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**Feasibility in Applying Agile Project Management Methodologies to Building Design
and Construction Industry**

**Feasibility in Applying Agile Project Management Methodologies
To Building Design and Construction Industry**

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Abstract

During the past few decades, fundamental changes have taken place in project development, planning, and execution. This has taken form with embracing new techniques such as various agile project management methodologies to develop products, instead of using the traditional waterfall project management methodology commonly used today. Using agile has been very successful as a large portion of the IT world has integrated it within their companies. Unfortunately, professional fields such as the building design and construction industry have remained mostly with the traditional methods impacting the projects in terms of cost, scheduling, and other project elements that can benefit from the advantages found in agile methodologies. This thesis paper will research and illustrate what is involved with the process of adopting and transforming companies from the traditional to the agile methodology, and will explain the benefits, the hardships, and other components relevant to illustrate what needs to take place in order to implement agile in the construction industry, as well as layout possible solutions that can ease the adoption process.

Keywords:

Agile project management; traditional waterfall project management; project planning; project execution; building design and construction industry; information technology; schematic design, design development; construction documents; programming; MEPs; request for information, request for qualification, request for proposals, bidding,

Table of Contents

Abstract.....	2
Keywords:	2
Introduction.....	4
Problem Statement and Justification	6
Literature review - Analysis of Related Work	8
Proposed Solution Approach	13
Methodology	17
Findings.....	20
Discussion and Recommendation - Hybrid Prototype	30
Conclusion	46
Recommendations of Future Work.....	46
References	48
Appendices.....	50

Introduction

Agile Project Management and the Change It Carries

In the past few decades, specifically in the Information Technology world, a different approach for developing, planning, and executing projects has developed. This system that was developed is the Agile project management. The reason why this approach is so meaningful, is that it provides a critique and means to improve what was practiced for decades in the traditional project management system in many ways. As an example the traditional method focuses on the end product, thus structuring the project elements around this cause which providing a inflexible process. The changes Agile apply in the project implementation process includes scheduling, project costs due to more efficient processes, changes in staffing needs and other resources related to project implementation. Unlike the traditional method, the agile project management is a short iterative based system which allows a usual bulky process of product development, to be shortened substantially due to fast pace trial and error cycles as Cobb (2014) illustrates. In addition, where usually in the traditional method the project manager usually assigns specific tasks to individuals within the team, the Agile process avoids having these hierarchical barriers between the team members, and allows them to work collaboratively and independently, as a team. This is a major benefit as communications and coordination become much more efficient. The team members feel more involved, and most importantly, this raises the motivation as the work culture is being transformed into a communal joint effort. To conclude, the agile methodology has spread like a brush fire throughout the information technology world reaching all industry levels transforming huge corporate environments as Rubin (2013) exemplifies Toyota and IBM as such cases.

How Agile Adoption Relates to My Interests

As an architect that is part of the building design and construction industry, there are many challenges, complexities, and numerous communication routes that are required in order to help solve the issues involved in designing and constructing a building. Commonly today, the process for planning and executing such projects takes shape in the traditional project methodology or also known as waterfall. I think at many times this process becomes slow, inefficient, and costly due to communication and coordination issues resulting this project execution structure. Also the traditional project execution processes are potentially adapting to the rapid changes in technological developments and other components that change rapidly and influence the way in which architects plan buildings, and other elements regarding the assembly of buildings such as new construction techniques. I believe as many variables occur around the project's environment, so does projects processes should adjust accordingly in order to improve its efficiency. Another reason that building design and construction projects can be at times inefficient, are due to large teams involving dozens of different consultants and stakeholders. This creates a bulky communication flow which can lead to slower progression, and potential problems during the execution of the project's implementation, as each task is developed in a slower manner, delaying progression substantially.

Some claim that building design and construction project are too complicated to adopt Agile methodologies, but an example of an industry that implement complicated projects that use Agile nevertheless, is the Information Technology world. Software development is also complex and involves many stakeholders, but the Information Technology world still uses agile project management techniques such as the Scrum methodology. By doing so, the team structure is changed and ultimately simplified to ensure better operation through the planning and

development phases. The hierarchy is also minimized and the steps needed to communicate with the relevant stakeholders is becoming simpler, creating better team workflow and shorter tasks required for progress (in Scrum there are three project staff elements instead of potential countless types of stakeholders within a typical large team: the scrum master, product owner which deals with the client, and team which is considered a single collaborative unit).

