goals and objectives, the steps involved in achieving those goals, and the expected outcomes. User stories, on the other hand, are a more lightweight and informal technique that focuses on describing the user's needs and priorities in a simple and concise way.	[23–30,36,38–41,43,44,59,72]
Retrospectives	Retrospectives are a key practice in agile project management that involves regular reflection and continuous improvement. Retrospectives are typically held at the end of each iteration or timebox and provide an opportunity for the team to reflect on their work, processes, and collaboration, and identify opportunities for improvement. During the retrospective, the team reflects on what went well, what could be improved, and what actions they will take to address any issues. The goal is to create a culture of continuous improvement, where the team is always looking for ways to work better, faster, and more efficiently. By holding regular retrospectives, the team can identify, and address issues early, and continuously improve their processes and collaboration, resulting in high-quality software products that meet the needs of stakeholders.	[23–25,27,29–31,33,34,36,38–41,43,48,49,66,68,73,74]

Apart from the 10 major agile practices, the authors came across some additional practices (such refactoring, pair-programming, and coding standards), which were not included in Table 2 because they are unique to software development projects and are not applicable for contexts outside of software development. Once the practices are extracted through the systematic literature review, the authors proceeded to the execution stage of the project.

3. Methodology

This section discusses the procedure that the research team adopted to identify appropriate agile practices that need to be used in the design stage of a building construction project. During this study, the researchers came across an architectural consultancy company that has adopted agile methodologies in several successfully completed projects. The organization is a privately held organization that is owned by a chartered architect with more than 30 years of experience. The firm is in the Colombo district of Sri Lanka, and it has 33 employees.

The researchers contacted the owner of the architectural consultancy firm to find out if this person was willing to attend a formal interview on how his company adopts agile project management practices for certain design projects. Once the researchers received approval from the owner, they arranged a total of three two-hour-long meetings. During the first meeting, the researchers verified that the firm facilitates continuous design, flexible scope, living with uncertainty, and constant customer interaction when using agile project management, since those are the four main characteristics that are unique to projects when agile project management is practiced [7,8]. The main objective of the three discussions was to present to the owner the characteristics that building construction entities could practice if they are to adopt agile project management methodologies (as listed in Table 2) and solicit the owner's opinion on each characteristic.

In the first meeting, the researchers explained the agile manifesto and verified that the owner was aware of the basic features of agile project management. Then, the researchers

explained the process wished to carry out during the interviews. As per the process explained by the researchers, the researchers first mentioned a practice and provided a description of the practice. Second, they asked the owner to comment on whether his firm had adopted the practice when performing certain design projects. Third, the researchers asked the owner to elaborate more on the practices the firm adopted. During the first meeting, the researchers asked about maintaining backlogs, running sprints, and encouraging cross-functional teams. During the second meeting, the researchers asked about continuous integration, establishing information radiators, and iterative and incremental development. During the final meeting, the researchers asked about stand-up meetings, timeboxing, development of use cases/user stories, and retrospectives.

