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SCRUM IN CONSTRUCTION INDUSTRY TO IMPROVE PROJECT PERFORMANCE IN DESIGN PHASE

YINGCHEN LIU
Harrisburg University of Science and Technology

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YINGCHEN LIU

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Abstract

As building technologies dramatically developed over the past several decades, construction project delivery methods evolved tremendously. Since the Renaissance, the fields of architecture and construction have been regarded as complex art forms. Today, both disciplines are regarded more as technical fields meant to improve human functional, technological, and practical needs. Therefore, the management of a project plays a more critical role in contemporary construction projects.

Over the several decades, there has been no significant change in the way of construction projects managements changes. However, client requirements and expectations are constantly evolving. Because of this disconnect, traditional construction management practices cannot meet the needs of the current market. The potential project risks are increased by the gap between how the projects are conducted and how the projects should be managed. This negatively impacts the overall performance of the project as well as the quality of delivery.

Recently, more and more construction projects have begun improving project performance by utilizing new management frameworks. Most notably, “Agile” construction has gradually garnered attention throughout the industry because of its outstanding ability in managing risks and changes.

This thesis researches the implementation of “Scrum” (a framework of Agile project management) from the information technology field into the construction industry by means of literature review. Through precedent analysis, the benefits and shortcomings of Scrum will be revealed. The benefits of Scrum that contribute to overall project performance will be analyzed in detail through the findings made through case studies, personal interviews, and a comprehensive literature review.

The result of the research shows that Scrum provides significant improvements for construction project performance in many ways. By decreasing uncertainty and increasing management of risks, it has obvious potential benefits in the design phase of a construction project.

In sum, this thesis identifies the advantages of the project performance by using of Scrum in the design phase of construction projects. It predicts the future outlook of the possible development for Agile models in the construction industry. The thesis also includes the recommendation section to provide the suggestions for the future researches.

Keywords: construction project, Agile construction, scrum, project performance, design phase, architecture project, project management, non-IT fields

1. INTRODUCTION

Project management plays an extremely integral role in construction projects throughout all phases from design to onsite construction. There are two major reasons for this: the high degree of the project complexity and the magnitude of project uncertainty. Decades ago, architects were rarely involved in construction process and phases besides the design phases. However, as the industry developed, so have the roles of architects. According to Gandhi (2014), architects are expected to be equipped with a comprehensive set of skills, including having a strong understanding of the real-estate market, post-construction demands planning, and co-ordination and control of diverse stakeholders and new construction technologies. Therefore, project management skills are highly needed by contemporary architectural and construction firms.

Since the 1960s, as building construction became more complex, experimental and innovative, the term ‘architectural management’ appeared for the first time. From then on, “waterfall” project management, also known as traditional project management, became the most common management method and technique in the industry. As Burger (2016) indicated, the process of the workflow is to move downhill towards completion, similar to an actual waterfall. This approach creates clear milestones between each task. At the same time, this methodology provides a systematic approach for architects to manage projects in a chronological sequence. Another obvious advantage of the waterfall framework is that it organizes individual team members to focus on specific aspects of the project. However, this work flow can efficiently prevent overlook with small details but fails to control the quality of the deliverables when uncertain changes occur. For example, if any unexpected change orders are inserted into the project, the construction schedule will be delayed. Unfortunately, unforeseen circumstances and

changes cannot be completely avoided since the requirements and demands from stakeholders and user groups are continuously changing, especially for larger-scale, highly-complicated construction projects. In addition, the traditional project management technique has severe limitations on the clients' feedback and input involvement. This creates a gap between the project team and the client, which may harm overall project performance.

As the construction industry evolved, the idea - Agile Construction - has been adapted to overall construction project delivery. According to Daneshgari (2010), this revolutionary application of a new system improves the contractor's ability to rapidly adapt to job site changes, minimizing the time between when a risk is detected and when it is corrected. Additionally, the implementation of Agile construction management brings a more highly motivated and trained work methodology during design phases by creating greater consumer value. In 1993, the term "Lean Construction" first appeared in the general lexicon (Gleeson & Townend, 2007). Additionally, according to Abdelhamid, El-Gafy, & Salem, (2008), Lean Construction focuses on the holistic pursuit of concurrent and continuous improvements in all dimensions of the built environment through the beginning to end of the design and construction process. When considering client needs, this approach creates improvements in construction processes with lower cost and higher value (Koskela, Howell, Ballard, & Tommelein, 2002). Because of this, Lean construction has propelled construction project management into a new era. This new paradigm then gave rise to many early contractor involvement (ECI) project management approaches, like Integrated Project Delivery (IPD), and Integrated Lean Project Delivery (ILPD). Its outstanding successes has contributed to tremendous profits throughout the entire industry, which also encourages architects to further explore utilizing Agile management framework in their own field.

As a major industry disrupter, Agile Scrum gradually improved the software development field. As an incremental and iterative Agile framework, Scrum is defined as “a flexible, holistic product development strategy where a development team works as a unit to reach a common goal” (Takeuchi & Nonaka, 1998). Unlike the traditional waterfall project approach, Scrum is a feedback-driven empirical methodology. Transparency, inspection, and adaptation are its three pillars. These three pillars enable the five values of Scrum: Commitment, Courage, Focus, Openness and Respect. It encourages all team members to keep close communication and physical co-location: an ideology that is largely absent in other traditional project delivery methods. All these aspects demonstrate that Scrum is an ideal framework to express Agile project delivery. Recently, more and more people have begun researching the feasibility and benefits that the Scrum framework brings to construction and other non-IT fields.

Therefore, by using the approach of conducting a literature review, survey/questionnaire and individual interview, this thesis will focus on research demonstrating how Agile construction management could improve the performance of construction projects compared against traditional project processes. This thesis as a preliminary research component will provide a primary foundation by reviewing literature such as relative journal articles, books, analyzing practitioner reports and real-world case studies where Scrum is used. With the preliminary research, the author will also continue exploring more detailed empirical research in the thesis. By means of analyzing data from survey and interview the reader can expect a detailed exploration about how this framework will impact the project performance as far as the quality of the project deliverables.

2. PROBLEM STATEMENT AND JUSTIFICATION

"Architecture is 20% design and 80% management" (Gandhi, 2014). The knowledge and techniques of controlling costs, communication, time, integration, risks, which can help improve project performance appear to be particularly important in the construction industry especially during the design phase. This differs greatly from traditional business projects where generic solutions can be copied and re-used. According to Gandhi (2014), "Construction projects are a combination of creation and order." The solutions of construction projects, especially in the design phase, are more innovative, experimental and creative. Many elements cannot be re-used and recycled from project to project. This reality requires that architects accurately plan details and efficiently deal with changes for each project.

However, project performance is way more difficult than it looks. In order to optimize project performance, measuring performance success is key (Pitagorsky, 2013). In the construction industry, especially in design phases, almost every project team is challenged to measure project performance. Typically, it is a very tough task to manage, execute and deliver construction projects having several obstacles and changes within a scheduled time, budget and scope. In the design phase, it is obvious that under the traditional waterfall project framework, project performance is very difficult to be measured and monitored. This becomes one of the main reasons that the quality assurance and quality control (QA/QC) processes are critical to the performance measurement in traditional project management. But in reality, many times even professionals are not aware of the job responsibilities related to QA/QC functions (Usmani, 2012). This issue happens more often in organizations where they do not assign specific specialists to take charge of the processes. If the problem cannot be solved, issues occurring during early design phases may cause more complicated problems in the later phases, such as in

on-site construction phases, maintenance, and operation phases. This can even lead to detrimental errors and overall failure of the whole project.

If the above-mentioned issues cannot be addressed, the whole industry may continue facing the challenges associated with poor project performance. The rapid development and quick change of the construction market may also drive project management in the construction field to experience delays and lag behind current market expectations. Thus, a better framework that can support project team to produce better buildings and improve the project performance is needed.