The following chapters will examine existing literature in order to learn how agile project methodologies are applied in software development projects. By learning the advantages, disadvantages, and other elements involved in Agile, there will be greater understanding how to apply these methodologies in projects to create more efficient processes, ultimately illustrating how can Agile be applied in building design and construction projects. This will also help develop insights and understanding how these processes apply when transforming the organization and project development structures from the traditional project management, into the agile project management. Analyzing relevant literature reviews will illustrate the benefits that Agile adoption can result, and would also allow to understand the extent of the possibility to integrate such system within architectural projects. Reviewing existing literature and understanding the known facts of different attempts made for introducing agile in companies, will help create overall knowledge needed to understand how to make the process for designing and constructing a building more efficiently.

Problem Statement and Justification

Problem Statement, and Its Methodology

In the past years agile has become a very popular methodology for project implementation in companies. However, changes mostly relate to the Information Technology industry. In order to provide a better understanding what is involved in such transformation, two

topics will be reviewed regarding Agile adoption. The first topic relates to common issues and problems that occur by adopting agile from the Information Technology industry: as most empirical content and lessons learned can be extracted from this industry. These different case studies mentioned include information of countless companies have adopted this system already and a good deal of information exists to learn from their process changes and adoption.

The second topic studied is relating to the issues that can occur when adopting agile in non IT companies, and mapping out what are the fundamental differences between the fields (if there are any). This should be important to understand and answer if it is possible to transform into Agile, due to the fact that this project management methodology has created vast advantages in the Information Technology world leading to many benefits such as cost reduction, better team work, improved firm culture that created speed efficiency in planning and executing project processes. As the majority of the specific information exists on Information Technology companies adopting agile, this will allow to map the challenges and issues involved, and analyze how the adoption process can influence and impact processes in the building and design and construction industry through critical thinking.

The following chapters will deal with the different issues that can occur while transforming from the traditional project management into the agile processes. As it requires a major fundamental cultural change in a company, it will be important to chart in advance what will be the issues that can possibly inhibit from such a change to occur. Understanding potential issues, will enable to create a layout of the proper measures can be charted and pinpointed to assure the success of such reforms. The main focus ultimately is figuring out how to adopt the Agile project management structure in the building design and construction projects. This research paper will not explain how to directly implement agile to a specific project mentioning

its required characteristics and processes as projects tend to vary highly from one another, and too many variables are involved making this attempt impossible. Instead, the following chapters will elaborate on the issues involved in a more holistic way. This will help create a general understanding of the potential issues involved with the adoption process, and will enhance the understanding if such issues can even be solved, and if so, what would be their remedies (or potential ones). Discussing the problems will allow to understand whether this is even possible, as well as provide the insight needed to take such decisions.

Literature review - Analysis of Related Work

This chapter includes the review two literature reviews involving the adoption and adaptation of agile. The first literature review named Agile Method Implementation, written by Sabah Nouri and Mohammed Hussain (2012) from the University of Gothenburg, Sweden, explores challenges and solutions that can occur when implementing Agile. Hussain and Nouri are interested how adopting agile impacts the company both on the organizational level, as well as the individual and team level. In the review Hussain elaborates on the challenges involved with adopting this method, and also proposes several solutions. In order to investigate these two elements, Hussain listed various articles and conducted his study based on nineteen prime sources which he found most relevant for these topics.

Hussain defines **six challenges** that involve agile adoption and adaptation as the project development and execution methodology:

1- Transferring the bulky traditional project management into a fast pace quick iterations based project cycles that agile includes. This is relevant especially when a company a transforms its processes and adds new project process techniques, yet still needs to keep the industry standards. This level of balance is difficult to achieve and is still being experimented in many companies.

The integration process can be applicable to different elements in the project such as software integration, team cooperation and coordination with various stakeholders. This would allow to define in a more clear manner the differences in the two project management methodologies and which applies to which component in the project, and other elements that can rise due to this system transformation. Meaning, focus on project specifics to propose their solutions would allow to better define the approach needed to solve these challenges.