For the ease of understanding, the methodology adopted for this study is shown in Figure 2 below.
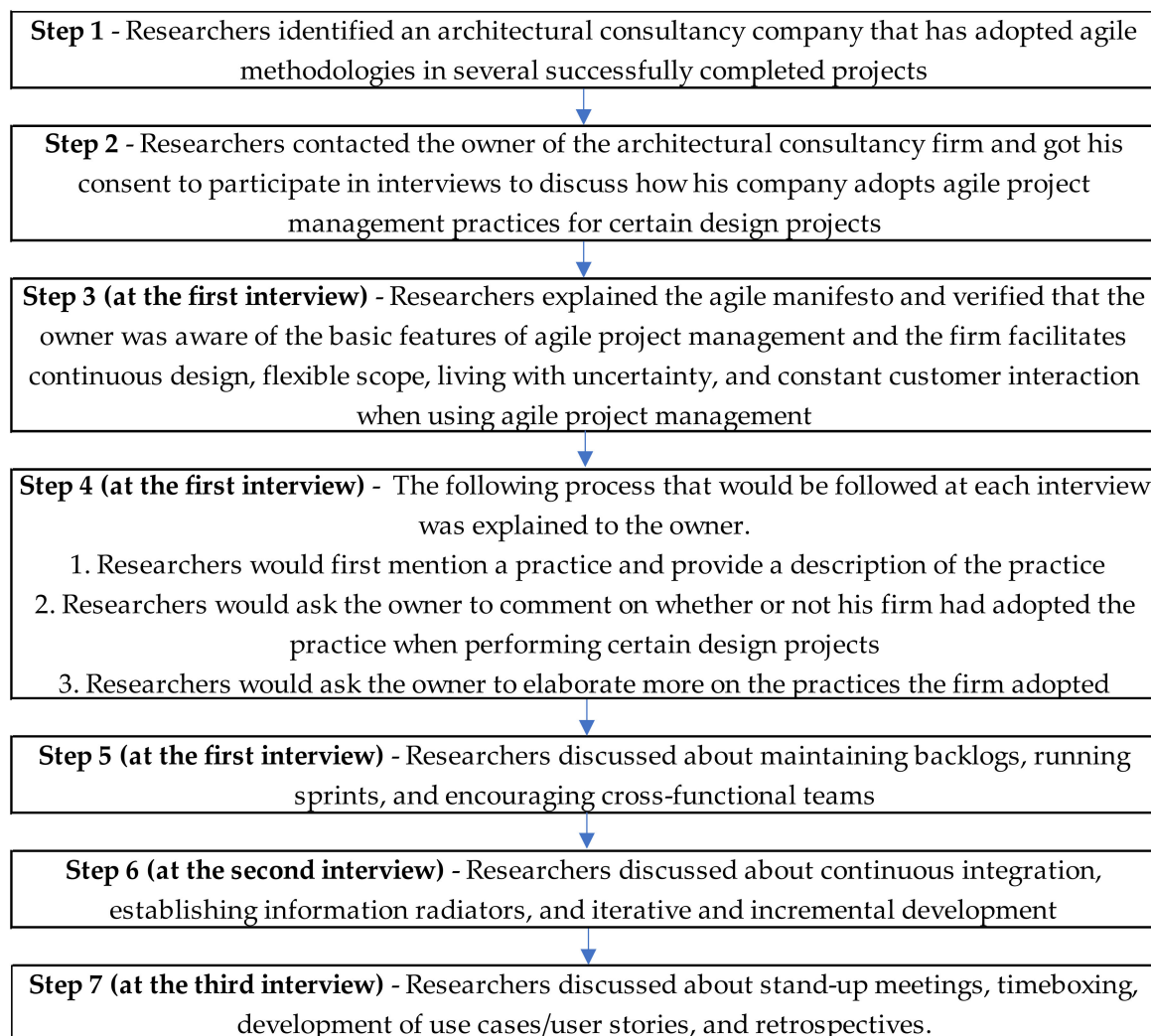
Step 1 - Researchers identified an architectural consultancy company that has adopted agile methodologies in several successfully completed projects
Step 2 - Researchers contacted the owner of the architectural consultancy firm and got his consent to participate in interviews to discuss how his company adopts agile project management practices for certain design projects
Step 3 (at the first interview) - Researchers explained the agile manifesto and verified that the owner was aware of the basic features of agile project management and the firm facilitates continuous design, flexible scope, living with uncertainty, and constant customer interaction when using agile project management
Step 4 (at the first interview) - The following process that would be followed at each interview was explained to the owner. 1. Researchers would first mention a practice and provide a description of the practice 2. Researchers would ask the owner to comment on whether or not his firm had adopted the practice when performing certain design projects 3. Researchers would ask the owner to elaborate more on the practices the firm adopted
Step 5 (at the first interview) - Researchers discussed about maintaining backlogs, running sprints, and encouraging cross-functional teams
Step 6 (at the second interview) - Researchers discussed about continuous integration, establishing information radiators, and iterative and incremental development
Step 7 (at the third interview) - Researchers discussed about stand-up meetings, timeboxing, development of use cases/user stories, and retrospectives.