Agile construction, as a system that relies on input from the work information sources, provides assistance on measuring performance at the initial stage (Daneshgari & Wilson, 2006). It simultaneously requires collaboration of information up-front for project planning as well as throughout the whole processes of a project in order to receive real-time feedback. The real-time input of Agile construction then creates the benefits of achieving real-time performance measurements (Wikimedia Foundation, Inc., 2018). This thesis aims to investigate the application of Agile Scrum in order to strengthen the project performance measurements of construction projects. This incremental and iterative – based management methodology may improve the project performance better by reducing the number of changes needed in a project.

However, instead of focusing on all phases from design to construction, this thesis will only focus on the design phase including Pre-design, Schematic Design, Design Development and Construction Documentation. Additionally, the project performance will be the major focus of the research.

During the preliminary research stage, the literature review will be used as the major approach in developing the proposal. When it comes to the following secondary research, the

contents of the thesis will be more focused on using survey/questionnaire and personal interview to get valid data in consolidating the research.

3. LITERATURE REVIEW

In order to accurately explore the benefits brought by the Scrum framework with project performance, first of all, the author reviewed literature that is most relevant to Agile Scrum applications in the construction industry. Based on the information provided by the reviewed literature, the analysis and consideration about the benefits brought by Scrum with project performance will be further discussed in this section. Additionally, all reviewed research will be compared and contrasted.

Typically, construction projects require comprehensive engagement across multiple disciplines (Wikimedia Foundation, Inc., 2018). Disciplines like the project manager, construction manager, designers, architects, design engineers, construction engineers, general contractors, sub-contractors, specialty consultants and so on are all involved within one construction project. Even though each discipline plays a specialized role along each project process, delivering construction projects, historically, is collaborative, long-term and complex; large-scale construction projects deliver products after years or even decades.

The project timelines have been increased too long with the increasing pace of business competition (Tripp, 2012). Depending on the changes in the circumstances and the progress of time, decision-making could become very complex (Cho, Hong, & Hyun, 2009). Project management pressures are escalated by time increase caused by heightened competition. Therefore, the quicker the project delivers business value, the less risks and pressures will impact the project performance. At the same time, a construction project is in a state of constant change with both planned and unplanned (Daneshgari & Wilson, 2006). In this very fluid work environment, project teams are being asked to adapt to the rapid changes of market, technical

and user requirements (Tripp, 2012). This requires the projects must be managed without negatively affecting team performance.

According to the research by Memon, Roslan and Zainun (2014), most construction projects face the issue of time overrun and it has become a common global phenomenon. As shown from the below Figure 1, the traditional waterfall approach used in construction projects has a linear process structure. This creates a number of limitations between each stage. The flexibility of projects is low, and the delivery of business value is usually achieved at the end of the project (Tripp, 2012).

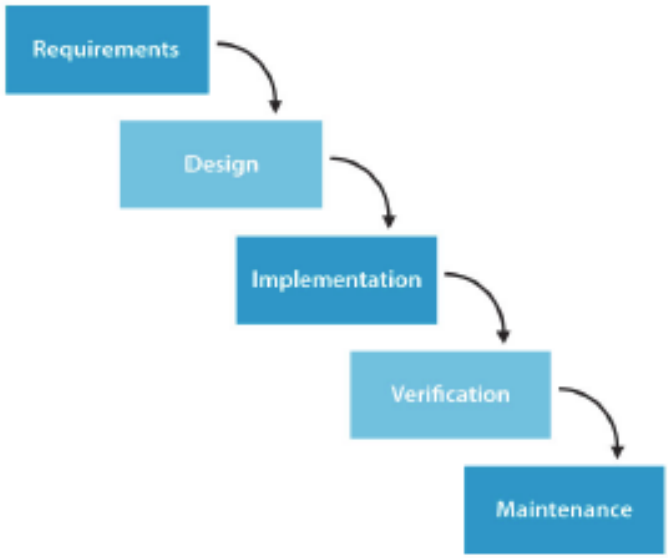


Figure 1 An illustration of an example of the Waterfall management approach. (http://www.waterfall-model.com)

Agile methodology known as the latest generation of development methodology, has developed and emerged over the past two decades (Beck & Andres, 2004). As a type of project planning and schedule management, Agile in construction projects facilitates rapid response to changes in the dynamic nature of the business environment. This promises the deduction of overhead, the increase of project flexibility, more customers' satisfaction and the higher margins (Daneshgari & Wilson, 2006). Compared with the traditional project management

methodologies, Agile methodology could better deal with the construction project management on the jobsite. In a highly dynamic work environment, the strengths of Agile management include the creating and embracing of changes, the continuous and early project deliverables, the delivery of simple solutions and the cultivation of empowered teams (Tripp, 2012).

Scrum is one of the Agile project management frameworks where different processes and techniques can be applied (Streule, Miserini, Bartlomé, Klippel, & de Soto, 2016). As Verheyen (2013) stated, "Scrum replaces a programmed algorithmic approach with a heuristic one". This framework can solve unpredictable and complex changes and problems more efficiently. The literature related to Agile management in the construction industry, especially with a Scrum framework, and focus, will be reviewed. Therefore, through this literature review, a foundation for locating relative resources on the chosen topic will be provided. In addition, findings from the literature review will support the initial exploration and further research of the focused topic.

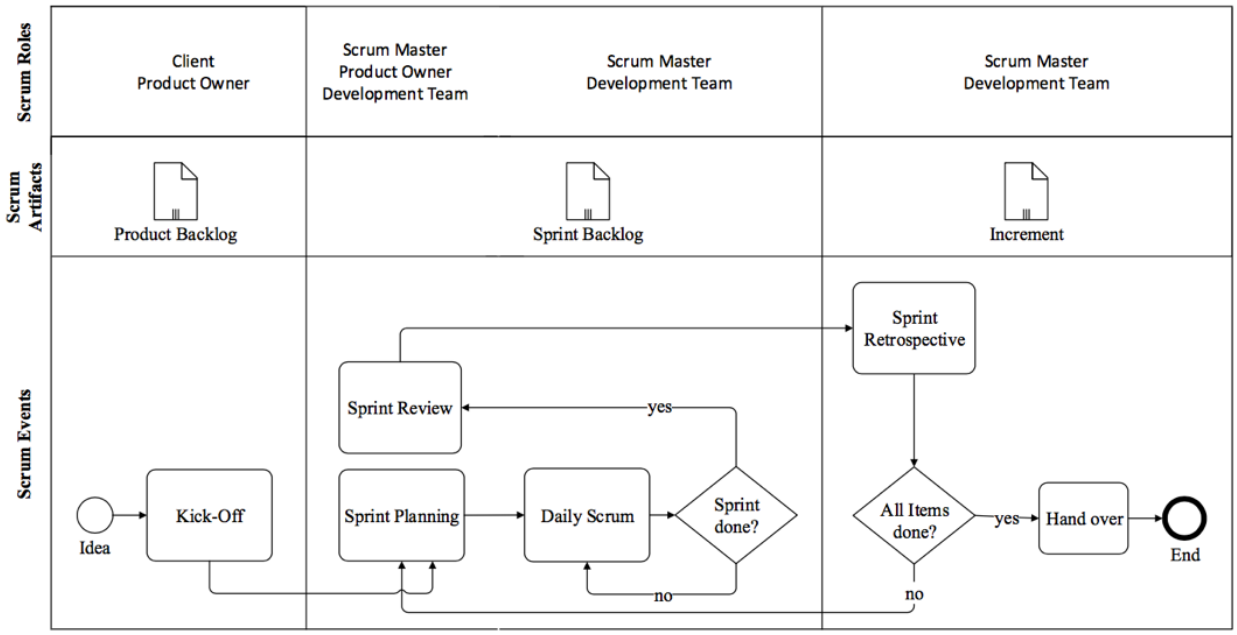


Figure 2 Typical Scrum Framework

As shown in *Figure* 22 (Streule, Miserini, Bartlomé, Klippel, & de Soto, 2016), Scrum Roles, Scrum Artifacts and Scrum Events are three major components of a typical Scrum framework (Schwaber & Sutherland, 2016). In a typical Scrum framework, the Scrum roles consist of Client, Product Owner, Scrum Master and Development Team. All these different roles will engage in different Scrum Artifacts, such as Product Backlog, Sprint Backlog and Increment. Under each Artifact, more detailed Scrum Events happen to ensure the Artifacts can be achieved and accomplished. (Scrum Alliance, 2016)

Other Agile project management frameworks, like Lean Construction, Integrated Project Delivery (IPD), etc. have made significant headway in the construction field. However, Scrum is still sparsely applied in non-IT fields. Therefore, the preliminary research about the feasibility and benefits of Scrum in construction becomes critical before investigating the potential for underlying benefits.