2- The challenge relates to the business processes of projects. Where in the traditional method the basis for project layout are contracts, and specific scheduling such as main deliverables on certain dates, in Agile, these components have minimal influence. In addition, it is not just formal project procedures that have to be fundamentally different, but also operational behavior of the team members. In Rubin's (2013) Scrum book, the team member will have to be much more motivated, open minded, have the capability to improvise and become flexible to different project issues that would occur, and also become a 'generalist' and not necessarily a specialist which is common in the traditional project methodology setting. The agile team member is not the typical team member which receives daily tasks , completes them, and awaits to the project manager to receive additional tasks anymore. Instead, it requires the team member to operate in a dynamic environment where changes occur all the time, tasks get modified and the team member will have to adapt these quick changes, find a solution, and deal with the issue at hand.

3- This challenge deals with the individual involved in agile adoption. One of the fundamental differences between the traditional project methodology and the agile methodology, is the way the team is structured and operates. As an example, the project manager in Scrum Agile methodology is not really existing. The team is self governed and tend to complete the tasks based on their own decisions based on consensus and agreement. Well, there is the Scrum Master

and the Product Owner which help prioritize tasks by listing the sprints (the content in which the iteration cycles will be structured on, and will listed what needs to be completed), but eventually, the team conducts the work and tasks internally as Rubin (2013) illustrates.

Another issue is the need to change the workspace configuration to adopt the Agile culture in a more successful manner. Meaning, cubicles and other individualistic typical corporate layouts are contradicting the essence of Agile, and would require a workplace layout and structuring configuration to be able to accommodate the communal setting that would spark innovation, and cooperation.

4 - The fourth challenge deals with communication issues that can arise when adopting Agile. In the traditional method every correspondence is formal and documented. This takes form via the RFI process, e-mails, meeting minutes, change orders, etc: every element in the traditional project management is documented and is used for legal purposes if needed. In Agile, the communication is based on "informal" ways in order to speed up information flows, thus, enhance the project's speed. These fundamental differences can lead to tracking issues and confusion when implementing Agile for a team not used to such system.

5- The fifth challenge deals with management issues resulting the implementation of Agile when attempting to build the trust and moral values between the clients and the project team. Hussain also explains about the hardships in creating stakeholder involvement, as Agile requires much more client participation during the project's process compared to the traditional methodology. Another managerial challenge that can occur regarding stakeholder relationships, is managing the teams through long distances, where a project team can be scattered across different locations. These elements can help create a sense of lack of hierarchy, which can potentially lead to scheduling and coordination issues.

6- The last challenge is the cultural adaptation that can occur when trying to implement a new methodology within a company. Procedures, processes, and methods of working can develop over decades. Implementing a new project planning and execution structure can be difficult for some employees. This can vary with communication differences and other procedures that might be problematic when dealing with different colleagues at the firm, and also different stakeholders relating projects.

The second literature review studied is named "A Systematic Literature Review on Agile Project Management" written by Sumsunnahar Sheuly (2013), for Lappeenranta University of Technology. After explaining the different methods and techniques that exist within the Agile project management processes, Sheuly briefly mentions the main concepts that allow Agile project management to become advantageous to a company.

The first advantage explained is the enhancement of communications through improvement of the team's operation. This involves making the teams self managing, instead of individuals receiving tasks via the project manager which can sometimes take some time until decision is made. Also, the project's execution structure and scheduling changes from the planning towards an end result, towards relying on short increments including many trial and error cycles, allowing for less planning and ultimately, more quicker development leaps that allow for more iterations and product progression compared the traditional method. This impacts the product substantially as it allows for more creative thinking and development during planning. This is great characteristic for an innovative project that the final outcome may not be known necessarily. Rubin (2013) explains that Agile minimizes the overall risk involved during the project's development phases, as it increases chances the product will work successfully by allowing for more testing, along with a stricter cooperation between the project team and the

client, improving the product's desired result. Sheuly continues to elaborate on different Agile methodologies. In terms of the literature review, Sheuly (2009) created selection and filtering procedures to reflect the most relevant data in order to understand the content in order to derive beneficial relevant conclusions. The overall data is derived from a selection of forty four articles that were searched through various scholarly search engines, and that fit the criteria. The references included different industry reports, empirical data, and different research conducted to understand Agile's influence on different factors of the company environment such as team efficiency, adoption outcomes, etc. Thirteen articles were selected that are analyzing the introduction and adoption phase of agile into companies. Although Sheuly may refer to software or IT related companies, the lessons learned are relevant to any industry as all projects involve some commonalities such as communication, teamwork structures, company cultures, technology adaptation in projects, project implementation processes etc. These elements can increase the chances for Agile adoption. The summary in the literature review explains how adopting Agile have improved overall client relationships by creating better communications and collaboration.