Figure 2. The methodology adopted for this study.

Findings extracted from those discussions are given below in the Section 4 of the paper.

4. Practices That Drive Adoption of Agile Methodologies with the Assistance of BIMs

According to the owner of the architectural consultancy company, maintaining a backlog, running sprints, engagement of a cross-functional team, continuous integration, and iterative and incremental development of the design are practices that his firm adopted during their transformation to the use of agile project management methodologies. According to him, the transformation was not easy. Thus, full-fledged adoption of all ten

practices mentioned in Table 2 was not initially possible. However, since five practices during transformation can facilitate four principles of the agile manifesto, the owner claims that by adopting these five practices, any design organization can make a smooth transition from traditional project management methodologies to agile project management methodologies.

In addition, the owner highlighted another critical aspect, which is proper training in project management. As soon as he had the idea of implementing agile practices, he attended a course that trains professionals to receive the Project Management Professional (PMP) qualification offered by the Project Management Institute (PMI) in the USA. During that course, the owner received sixty hours of training. After that training, he completed multiple online training courses on agile project management methodologies offered by Udemy and Coursera. Once he was confident that he was ready to initiate the transition, he discussed with the stakeholders of one of the firm's projects regarding the possibility of implementing agile methodologies in the project, highlighting the benefits that the agile methodologies could offer. Once all the parties had agreed to the implementation, he conducted several one-hour online training programs to introduce all stakeholders of the project to agile project management methodologies. Furthermore, when it comes to projects that have adopted agile project management methodologies, unlike in projects that use traditional project management methodologies, the owner has to be involved with the project management process throughout the project from start to end.

Based on the initial background information provided by the owner, the owner was asked to provide additional information on the justification for each of the five practices he used in the transition to agile project management. The subsections below present the opinion of the owner on each practice, the benefits that each practice has offered his organization, and the various ways that the organization used BIM software and project management information systems during the transition.

4.1. Maintaining a Backlog

A backlog is a list of activities or tasks related to features of a product that a team may deliver to achieve a specific outcome [40,41,75]. Since the design of a building is an outcome that can be defined by a set of features, the consultancy firm adopted this practice. In software projects, project managers carry out a practice called backlog grooming, where the product manager and the project team keep adding new features as a project progresses, since some features that are not clear during the early stages of the project will become more clear in the later stages [76]. According to the owner of the consultancy firm, if BIM software is used, backlog grooming can easily be performed during the design stage. That is because, such as a software development project, the project team will work in a virtual environment when designing with BIM software, so that any change or an addition to the existing design can be accomplished easily and without much hassle.

Apart from defining tasks, the owner highlighted some other aspects related to the maintenance of a backlog in cases where the design of a building is accomplished with the use of BIM software. First, the backlog can be used to prioritize the design tasks based on their importance and urgency, which can help to ensure that the most critical design tasks are completed first. Second, the backlog can be used as a collaboration tool to facilitate communication and collaboration among multiple stakeholders, which can aid in keeping everyone on the same page and working toward the same goals. Third, it can help to reduce the risk of errors and omissions in the design, which can help to save time and money over the lifetime of the project.

When asked whether the firm used any project management information system to maintain backlogs, the owner responded that the firm uses Trello software, as the free version of Trello offers more features than other software packages do. Since the owner did not wish to invest in a project management information system until agile project management practices had been adopted, he chose to use Trello during the initial stage of transformation.

4.2. Running Sprints

A sprint, which is a brief microproject that lasts only a few days or weeks, consists of a selected set of activities from the backlog that is expected to be finished within this time frame [75]. At the end of a sprint, a demonstrable outcome is typically produced. According to the comments of the owner, the strength of a sprint is the demonstrable outcome. When BIM software is used in the design process, it is quite easy to produce demonstrable outcomes from time to time. For example, in one sprint, a project team could develop the plumbing and piping plan of a design; in another sprint, they could produce the electric wiring plan of the design. More importantly, apart from the demonstratable outcome produced in each sprint, the design would progress.