Scrum has been widely used in the information system industry since 1986. The term was first introduced by Hirotaka Takeuchi and Ikujiro Nonaka (Wikimedia Foundation, Inc., 2017). The similarities between Information System Industry and Construction Industry arguably demonstrate that Scrum would provide enhancement for project values and feasibility for process adoption. According to Owen, & Koskela (2006) “Both the information systems and construction industries use essentially a design and product development process, with limited, tailored re-use of designs and components”. There is an obvious parallelism between information system and construction, especially during the design phase.

Beyond the theoretical analysis, in the case study conducted by Streule, Miserini, Bartlome, Klippel, & de Soto (2016), the project team became convinced that compared with traditional project management approaches, Scrum makes project teams more efficient. The

benefits brought by Scrum include higher transparency, better communication and collaboration, better flow of information and faster project development. By applying Scrum, a single project team member was enabled to see the other team member's thoughts, therefore enabling each team member to understand why a certain task was performed in specific way. Additionally, in their research, it indicates that if construction projects have almost all expertise internally with the firm can easily apply with the Scrum framework. Construction projects can also implement with the proper Scrum framework even if some of the project team member are external. In addition, during the construction phase, by means of Scrum, the communication time can be reduced between different firms (Streule, Miserini, Bartlomé, Klippel, & de Soto, 2016).

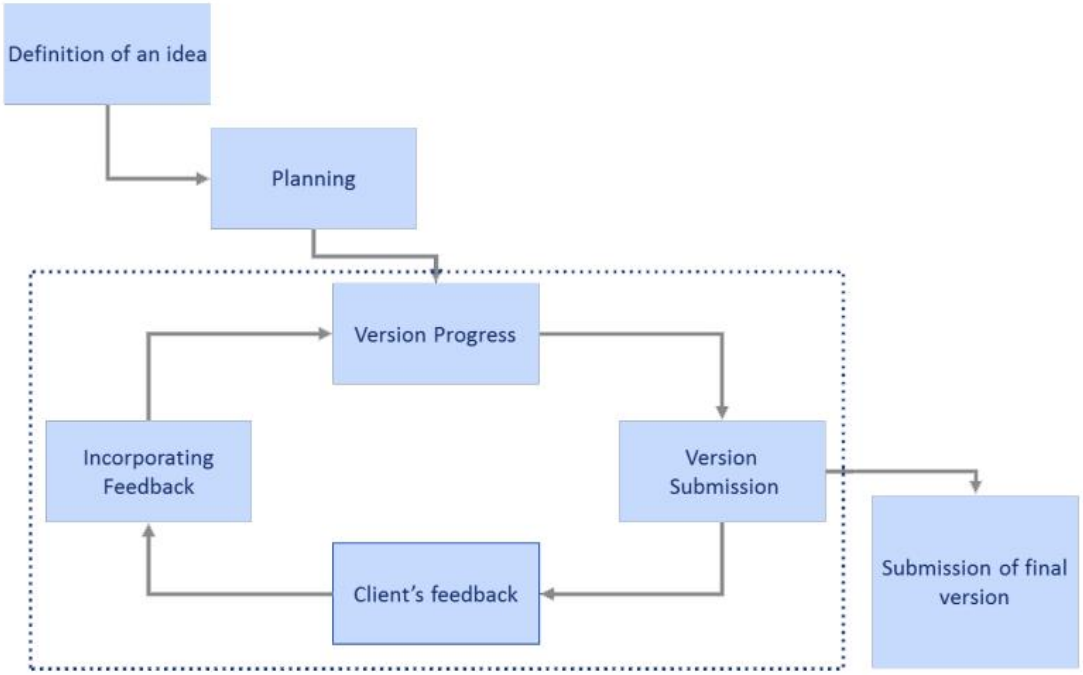


Figure 3 Project life cycle of iterative projects (adapted from Wysocki, 2006)

Above Figure 3 illustrates the iterative processes for software development projects (Wysocki, 2006). As in the design phase of construction projects, ideally, the feedback loop among the iterative life cycle would continuously repeat until the customs are satisfied with the

outcomes. However, under the current conventional waterfall management technique, it is hard to achieve the project success. The major reason is that the traditional method of management improves the coordination but cuts down the variability and then reduces the satisfaction of clients (Demir & Theis, 2016). According to Moe et al. (2010), instead of setting the goal of optimization, the Agile method has formed the project goal with responsiveness and flexibility. This could work better with the "feedback loop" in iterative cycle.

Furthermore, according to the implementation report by Demir, & Theis (2016), the approach, adapting from the Scrum, named Agile Design Management (ADM) has been developed to address the existing issues in the design phase of the construction projects.

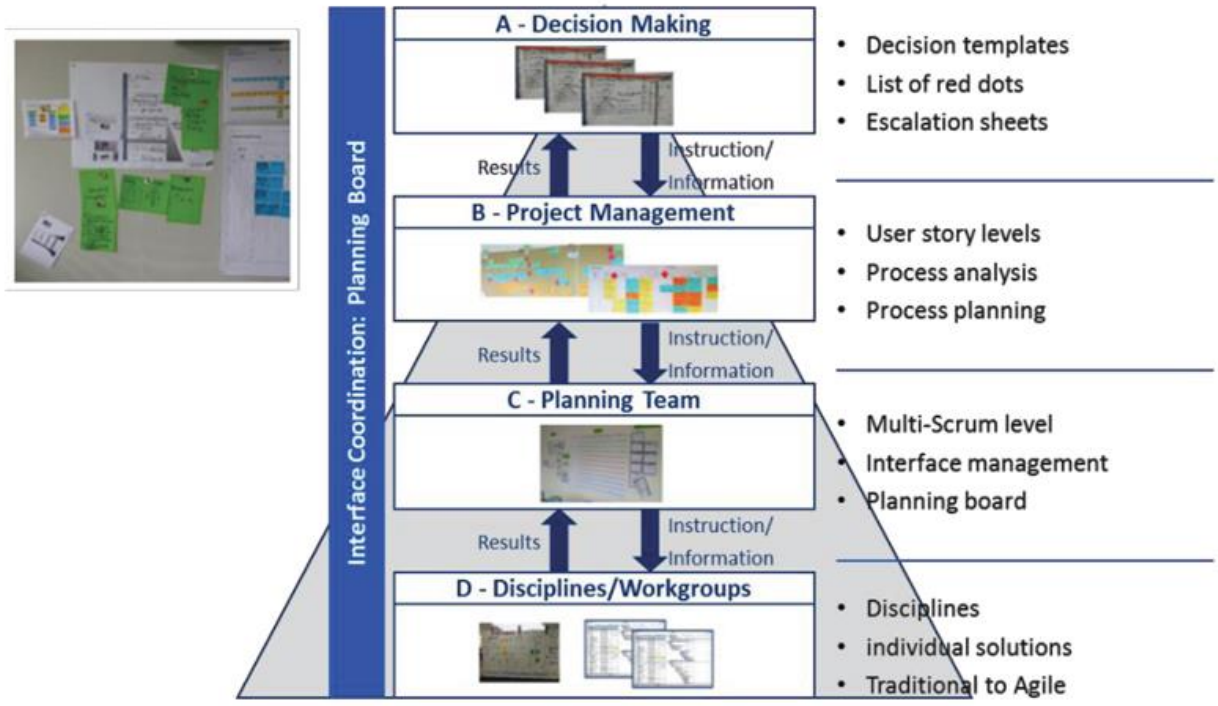


Figure 4 Adaptation of the organizational and operational structure (adapted from Demir & Theis, 2016)

The structure that is illustrated in Figure 4, as derived from Scrum, shows that ADM intends to enhance coordination, interface management, collaboration and transparency

throughout the project processes. Based on Demir, & Theis (2016) stated, when the conventional waterfall model is applied to a construction project, especially in early design phases, in most of the cases the waterfall will turn into a “free fall” model. This is because the dynamic and uncertainty of the environments needs highly intensive integration, collaboration and coordination. Using a traditional waterfall framework becomes very difficult when attempting to manage the dynamic nature of projects and uncertainty in design phases since there is lack of transparency and real-time feedback. Besides analyzing the shortages of the conventional method, the report further indicated the improvements made by applying a detailed project plan with ADM. Based on the data from the case study, the conclusion showed that the transparency throughout the whole processes is improved, the identification and communication of problems and risks are better taken, the integration of information and the coordination between different disciplines become more efficient, the motivation of project team members increased, responsibility of each team member becomes more clear, the workload of individual employees are reduced, project resources become better, and gathered information are implemented more accurately (Demir & Theis, 2016).