As the information presented in the literature review helped to understand benefits within the agile adoption process, Sheuly has not explained enough regarding the requirements of individuals within the teams involved in agile. This includes their personal attributes such as their communication skills, interpersonal skills, and motivation required in Agile: all that can impact the successful implementation of such method. This element will be elaborated in the following chapters.

Sheuly recommends for future research to analyze how separated work environments with multiple teams can operate with efficiency in the Agile model, meaning what happens when

multiple teams collaborate from different geographies. This problems he discusses about will be outlined with potential solutions in mind, and will be examined in detail in the following chapters. Another issue lacking sufficient understanding is the return of investment figures that will help provide empirical data that can assist decision makers when adopting Agile and comparing it with the traditional method. I assume Sheuly did not find this valuable data as private companies keep this information private for obvious reasons. Even though I might not find any resources, I do not believe this information is critical to analyze, as countless companies have clearly profited and became more efficient from Agile as they transformed their company culture and structure to accommodate such system. Such failure would cause these companies to return to their source operational methodology. Sheuly concludes that more elaboration is required regarding the challenges and issues that occur when adopting Agile from a waterfall based system. Following chapters will discuss and illustrate this topic in detail.

Proposed Solution Approach

The proposed solution for the challenges presented in the two literature reviews is broken into two areas of focus. One would be to propose six solutions for the six challenges mentioned in the first literature review of Hussain, M. and Nouri, S. The second area of focus is to discuss the issues mentioned in the second literature review by Sheuly S. will help to understand the elements that can potentially problematic when adopting Agile.

Solutions Proposed for the First Literature Review

The solution of the first challenge mentioned: industry standards conflicts with Agile, is to assemble a creative team that can think out of the box from the beginning of the project in order to allow them to test, examine, and create a hybrid process between Agile and the traditional project systems. Because Agile will still be experimental and new for the company

involved in the Agile adoption process, it is important to assemble people that are good in approaching new unfamiliar problems. This will help them learn, adapt, and solve issues involved with implementing Agile in a more efficient way. Once a single team will be successful, this will serve example to the rest of the firm, and eventually, will help reshape and train the company's culture to adjust its systems and operation.

For the second challenge: business processes conflicts with Agile, the solution should be a training program that will be developed and outlined in order to allow the team to adapt the new processes involved in Agile in a more delicate manner, gradual manner in the attempt to make the transformation process more successful. This mechanism should address all new elements introduced in the Agile process that does not exist in the traditional method such as user stories organizing the various tasks at hand through sprints (iteration cycles). Also, focusing on the differences of team member duties and tasks and the way it will be implemented, learning new communication procedures and other elements involved in Agile, and specifically Scrum which has fundamental characteristics that would be taken as example and this will be elaborated in the following chapters.

The third challenge: the human factor issues when adopting Agile, a unique hiring process should occur that will involve selecting highly adaptive people, with great team skills, and that are good in collaboration and communication. Elaboration on the selection process of the individuals that would take the first steps to help the cultural transformation into Agile (at least in the beginning of the process). They should be able to then lead the company into a firm wide change. In addition to the individual selection, elaboration should take place regarding the creation of a 'team' workshop, where the team will get to know each other through different challenges and fun tasks (outside the conventional workplace), where eventually, they will get to

know each other in preparation for the project initiation. This factor of creating a better team that can interact in a more efficient manner, will help lead to successful project implementation.