Furthermore, running sprints could be used to break the design process down into smaller, more manageable tasks that can be completed within a set period. This strategy can encourage better collaboration between team members, as everyone is working towards a common goal and can communicate more effectively. According to the owner, the practice of running sprints played a decisive role in training stakeholders to work towards a common goal in a virtual platform (i.e., BIM software).

As sprints involve regular check-ins and status updates, they can increase transparency and accountability. This can help to ensure that everyone on the team is aware of what is being worked on, what has been completed, and what still needs to be achieved. The owner indicated that this is also possible in the design stage of a building construction project when BIM software such as Autodesk Construction Cloud is used.

Finally, as per the owner, sprints can help teams be more adaptable to changes that may arise during the design process. By breaking the project down into smaller tasks, teams can more easily adjust their approach and pivot as needed to meet changing project requirements or stakeholders' needs.

Based on the above-mentioned justifications, the owner adopted the practice of running sprints in all the projects that used agile project management. Trello has made the adoption of the practice easier since the free version of Trello supports sprints.

4.3. Engagement of Cross-Functional Teams

In the design process, several parties contribute to the design of a building. According to the consultancy company, three main parties—an architect, a builder, and a project owner—are involved. The builder is typically represented by several individuals, such as an electrical engineer, a civil engineer, a mechanical engineer, a landscape architect, and others. All three main parties have finance and legal professionals. The standard practice in the building construction industry is to have a kick-off meeting, divide the responsibilities among the parties, and then work in silos to fulfill the respective responsibilities. The consultancy company has changed this tradition by promoting a cross-functional team environment in which daily online meetings are introduced within each sprint. For example, even though the preparation of an electrical wiring plan is the responsibility of the electrical engineer and their team, when a cross-functional team is formed from the start of the design process, others could comment on the wiring plan and request changes to the plan if the plan will negatively impact another component of the design.

According to the owner of the consulting firm, the practices of maintaining a backlog and running sprints make it easier for a cross-functional team to work together (even on a remote basis), since everyone can see what exactly is happening and can notice the progress. On the other hand, the formation of a cross functional team would benefit backlog grooming, running a sprint productively, and other activities. Thus, forming a cross-functional team could complement the practices of maintaining a backlog and running sprints.

Another important aspect regarding cross-functional teams that was highlighted by the owner of the consulting firm is that when a diverse team of professionals is involved in the design stage, there is a greater likelihood of catching errors and identifying potential issues early on. This can lead to improved quality and reduced costs in the long run.

Moreover, when BIM software is used, it becomes easier to form a cross-functional team. That is because BIM software allows multiple parties that are based in different geographic locations to work together on a design. For example, during the COVID-19 pandemic, the design firm used Autodesk Construction Cloud, a powerful software tool to guide construction management. According to the owner of the consulting firm, this software tool enabled the cross-functional teams to work together remotely on their design projects, which enabled all stakeholders in a project to continue their work remotely as well.

4.4. Facilitating Continuous Integration

As mentioned above, in a typical construction project, after the kick-off meeting, parties begin working in silos. Then, after a certain period, they integrate components they design. If a rework is required, the parties go back to their respective silos, and the cycle continues until the desired result is achieved. The consultancy company prevented this from happening by introducing a concept called *continuous integration*. BIM software facilitates continuous integration. For example, when using BIM solutions, the electrical engineer and their team can build the electric wiring plan on top of the building design completed by the architect. The mechanical engineer and their team can then build the plumbing design on top of the building design and the electric wiring plan. According to the consultancy company, when a properly functioning cross-functional team is formed, it is easy to pull together different components of the project designed by different groups on an ongoing basis. This practice can greatly reduce the time and effort required for design changes by detecting errors early and providing rapid feedback, which can help to ensure that the design is completed on time and within budget. At the same time, it can also increase customer satisfaction, as customers are able to view the working outcomes regularly during the demonstrations presented at the end of each sprint.