According to Yllén Johansson (2012), a similar conclusion has also been drawn. Also, by conducting an interview with project managers and architects engaged in four different projects in different phases, the research also found that client involvement has been efficiently increased by implementing Agile project management in construction project during the design phase (Yllén Johansson, 2012).

Among the above-mentioned research, they all used different approaches, such as generating hypotheses, case studies, surveys, interviews, etc., to get the applicability, feasibility and benefits of Scrum in construction projects validated. However, each research conducted has

its own focus and limitations. For instance, in research by Owen, & Koskela (2006), Agile in construction can only be resolved on a theoretical level; a proven model that can successfully fit in the proposed theories still needs to be developed. Also, the research is focused on the overall Agile management instead of Scrum for this specific framework. In contrast, the case studies conducted by Demir, & Theis (2016) and Streule, Miserini, Bartlomé, Klippel, & de Soto, (2016) are more focused on the Scrum framework. What is more, these two works of literature further showed the benefits by applying Scrum not only on the theoretical level but in practice level as well.

In sum, it is applicable, workable and profitable to implement the Scrum framework into construction projects.

However, understanding applications of Scrum in the construction industry is still in its infancy stages. A deeper exploration and research for advantages by applying Scrum in different types and scales of construction projects is still necessary. At the same time, even though both theories and practices are developed to a certain level in order to convince the performance improvements brought by applying Agile scrum, a proper analysis of scrum that can applied to the whole industry instead of independent projects of the specific building type is still required.

4. METHODOLOGY

Recently, the Agile approach has become an alternative to the traditional waterfall approach both in IT fields and non-IT fields. In the construction industry, this trend is also becoming more and more popular. At the same time, many architectural and construction companies actively produce a number of projects with new Agile frameworks, such as Lean Construction, Integrated Project Delivery (IPD), Pull Planning (Kanban Sim) and so on. The benefits brought by using the new frameworks are obvious. This has inspired the author to conduct a further research about the project performance merits that will be potentially be brought about by applying Agile into construction projects. In order to approach the expected result, the author proposed to synthesize knowledge from various sources by means of different research methodologies. This section indicates the outline of the research methodologies and approaches that were conducted in order to develop the thesis.

Literature Review

Through the literature review approach, articles, papers, journals, and books about the chosen topic are provided. The feasibility of the Agile approach implementation and the processes of applying Agile project management are identified by reviewing the relevant literature and practitioner reports. Furthermore, the literature specific to the use of Scrum in construction help provide the framework with which to improve project performance by using Scrum. This thesis addresses the question about the applicability of the Scrum in the construction industry by means of literature review approach. The literature review not only answers the research question on a theoretical level, but leads the author to understand the chosen topic with additional depth. After the contents of the research literature have been reviewed, the major points are extracted from the body of work and the research question may be answered.

Survey/Questionnaire

A preliminary research study through survey/questionnaire was conducted to review the benefits of construction projects using the Agile approaches and will help to explore how the new Scrum framework could potentially enhance project performance. As the primary major resource, the survey/questionnaire designed for this thesis provided the applicability and representativeness of the proposed question. A total ten questions are asked in the survey. It includes both close-ended questions and open-ended questions, such as single choice, multiple choice, true/false and Q&A. The survey was conducted by using an online survey development cloud-based tool (Survey Monkey), and the survey was sent out to the survey participants via email or public web link.

Being in the construction field for several years, the author had enough contacts to help collect valid data to support the thesis. Professionals who have taken the survey/questionnaire all have experience with different scales and types construction projects. In order to avoid partialities, the author sought more than 20 survey responses. In addition, the people who took the survey were demographically divers to reduce the bias. For example, the survey respondents have played different roles in project team, experienced various type/scale of construction projects, and had sufficient project management engagement.

After identifying the survey questions, the collected data was analyzed in detail. The conducted survey mainly focuses on the construction projects in design phase. Through the data analysis, the improvements provided on project performance are identified throughout various aspects of the project. The data collected by conducting the survey/questionnaire as a valuable empirical evidence aims to support the analysis of initial proposed research.

Small Sample-Sized Individual Interview

Based on the above-mentioned solution approaches, the author continuously focused on the chosen topic with detailed empirical research by conducting interviews with a small number of selected architects who work in a San Francisco – based architectural firm. As a major pioneer in the construction industry, the firm has taken the lead in applying Scrum framework in construction projects during the design phase. Each interview was held semi-formally within a company conference room. The interviews were conducted as a Q&A process one-on-one with the similar questions asked in the survey/questionnaire. All the interviewees are experienced with delivering practical construction projects by using Agile project management methodologies. Compared with the previous traditional approaches and methods, the interviewees explained the advantages that Agile can bring to construction projects to enhance the overall performance.

In sum, since this thesis focuses on the specific Scrum framework in construction projects in design phase, the conducted research analysis is designed to focus on this objective.

5. RESULTS & FINDINGS

As shown in Figure 5 below, the author has sent out a total of 31 survey invitations via email by using Survey Monkey. In addition, the author created a public survey link and posted through LinkedIn to collect the data. After a two-week collection process, the author gathered 24 total responses through email invitation and 1 total response through public survey link.

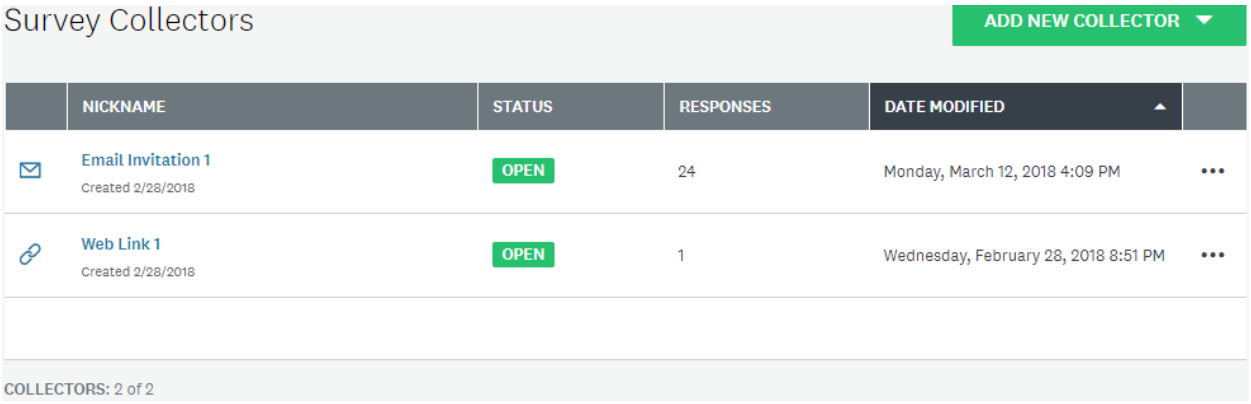


Figure 5 Survey Collectors (adapted from Survey Monkey)

In the following screen snip from the Survey Monkey, there are 18 out of 19 responses completed and valid. Based on the data collected through survey and interview methodologies, this section describes the survey outcomes and indicates the analysis of the data trends.