The solution for the fourth challenge mentioned: communication issues when adopting Agile, is not by eliminating mandatory external communication channels that exist and that were created in the traditional project methodology. The reason is that in the building design and construction industry there is a pretty strict communication structure such as in different software that are in charge of facilitating different orders from the architect to the contractor, and help the construction team fit the design intent in the final assembly. Some of these became legal standards and are intertwined with legal contracts relating the project contracts which cannot be abolished. Thus, disregarding these processes will definitely result with the failure of Agile implementation. However, communications in Agile are not worthless, far from that. The 'informal' standards in Agile should be elaborated in the following chapter, but mapping where in the project's process they should take place is crucial, as it cannot occur anytime and in every step in the project. The solution is to map the different communication routes in the types of projects that involve the building design and construction industry, and where the 'informal' routes can take place within the project's process. It is likely and will be elaborated in the following chapters, that internal coordination is the likely element to benefit from the Agile transformation of informal communications.

The solution for the fifth challenge: trust and moral value between team and client when adopting agile, this thesis argues against Hussain's claim of trust and moral issues arising in Agile methodology. The reason is that this challenge is not a unique element to Agile, but involves all project types. In every project trust should be obtained between all stakeholders (internal and external) through time and efficiency of the team. This could be enhanced through

team-client visioning sessions, routine meetings, and maximizing communications as much as possible to allow for a relationship buildup creating good trust between the various relevant stakeholders. Regarding the stakeholder's involvement extent within the development process of the project, the clients tend to actually be positive with having a close relationship with the project team, at least in the architectural world. By creating from the beginning of the project, a culture of cooperation and client integration in the process, the product will be of better satisfaction to the client.

For the sixth challenge mentioned: cultural adaptation when adopting agile, there are several ways to deal with such a challenge, even if it means a partial solution. One option is to assure that the team that starts adopting Agile is not starting from scratch, and they are fully aware of the industry standards and are experienced with the traditional approach: this should be a hiring criteria for the team member's qualification (at least for the first team involved in the adoption process and its implementation in the company). The first team that will take these first leaps will understand eventually how to create the balance needed between the traditional or Agile, to better integrate employers with this new project implementation structure.

The following chapters will go into depth into each of these challenges elaborated and will provide guidelines that would ultimately help to develop procedures. It is important to note that how projects will be structured and sequenced will not be listed as a to do list as projects tend to vary from one another, but will provide insights regarding the processes and knowledge needed to create the first Agile team in the company, and allowing them to execute their first Agile project successfully.

The second literature review elaborates on different needs required for a successful implementation of agile. While some of these elements are mentioned in the six challenges

mapped above, Sheuly (2013) elaborates on the general issues relating to Agile. As an example of the individualistic characteristics needed from an Agile team member. In this case, identification is needed to locate the prepossessed characteristics required for an Agile team member in order for Agile to work. A team member should be able to carry different tasks and have characteristics such as have a low ego, be able to work in a team, have the resourcefulness to solve problems, and be dedicated team members as it is vital for agile processes. Another example of a general issue raised is how to overcome the operation of teams working in different locations. As this happens in every project type and is not unique to Agile, this paper will disregard this element, as this is a general project coordination problem and is not unique when adopting Agile.

When identifying the differences between the two literature reviews, the first one lays out the specific challenges required to adopt Agile, and the second literature review helps to identify the general requirements that should be mapped in order to help with applying Agile. The following chapters will further elaborate on these processes, and illustrate the data required in order to apply Agile in the non Information Technology field. Analyzing the data in the articles referenced in the literature reviews should allow to thoroughly elaborate and understand the elements needed to map to understand the difficulties and challenges in the Agile adoption process.

Methodology

Current Analysis

The previous sections illustrated through analyzing two major literature reviews, what are the main challenges that are involved in adopting Agile methodologies in a company, and what are the hardships that are needed to overcome in order to successfully implement such transition.

In addition to the challenges, the benefits that are involved from applying Agile in companies were exemplified through illustrating the enhancement and efficiency of the project's processes, planning, and execution(see problem statement, and literature review - analysis of related work chapters).

After reviewing these different challenges the chapter of the proposed solutions propose ways to overcome these hardships, in order to allow for a better smoother adoption process of Agile.

Next Step and the Incorporation of Selected Methodology

As this paper deals with what is involved in applying the Agile methodology within the building design and construction industry, these are the methodologies that would be in focus would apply for the rest of the thesis:

- Compare existing methods.
- Propose agile methodology alternatives within the architectural process.
- Summary of findings and propose recommendation for future work.