4.5. Iterative and Incremental Design Development

Iterative and incremental design development has allowed the owner to break down the design of a construction project into small, manageable pieces or increments. Each increment is then designed, reviewed, and tested before being integrated into the larger project. The owner of the consulting firm mentioned that this practice promotes flexibility, rapid iterations, and continuous improvement.

The iterative nature of the design phase allows the design to be adaptive, where the project team can develop the early stages incrementally and can refine the design over and over in later iterations (i.e., sprints). According to the owner of the consulting firm, this is possible by adopting the practice of iterative design development, in which the team can continue to produce iterations on the design, conduct regular design reviews, and incorporate feedback from the stakeholders. This process should continue until the design meets all requirements and constraints and is ready to be implemented in the construction phase.

In reality, the final design of a building is something that cannot be foreseen at the start of the design project. However, as BIM software facilitates iterative and incremental design development, the project team could easily tailor a design incrementally by performing several sprints. Another main advantage in adopting the practice (i.e., iterative and incremental design development) is that it is complemented by other practices mentioned above (i.e., grooming backlog, sprints, and continuous integration).

4.6. Adoption of Other Practices

According to the owner of the consulting firm, the adoption process is incremental; thus, it is also time-consuming. Before the adoption of the five main practices, a culture that welcomes agile practice must first be developed by implementing the practices that are easiest ones to adopt. For example, setting up information radiators is a practice that can be adopted once a culture that embraces agile methodologies has been created. In the context of the consultancy company, if they are to establish information radiators, they

must do it using Trello. The professionals in the construction industry are not generally considered to be savvy with the use of information technology [77]. Thus, the introduction of information radiators at the start of the transformation process could slow down the transformation effort or can cause it to fail.

In terms of daily stand-up meetings, the owner of the consulting firm said that he did not introduce this concept as a practice, since he did not want to introduce novel practices or too much jargon at the start of the transformation. However, he did make sure that the team met daily to discuss their progress and bring up any issues they faced. During those meetings, ongoing sprints were used as a guide. The owner made sure that the team members only discussed matters that were related to the tasks in the sprint.

The owner of the consulting firm indicated that timeboxing was not used, as it would have added extra pressure on the project team members. However, the owner believed that timeboxing was the next best practice to adopt, once the team had become accustomed to using agile project management methodologies, since timeboxing adds certainty to the project by providing the opportunity to define the duration of each task.

The owner of the consulting firm also mentioned that use cases and user stories were not used, since both the project team members and the customers were not aware of these concepts. As both parties are familiar with traditional project management methodologies, they are more comfortable in drawing up a task list than they are developing use cases and user stories. According to the owner, the development of use cases and user stories should be introduced as a practice after all parties have obtained proper training in agile project management methodologies. The owner has attempted to explain the purpose and the process for developing use cases and user stories to two of his high-performing employees. However, both employees found the concept difficult to understand, and they were not comfortable with the concept.

The owner of the consulting firm felt that conducting retrospective meetings was not a required practice at the initial stage of the transformation. He perceived these meetings as being burdensome to the project team, since professionals in the building construction industry are not accustomed to the large number of meetings that agile methodologies demand. However, his team members, suppliers, and customers who agreed to adopt agile project management methodologies in certain projects conduct a kick-off meeting, daily meetings, sprint planning meetings, demonstrations, and steering committee meetings during the life cycle of a project. The owner believes that daily meetings and sprint planning meetings can be used to fulfill the objectives of a retrospective meeting. This is especially true for sprint planning meetings, where the owner ensured that the project team could spend time discussing what went wrong, what could be improved, and what actions they would take to address any issues that arose in the previous sprint.

5. Discussion

This study was able to achieve its objective by proposing five practices that a firm could implement to successfully adopt agile project management methodologies with the assistance of BIM software during the design stage of a building construction project. With these findings, it is possible to generate several significant implications. In this section, these implications are discussed, along with the limitations of the study and suggestions for future research.