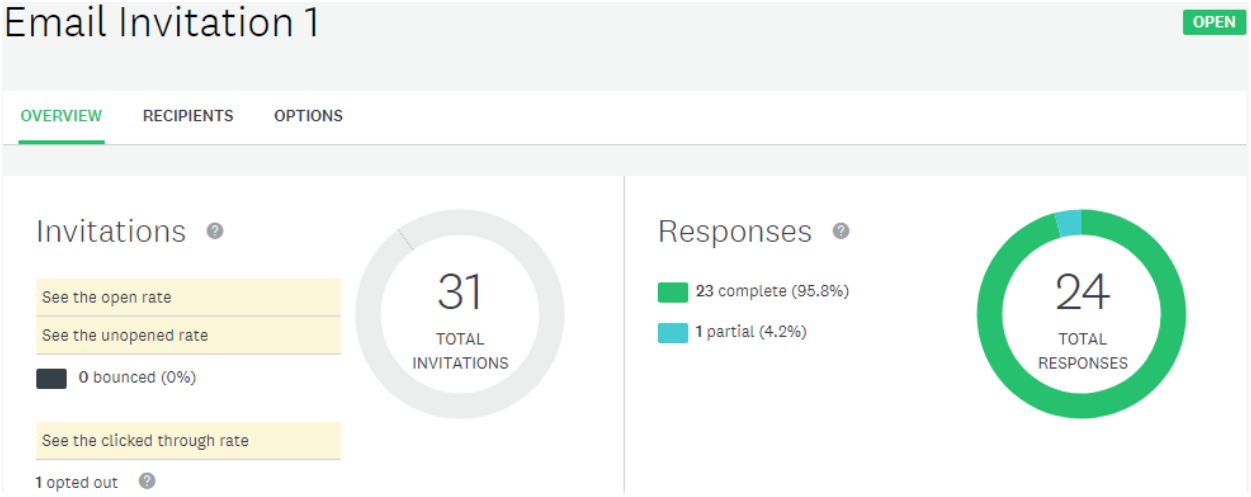


Figure 6 Email Invitation (adapted from Survey Monkey)

The design intention of the first four questions from the survey/questionnaire is to gather the professional background from each survey participants. Below are the four questions that were conducted to help identify the objects' basic information.

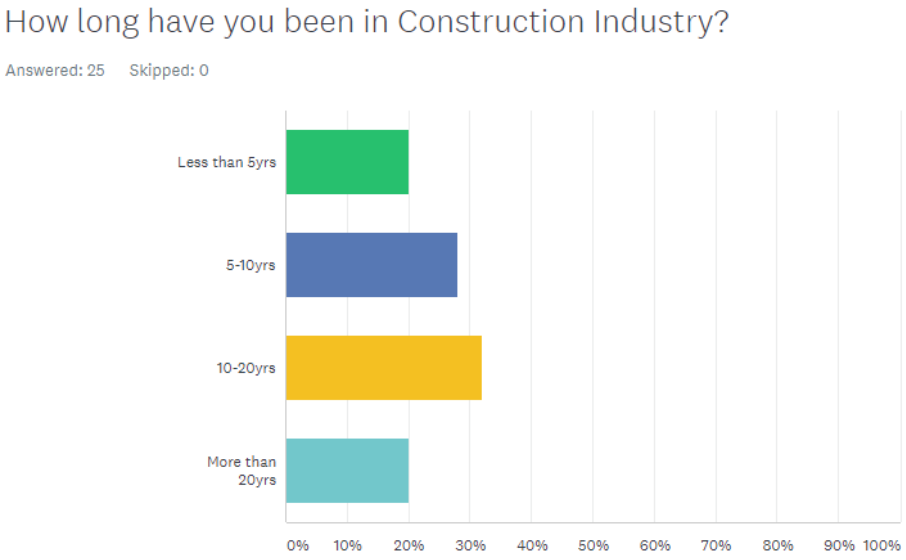
How long have you been in the Construction Industry?

What is your major role in the project team?

What type of construction projects are you doing most frequently?

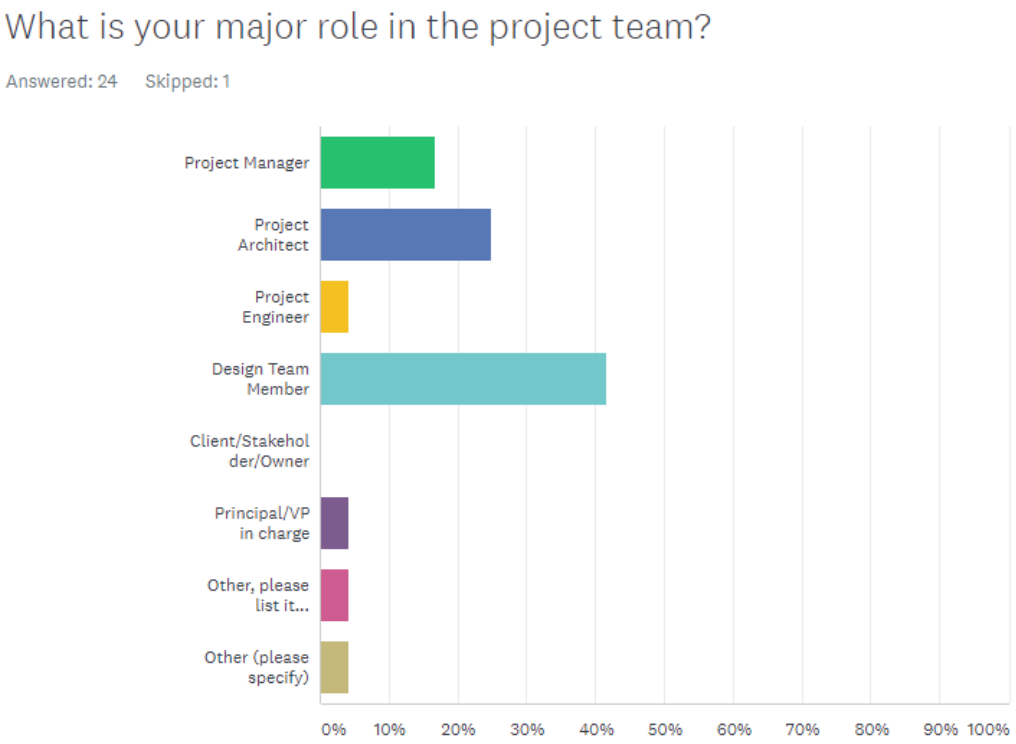
What scale of construction projects are you doing most frequently?

As a part of the conducted survey, above-mentioned questions were supposed to collect the data that could identify the participants' identities. In addition, the answers of these questions help the author control the variety of the experience of the survey objects. Therefore, the data trends are able to reduce the deviations and avoid bias.