These following elements help to chart what is needed in the following chapters to enhance the thesis statement, and to supplement the content written thus far. The following sections will be supplemental to the current content written in previous sections: challenges, hardships, benefits of agile adoption.

Elaboration of the Methodology Sections

The first method of comparing existing methods that address the general area of thesis problem statement, will explain the architectural project process and pinpointing the flaws and problems in current architectural process with relation to traditional method. In order to understand what needs to be changed in the architectural process, a mapping and charting of the relevant parameters within the architectural project process will be illustrated, to allow to see

what makes problems with regards of its implementation in the traditional method. By understanding the flaws of the architectural process, meaning, seeing what is existing will allow to see while some aspects are feasible in applying Agile methods in the architectural process.

The third method will be proposing Agile methodology alternatives in the architectural process (including Kanban and Scrum elements) : The creation of the hybrid as it fits to the architecture process. This section will support the thesis study as it would illustrate where the Agile methodologies can replace current flawed aspects within the architectural process. By creating a new hybrid, and explaining its structure, the paper will illustrate with great detail the sense of the new design process and its requirements, and will help support the thesis study of the feasibility in creating the Agile-traditional hybrid within the architectural project process. This essentially will be a prototype structure. This chapter will apply the following methods of development of any detailed design or requirements analysis that support thesis study, and with developing a project prototype as a basis for reference.

The last methodology is the findings, and proposed recommendation for future work. This final chapter will include the findings and conclusions of the hybrid developed, and will include recommendations for future studies to create additional refinements in this new architectural process. This chapter will include generating result, conclusions, and future recommendation for additional research.

Findings

Comparing Existing Methods

The Architectural Process in the Building Design and Construction Industry in the Pure Traditional Project Management Methodology

The building design and construction industry involves a highly layered process that is based contractual documents organized by the American Institute of Architects: an organization coordinating and promoting knowledge, industry standards, and other elements such as professional development resources, to enhance the value and overall stance of the profession in the United States of America. Even if these documents are not used by decision in various projects, they are essentially a guideline of procedures and offer the standards of project procession layout in the building design and construction projects. These include several phases which are commonly used in the industry today. As an additional note, building design and construction project structures became so refined that it allows architects to be legally protected by hundreds of sections refined over intervals of ten years, involving architects, contractors, lawyers, and clients providing feedback of what should improve according to past events during projects, and where there were legal issues, now corrected to protect project stakeholders even further. This allows a comprehensible structuring and standardizing of this industry and is not likely to change. Thus, this chapter will not attempt to replace an irreplaceable process with Agile adoption, but will elaborate what current project structure flaws are. This will be done by elaborating what these project phases include, and essentially what are the problems seem in this process. Specific elements will be pinpointed and will be argued how they could be improved by Agile adoption, and what specific elements are problematic that impact cost, time, and quality in the current process. This chapter will also deal with how and where Agile elements can replace

existing project elements common to the building design and construction structure in order to make this process more efficient. This chapter will mainly focus on elements within the architectural point of view, as the process of designing and ultimately observing the construction process of buildings can impact the cost and schedule required for project completion, which agile could impact and modify to ultimately create a more efficient process.

By elaborating on the various phases involved in building design and construction projects as elaborated by The American Institute of Architects Contract Documents. (2007), this chapter will illustrate what involves in the project from the architecture profession and perspective, to help understanding the communications requirements and their different intensities required, in order to see how the traditional method impacts the process negatively. As Agile promotes the efficiency of communication flow between the stakeholders, knowing which parts of the process require Agile modification will be identified and clarified.

Phase One: Programming and Conceptual Design

In this initial project process, the architect will meet with the client and will try to retrieve critical information that will allow to understand the major building requirements, and the problems that need to be solved in order to eventually fulfill the client according to his or her wishes and needs. Basic data will be collected through interviews such as the program which is the building uses. An example of different building uses can be whether it be appropriated to retail, commercial, governmental, education, cultural, aviation uses, and others.

This phase involves a very minimal number of stakeholders: the client and the architect, and perhaps a minimal architect team to aid with this information gathering. As this phase is relatively intimate and requires introduction with the client, communication flow is highly efficient if the architect prepares for the data collection in an effective way. An efficient meeting

in terms of connection with the client will mean that more personal information will be extracted, and would allow ultimately to have better data in order to proceed to the schematic design phase in ultimately create a better process ahead. As there is a direct link between the a minimal number of relevant stakeholders to a highly effective communication flow, with minimal interruptions and delays, there is good efficiency in this process and advancement towards progressing on project goals. Thus, there is no need to modify this current phase structure.