The primary contribution of this study is that it expands the theoretical understanding of the practices that can drive the adoption of agile project management methodologies in the design stage of a building construction project with the assistance of BIM solutions in a developing country context. Another important aspect of the five practices is that they cover the characteristics suggested in the agile manifesto. Although some studies in the literature (e.g., [18,75]) have suggested practices that building construction organizations could adopt to drive the adoption of agile methodologies, a few researchers have attempted to address the topic in the context of the design stage of a building construction project in which BIM software is used.

The remaining implications are practical implications that building construction firms or architectural consultancy firms could consider when they are trying to adopt agile project management methodologies in the design stage of building construction projects. Fitzgerald et al. [42] (p. 200) argue that "an *a la carte* selection and tailoring of practices can work very well," as opposed to trying to adopt all the agile practices at once when customizing agile methods for adoption. The findings of this study agree with this approach, since the owner of the architectural consultancy firm suggested that it is not necessary to adopt every agile practice mentioned in literature when a design firm in the building construction industry transitions from traditional project management methodologies to those of agile project management. According to the owner, a change champion that takes the initiative to transform a firm from using traditional methods to agile methods is trying to implement a change in culture. In an industry such as the construction industry, cultural change is not easy to make; except for a few global companies, all other construction firms across the planet are accustomed to following a traditional routine. Thus, any changes must be incremental, rather than sudden or drastic. When one is making incremental changes, the agile practices that are the easiest to adopt must be introduced first. Once those practices are adopted, the remaining practices can be introduced as needed.

When going through the findings of the literature search, another key aspect that was noted is the importance of the role of the owner during the transition. Since the owner of the consulting business was enthusiastic about implementing agile project management methodologies in the projects his firm carried out, he was able to provide leadership, acting as the agent of change who successfully convinced his employees, suppliers, and customers to adopt agile project management methodologies. During the discussion, he pointed out the importance of top management support and a change agent when selecting and adopting the five practices. In his words, he indicated that "it is pretty important to have one or more people from the top management team that would consider this project their pet project and passionately drive it. Otherwise, forget the project and stick to traditional methodologies and save time, energy, and money." Past studies (e.g., [39,78]) have highlighted the same aspect, indicating that firms trying to adopt these practices must possess individuals with an understanding of what it means to be successful. Furthermore, Tam et al. [68] suggest that a lack of management support and involvement could be a factor that might prevent transition efforts from being successful. Even though the consultancy company has successfully completed six projects using agile project management methodologies, the owner will continue to be fully engaged with all future agile projects until he feels confident that his team will be able to handle agile projects without his oversight.

The next important implication is related to the role that BIM software plays in the adoption effort. According to Jethva and Skibniewski [1], full agility is possible only during the design stage of a construction project. However, they suggest that the adoption of agile project management methodologies is possible only if project teams are willing to use BIM software to design buildings. The findings of this study concur with the findings of [1] as when the owner of the consulting firm discussed his reasons for adopting each practice, he highlighted how BIM software complemented the effort. In fact, the owner is convinced that even if one person in the project is not capable of using BIM software, it will not be possible to adopt agile project management methodologies.

The final practical implication from this study highlights the importance of training and development of employees, suppliers, and customers regarding the importance and characteristics of agile project management methodologies. The owner of the consulting firm believes that it is important to continuously develop team competency through on-the-job training and formal training programs on agile project management methodologies. Moreover, he highlights the importance of having project team members enroll in professional training programs in general project management and agile project management that are offered by reputable organizations such as the Project Management Institute in the USA. In the case of the architectural consultancy company, the owner received formal

training in general project management and agile project management and has taken the responsibility of transferring the knowledge he obtained to his employees, suppliers, and customers. This aspect is highlighted by Abrar et al. [79], who argue that any project team that is making a transition from using traditional project management methodologies to agile project management methodologies must provide ample training and development opportunities that would facilitate the development of continuous competency.