ANSWER CHOICES	RESPONSES	
Less than 5yrs	20.00%	5
5-10yrs	28.00%	7
10-20yrs	32.00%	8
More than 20yrs	20.00%	5
TOTAL		25

Figure 7 Q1 Summary (adapted from Survey Monkey)



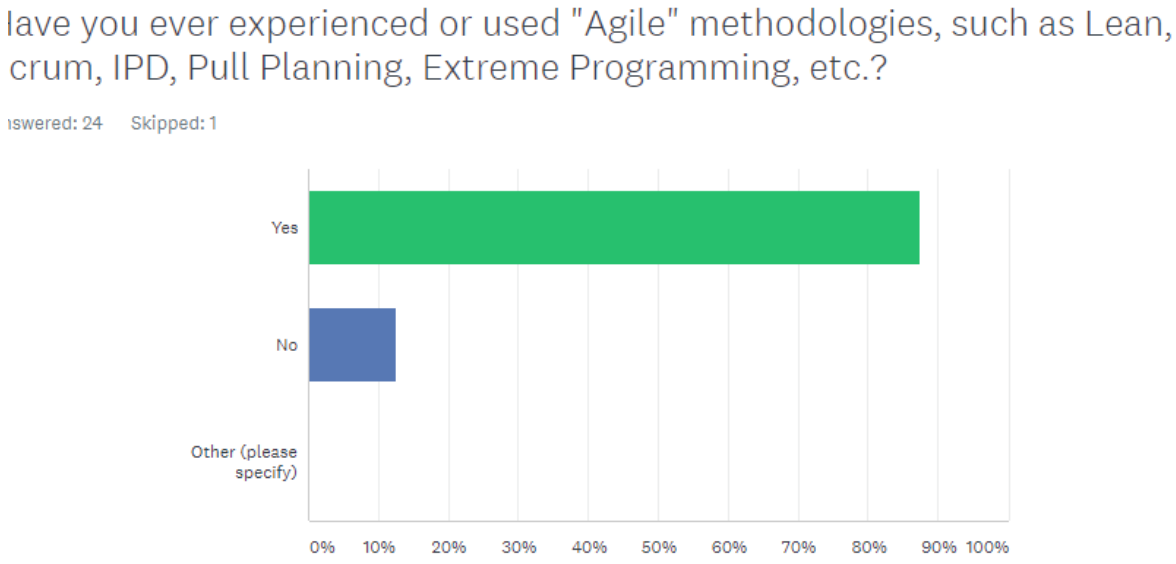
ANSWER CHOICES		RESPONSES	
Project Manager		16.67%	4
Project Architect		25.00%	6
Project Engineer		4.17%	1
Design Team Member		41.67%	10
Client/Stakeholder/Owner		0.00%	0
Principal/VP in charge		4.17%	1
Other, please list it out_____		4.17%	1
Other (please specify)	Responses	4.17%	1
TOTAL			24

Figure 8 Q2 Summary (adapted from Survey Monkey)

As the above figures indicate, the participants who completed the survey questions are evenly distributed into different professional levels and project roles. About 22% of the people who responded are Project Managers. Project Architects and Principal/VPs in charge in total comprised up to 45% from all the participants, these three roles are usually actively involved with the team and project management to some extent. This distribution ensures the answers of

the following questions are able to fairly represent and reflect the current situation of the construction industry.

One of the most basic findings during this research is that Agile project management methodologies have become very popular in the construction industry. Based on the data collected from the survey shown as Figure 9, most people in this field have experience with Agile approaches in varying degrees. However, there is a small group of professionals who still have not worked with any Agile project management methodologies. Since this management technology becomes more and more popular, it is obvious that the Agile approaches will play a more significant role in the future construction industry. This finding validates the feasibility of the Agile methodologies in construction projects in design phase.



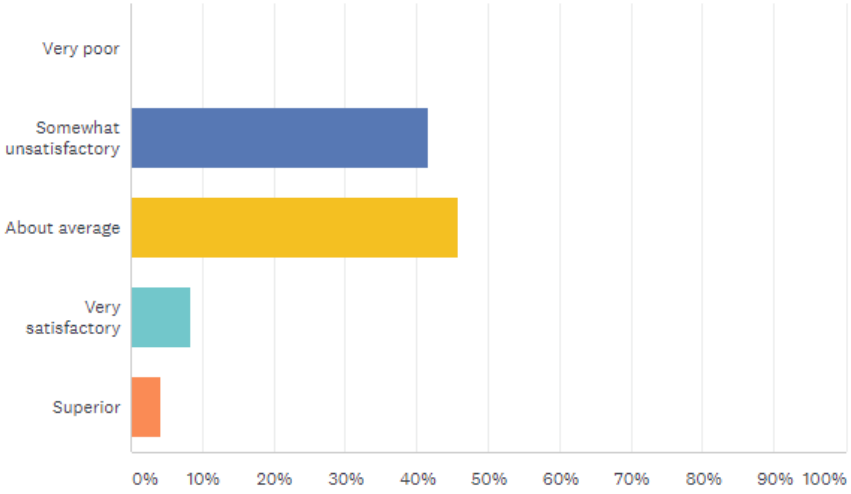
ANSWER CHOICES		RESPONSES	
Yes		87.50%	21
No		12.50%	3
Other (please specify)	Responses	0.00%	0
TOTAL			24

Figure 9 Q5 Summary (adapted from Survey Monkey)

Another interesting finding is how satisfied people are with the project performance of traditional "waterfall" project management frameworks. The Design-Bid-Build is a typical linear process. In design phase, the architects and consultants will provide the owner with bid documents, also known as construction/contract drawings. During this stage, the design team will work with the clients to identify the project goals and the clients' needs. The following bid phase and build phase typically will not start until the bid documents are completed. As one of the most popular traditional project management methodologies, it has played an important role in the construction industry for decades.

lease rate the project performance for the architectural/construction rojects process using traditional "Design-Bid-Build" methodology _____

swered: 24 Skipped: 1



ANSWER CHOICES	RESPONSES	
Very poor	0.00%	0
Somewhat unsatisfactory	41.67%	10
About average	45.83%	11
Very satisfactory	8.33%	2
Superior	4.17%	1
TOTAL		24

Figure 10 Q6 Summary (adapted from Survey Monkey)

However, as shown from the above Figure 10, the overall project performance of using Design-Bid-Build is not satisfied. The performance of majority of projects managed under traditional methods is at or below the average. This shows that the industry needs more efforts to improve the current construction project management structure to consequently increase the overall satisfaction of the project performance.

ANSWER CHOICES		RESPONSES	
Choices for Question A:		4.55%	1
Lack of real-time information share		18.18%	4
Responsibility and liability are not clear		0.00%	0
Project goals are not clearly identified		0.00%	0
Tasks and assignments are not clearly identified		0.00%	0
Lack of transparency		13.64%	3
Work environment is stressful and unsatisfied		0.00%	0
Project team is inefficiency/unproductive		9.09%	2
Project management is chaotic		9.09%	2
Choices for Question B:		13.64%	3
More real-time information and feedback are provided and shared		86.36%	19
Responsibility and liability are more clear		31.82%	7
Project goals are more clearly identified		36.36%	8
Better clients/stakeholders' engagement		63.64%	14
Team members are clear with the tasks and assignments		31.82%	7
Project has more transparency		72.73%	16
Project team works more efficient and productive		59.09%	13
Other (please specify)	Responses	4.55%	1
Total Respondents: 22			

Figure 11 Q7 Summary (adapted from Survey Monkey)

Furthermore, the lack of real-time information sharing and the lack of project transparency shown as the major problems of traditional management method (Figure 11). In contrast, the benefits of the Agile methodologies happen to make up for the above shortcomings of the traditional framework. Compared to Design-Bid-Build processes, the Agile project management methodologies have four major advantages:

1. More real-time information and feedback are provided and shared.

2. Project has more transparency
3. Clients, stakeholders and owners have better and earlier engagement.
4. Project team works more efficient and productive.

Based on the responses for this question, it clearly indicates that quite a few key benefits are realized by applying Agile management methodologies into construction projects. The finding shows that compared with the traditional waterfall management method, Agile management approaches are effective in enhancing the performance of the project and project team. The iterative project processes improve the project life cycle efficiency, transparency, communication and team engagement.

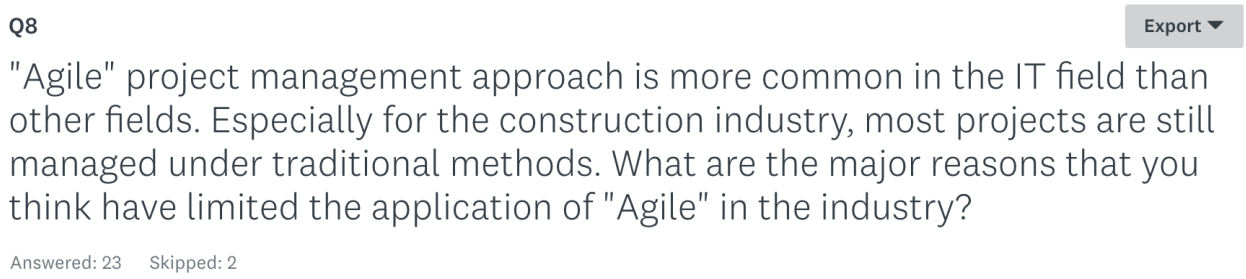


Figure 12 Q8 in questionnaire (adapted from Survey Monkey)

Question number eight is the only open-ended question in the survey. The design of this question intents to collect the data that could show the major triggers limiting the Agile implementation in the construction industry. Among the 23 answers, the major reasons can be summarized in three aspects below:

The Nature of the Construction Industry

One of the Agile management features requires the team to be collocated to increase the early involvement for all parties. The Agile method requires lots of interdisciplinary office coordination and communication, therefore it needs a higher level of clarification in terms of work flow and responsibility assignment. Since construction is a complicated process, it needs

the engagement from a number of disciplines, and the whole industry will need time to adopt this model. However, the nature of the design process requires different parties' involvement at different level during the same phase. Multi-disciplinary makes it extremely difficult to align from the very beginning of a project. At the same time, numbers of companies involved all with different cultures, working habits & competing objectives, this causes more difficulties for applying the Agile methodologies into the industry.

In addition, the design industry typically involves more creativity and innovation. The "uniqueness" of every building design makes construction projects frought with potential unforeseen changes; it is difficult to just copy and paste precedent projects management structure into new projects. This feature makes the kind of new Agile mythologies hard to be adopted into the traditional construction industry.

The Culture of Construction Industry

The culture of the industry is another key point that limits the application of the new methodologies. Since construction has been an industry for such a long time it is even harder to change processes and practices, while IT has existed for mere decades. Knowledge of how Agile project management works is lacking and insufficient across for the whole industry. Building Information Management and Modeling (BIM) as a new technique has been a slow change to the industry from decades ago. Agile project management methodology is too new of an approach, which will be a slow change as well for the industry to catch up.

There are also some difficulties with organizations (government, government sponsored, etc.) and their abilities to use new and different contracts which affects the industry. Overall lack of tech savvy personnel at the field/execution level and the resistance to change delay the development of Agile in construction. The same problem exists in technology such as public

transportation having abysmal technology and something that would have been fixed easily in the private sector.

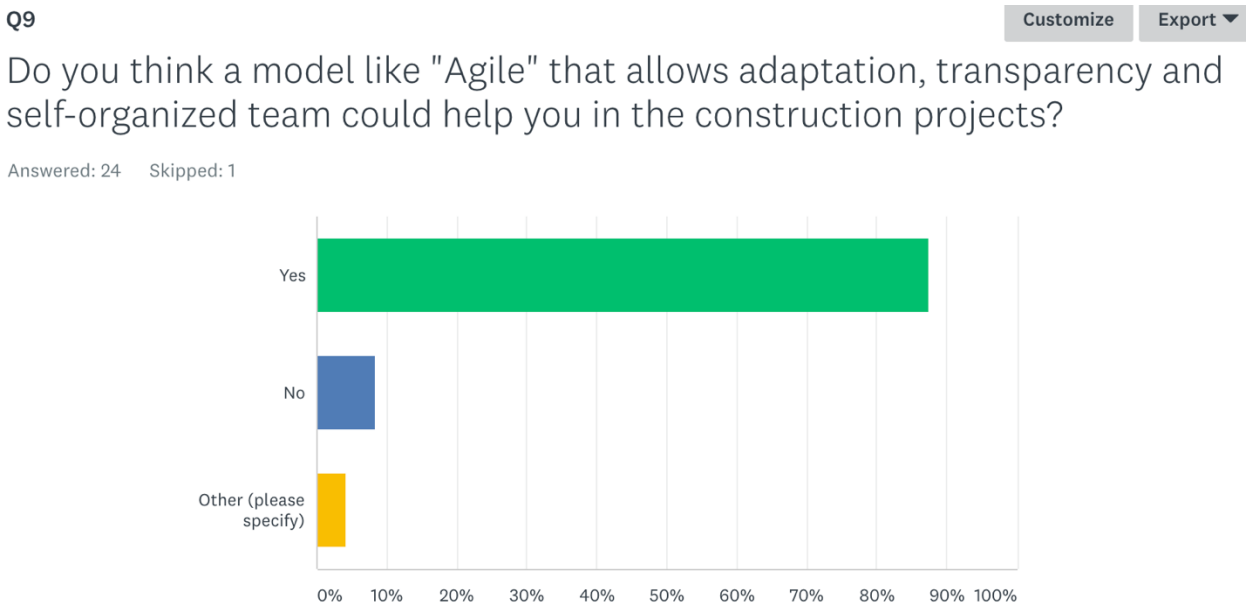
In addition, clients in real estate tend to keep traditional ways of doing business, and they prefer to conduct the project conservatively to avoid risks. Clients are either not familiar/comfortable with these 'new' methodologies or feel that their projects may not be large enough to derive benefits from Agile. By using Agile methodologies, more power is given to the contractor to influence the early design phase. Therefore, architect need to add a lot of value in coordination and design models are going to be a part of actual construction digital information. It takes more time and energy for architects under Agile management environment, but typically architects are not being compensated more.

The Cost of Industry Change

Other than above mentioned two major reasons, the financial problem plays an important role in slowing the application of Agile in construction as well. Since project in construction industry vary in type, size and scale, the upfront cost can be prohibitive to smaller projects. Assessments have to be made if a project is big enough to offset the upfront investment. Compared with the traditional construction project management methods, Agile needs a lot of preliminary input. It needs more researches to set the standard and template, and it requires continuous financial support.

Owners and clients not only have to be fully invested in Agile technique but they must also champion the processes. Since the standard for Agile application in the construction industry still need further development, it takes a lot of buy-in on the owner's part to agree to this delivery method.

In sum, the data from this question finds the major causes that trigger the slow development of Agile application in construction industry. It helps the construction field identify the correct and applicable route for the further development of Agile project management.



ANSWER CHOICES		RESPONSES	
Yes		87.50%	21
No		8.33%	2
Other (please specify)	Responses	4.17%	1
TOTAL			24

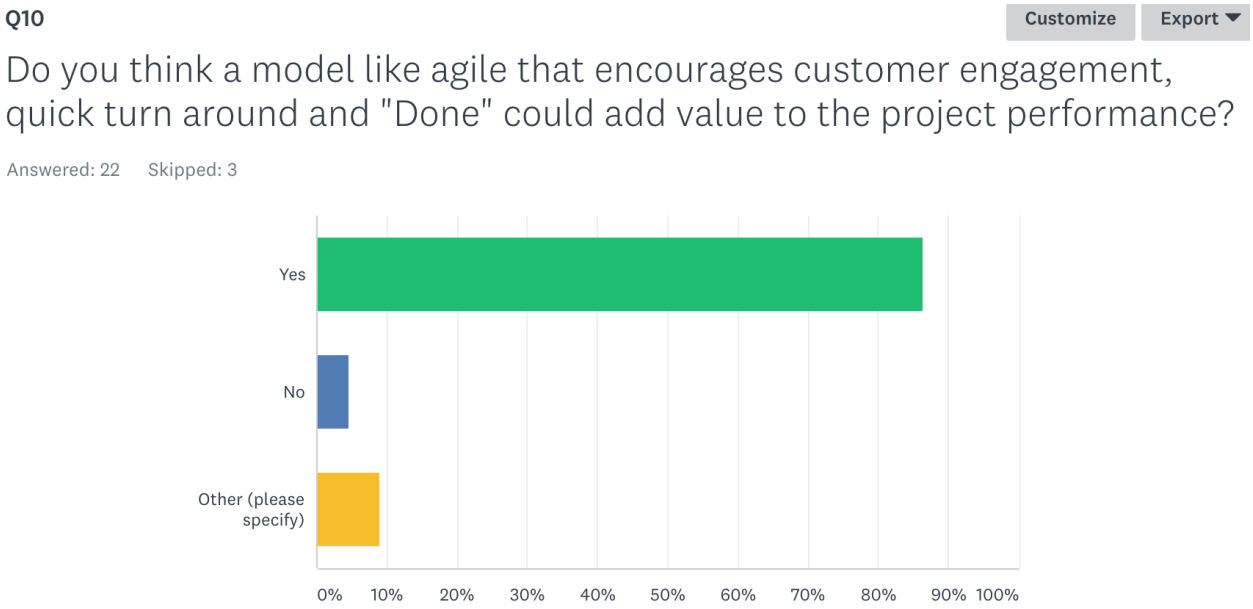
Figure 13 Q9 Summary (adapted from Survey Monkey)

The last two questions from the survey are both focused on the project performance. It finds that most professionals from construction industry agreed that the project methodologies like Agile would bring benefits to the project performance in many ways.