Despite the theoretical and practical implications discussed above, this study has several limitations. First, the findings of this study are derived from studying only a single architectural consultancy firm that uses agile project management methodologies. This is a major limitation of the study. As a result of this limitation, it is not possible to generalize the findings of the study. The main reason for this limitation is the fact that the researchers failed to find any other architectural consultancy firm or building construction firm that uses agile methods during the design stage. Second, this study only focused on practices that have driven the adoption of agile methodologies with the assistance of BIM solutions. However, according to studies such as that by Abrar et al. [79], several other organizational aspects such as absorptive capacity and organizational culture will have an impact on the successful adoption of agile methodologies. This study did not focus on those factors, since they were not within the scope of the study. Third, when the researchers were conducting the systematic literature review, this study used only the Scopus database, based on the recommendation of other researchers [16]. However, in other studies such as [14,15], it was recommended to use other popular databases such as Google Scholar, Web of Science, and PsycINFO. If the other databases were used, the researchers could have extracted additional papers for systematic review. Fourth, the researchers did not receive permission to speak with any of the employees, suppliers, or customers of the architectural consultancy company. Thus, the findings of this research are fully formulated from the perspective of the owner of the firm. Fifth, since the architectural consultancy company was using Autodesk Construction Cloud's BIM module, there is a chance that the results could change in an instance if another BIM software is used. Finally, this paper adopted a qualitative research method to carry out the research. This is another major limitation of the study. The rationale for adopting a qualitative approach is because the researchers were able to find only a single company for data collection. However, the adoption of quantitative methods would have generated more significant insights regarding the adoption of agile methods by the building construction industry.

Future researchers can address the limitations mentioned above. At the same time, this research implicitly paved way for a new research direction in the domain of agile project management in the construction industry. By using the list of practices mentioned in Table 2, future researchers could uncover practices that are applicable in other contexts. It would be of great value if future researchers could investigate factors that drive the adoption of agile project management methodologies with the assistance of BIM solutions by firms during the design stage of a building construction project. These studies would increase the awareness of organizational traits that must be improved. Finally, future researchers could conduct projects related to agile project management to empirically test the various aspects of the adoption of technology by employees, suppliers, and/or customers in the construction industry, since technology plays a crucial role in the widespread adoption of agile methodologies in non-IT industries such as the building construction industry and road construction industry. As highlighted in this study, BIM software is one IT tool that could revolutionize the industry. As cited by Jethva et al. [1], in the US, the use of traditional project management methodologies are common. If technology adoption could be accelerated, the transition to agile methodologies could also be accelerated. Another practice that must be promoted in the construction industry is the use of project management information systems (PMISs). This study highlighted the importance of a PMIS such as Trello to establish proper coordination among various parties.

6. Conclusions

According to the knowledge of the researchers, this is the first study that has investigated the practices that would enable building construction companies to adopt agile project management methodologies in the design stage of a project that uses BIM solutions. Thus, this study has the potential to initiate new debates in the domain of construction project management. Especially, this study informs the ability of adopting agile methods during the design stage of a building construction project. This could encourage future researchers that carry out research related to the adoption of agile methods in the building construction industry with special emphasis on the design stage of construction projects. Moreover, this study informs the importance of investigating more about the business aspect of BIM solutions. As per the discussion in Section 4, it is quite clear that without the BIM solution, the consultancy company would have never been successful in adopting agile methods. Hence, this study demonstrated the importance of BIM solutions in the domain of construction project management.

This study further informs the importance of tailoring and selecting practices that would drive the adoption of agile project management methodologies by building construction companies. The architectural consultancy firm proposed five practices that brought success to them in adopting agile practices. However, there is no guarantee that another building construction company would be successful in adopting agile project management methodologies by selecting the same five practices proposed by the architectural consultancy company. Finally, this study highlighted the importance of formally and informally learning about agile project management methodologies and technologies such as BIM. Thus, any building construction company that is longing to adopt agile project management methodologies must acquire knowledge regarding the above-mentioned aspects through formal and informal training.

As a final remark, this study would like to highlight the fact that the technological developments that have happened in the recent past, such as the advent of BIM solutions and PMISs could be used to drive the adoption of agile project management methodologies in the design stage of building construction project. That would provide more financial and non-financial benefits to building construction companies.

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