Scrum as a typical form of Agile framework contains all the important advantages that would help improve the project performance. As shown from the Q9 and Q10 data summary, transparency, inspection and adaptation are all considered could improve the project performance. This validated that Scrum, as a fact-based, experience-based, and evidence-based

Agile technique, places great emphasis on mind-set and cultural shift to achieve business and organizational Agility (Doshi, 2016).

However, a few of responses from these two questions also states the potential problems that might be occurred by adopting Agile into the construction industry. For example, quick turn-around times sometimes reduce the thought put into the work on a project, and it causes redo of work. In addition, Agile helps tracking and quick turnaround, but also adds lots of meeting and management effort that traditional design process does not typically have.



ANSWER CHOICES		RESPONSES	
Yes		86.36%	19
No		4.55%	1
Other (please specify)	Responses	9.09%	2
TOTAL			22

Figure 14 Q10 Summary (adapted from Survey Monkey)

Therefore, instead of directly copying and pasting the Scrum framework from the IT field to the construction industry, it is more significant to wisely adopt and modify the existing Scrum framework in order to make it fit the particular requirements of the construction industry.

Besides the survey/questionnaire collection, the author also conducted a few individual interviews. In order to gather the more comprehensive data regarding the thesis's research focus, three detailed face-to-face interviews are conducted with three selected individuals who have rich project management experience in the construction field. Among these interviewees, two of them have Agile experience in their previous careers. In order to remove the bias and partialities, the three selected architects have different professional backgrounds. And all of them have sufficient professional experience - at least 20 years - in a construction relative field.

Interviews are conducted with the similar questions that are included in the survey/questionnaire. Through the detailed interviews, the findings collected from the previous survey are further convinced.

Other than the responses collected for the questions, the author gathered more detailed opinions from them about applying Scrum in construction projects to improve project performance in the design phase. Even though all the interviewees agreed that the by using Scrum framework with the construction projects, the project performance are very likely to be improved, some obvious shortcomings still need to be fixed by modifying the framework structure. One of the most important findings from the interviews are that a hybrid Agile approach may work better than just directly adopting the existing Scrum framework into construction projects. A number of modifications, improvements, and adjustments are still needed before applying Scrum to the construction industry.

6. CONCLUSION

IT and software development fields gained significant benefits from applying the Agile approach. The objective of this thesis is to deeply explore and analyze the advantages of implementing Scrum in construction projects in the design phase. It is important to drive project management in the construction industry forward. Potentially, the study and research of this new framework could create a revolution in terms of project management throughout the entire construction industry.

As indicated in the research, preliminary steps have been taken by many project management practitioners in the field to improve project performance. Agile project management methodologies effectively increase the involvement of the clients. Through the way designing and processing the Agile approach, the participation of the client will be improved to create more custom satisfaction. And the early engagement of the client makes the design phase smoother. Scrum, as an Agile framework, provides a collaborative project managerial perspective.

Another major benefit brought by applying Agile to the construction project in design phase is the team efficiency. Since project team members are given appropriate levels of authority, the personnel are more motivated. This ultimately improves the project performance as team members feel more motivated to perform at their best.

In addition, Agile provides the bottom-to-top process which creates a work environment with transparency and increases the share of the real-time information and feedbacks. Since the people become more aware of their responsibilities, tasks and goals, the project deliverables are better produced.

Recently, it is gradually being applied to a range of project types within the construction industry. The benefits of applying Agile to construction projects are becoming evident to

practitioners and gradually revealed. By applying Scrum, interactions with the client, individual accountability, team collaboration, etc. have been improved. A complex construction project can thus better address changes and conquer risks with an adaptive Agile approach.

However, Scrum as an advanced tool still need further adjustments, modifications and development in order to be applied better to the construction industry. Although the Agile Scrum as an iterative system is easy to be implemented, the particular features of the construction projects still require new Agile approach to make changes accordingly.

In sum, the application of Agile Scrum framework in construction projects during the design phase can improve the project performance in many ways. Further development of the Scrum in construction still necessary in order to provide more benefits.

7. RECOMMENDATION

The thesis gives recommendations about the implementation of Scrum in the construction industry. In order to thoroughly understand the relationship between Scrum application and project performance in construction projects, the author recommends conducting further research by using different solution approaches. For example, precedent case studies and large sample-sized survey/questionnaire would help gain a more comprehensive understanding of the Agile philosophy.

The further research in the future should also pay more attention to this particular framework and conduct more detailed research. It is highly recommended to develop an empirical Scrum model that can be conducted to a practical construction project. Through collecting the data from the experimental projects to generate a study report that will provide an industry level of guidance about Scrum implementation.

Design phase is only a small portion of a construction project. More empirical research is necessary for further study about implementing Scrum in other phases of construction projects. Therefore, Scrum is able to become an industry project management standard that can be easily applied to the whole industry other than just experimentally used in a small group of construction projects.

In addition, since the improvements and advantages by using Scrum in the design phase of the construction projects are detailed explored and analyzed in many ways in this thesis, the recommendation of the future study and research will be focusing on the limitations of empirical Scrum studies on construction projects. When the limitations of Agile Scrum are clearly learned, the accurate adjustments and modifications can be created to make the Scrum add greater value to the industry.

No matter whether the construction industry will directly adopt it as “Scrum” or make it hybrid with another name in the future, only with a comprehensive understanding, the benefits can be significant.

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Appendices

EMAIL	FIRST NAME	LAST NAME	SENT	RESPONDED
chenxi.hu@smithgroupjjr.com			Yes	Complete
ChrisNe@dpr.com			Opted out	No
Cindy.xu@smithgroupjjr.com			Yes	Complete
cingcheung@gmail.com			Yes	Complete
CoryA@dpr.com			Yes	Complete
cristina.bontia@smithgroupjjr.com			Yes	Complete
danweiwang54@gmail.com			Yes	Complete
elaine.lu@smithgroupjjr.com			Yes	No
Emily.wong-suh@smithgroupjjr.com Click to view contact details			Yes	Complete
erica.hernly@smithgroupjjr.com			Yes	Complete

RECIPIENTS: 1 - 10 of 31

EMAIL	FIRST NAME	LAST NAME	SENT	RESPONDED
Gabriel.Fonseca@smithgroupjjr.com			Yes	Complete
innk.liu@smithgroupjjr.com			Yes	Complete
JackP@dpr.com			Yes	No
Jacqueline.Lee@smithgroupjjr.com			Yes	Complete
JeanG@dpr.com			Yes	Complete
Jennac@dpr.com			Yes	No
Jennifer.Brooks@smithgroupjjr.com			Yes	Complete
jennifer.morlock@smithgroupjjr.com			Yes	No
Jenny.Sun@smithgroupjjr.com			Yes	Complete
Lisa.meniketti@smithgroupjjr.com			Yes	Complete

RECIPIENTS: 11 - 20 of 31

EMAIL	FIRST NAME	LAST NAME	SENT	RESPONDED
zhang.jiang@smithgroupjjr.com			Yes	Complete

Table 1: Survey Email Invitation Recipients List

Audio 1: Interview Recording with Matt Davis

Audio 2: Interview Recording with Gabriel Foneca

Audio 3: Interview Recording with Jennifer Morlock

Doc 1: Survey/Questionnaire