Phase Two: Schematic Design

The schematic design phase involves the elaboration of the general scope specified in the programming phase into further detail. From the information collected about the building's program, the building different uses and other components are connected through relationships architects put together, and the formulation of this allows the building's form to take place following an initial understanding which building component is located where according to its relationship with another other program. Essentially it is an initial diagram of the building will look like, with minimum information. It is the general masses put together according to their relationships. As an example, a hotel's corridor will lead to elevators and emergency staircases leading out of the building or the main lobby space. This will appear as a diagram in this phase.

The initial requirements extracted from the client are being formularizing into initial building drawings: plans, sections, elevations, axonometric view (3D angular) and more, and initial building systems are being chosen (steel, concrete, or wood structure, mechanical systems, etc). Through different form investigation techniques such as model building and 3D modeling investigations through software, the architects will proceed with a more thorough form investigation of the building form now that the program and building use list is established with a clear square footage count. In addition to the building's parameters, the project's components are

also being set at this stage with great detail. This includes a preliminary evaluation of the budget (hence choosing building systems accordingly), the schedule of the design, understanding the material procurement and delivery methods, choosing a contractor, and dealing with other elements required to establish the project. Also, by the end of this phase there will be a complete understanding of owner requirements regarding what is required from the building.

The Schematic Design phase involves in terms of communication additional interaction and information extraction between the client and the architect. In addition, there will be initial communication with core engineers mandatory for building construction: structural engineers, mechanical electrical and plumbing engineers (MEPs), under contract with the architect. Also there is an option of adding geotechnical engineers and civil engineers as needed, under the contract of the client. As this phase is still initial and includes the slight elaboration of the building in terms of its conceptual characteristics, there is still a minimum requirement in terms of coordination with relatively low intensity. Also the design team of the architects still can involve a low number of people, as developing concepts for a building is applied better with small number of people in a team. Thus, the environment can be with a higher communication and more collaboration to encourage creativity. Additional hiring of team members usually start in the design development phase elaborated in the next section. As a conclusion for the schematic design, there is no need for integration of Agile adoption in this phase. There is relatively small amount of information that needs to be processed and analyzed, with relatively low number of stakeholders (small number of architects, client, core engineers). This structure allows for an efficient process that allows project progression through the current methodology.

Design Development

This phase is the further elaboration of what the building's components will be. This includes initial specifying of products used for building components according to the design intent, and design formulated in the schematic design phase. Also, specifying the different electrical, mechanical, plumbing, and structural systems that will be located in the building takes place in order to have better cost assessments in this phase. Also drawings from specialty consultants will allow for further elaboration of the systems that will be used, and that are required to be integrated within the building design required by the architects. The consultant types used vary from project to project, but in large more complicated building projects, more systems will be needed to be installed requiring more project stakeholders to be involved. An example of such consultants are: survey teams, lighting consultants, acoustical consultants, cost consultants, theater consultants, security consultants, code consultants, door hardware consultants, LEED consultants (high performance building parameters to achieve a 'green building' status by the U.S. Green Building Council), and many others.

As coordination becomes more complicated as all these consultants become an integral part of the building design development process, communication flow becomes more complicated. Also, architecture teams tend to expand in order to be able to coordinate successfully the rising quantity of data required for integration within the building design. Another important problematic element that exists in the pure traditional form of building design and construction projects relates to contractor involvement. Contractor is the stakeholder that ultimately procures the materials, and assembles the building. So it is important to understand that contractor's input from initial phases is critical in order to improve and create a more efficient process of the architects, related consultants, and engineers, through feedback and input

based on experience in building assembly. Although nowadays, in order to enhance project development efficiency and reliability there are some project methodologies that use contractors from initial phases such as the Guaranteed Maximum Price technique (add reference), typically in the pure traditional form and contract documents, the contractor will be integrated within the process only after the construction documents phase (see next section). This essentially blocks the contractor participation from the whole design process of the building until the construction drawings and specifications are sent for bidding.

As typically information becomes denser and requires more coordination through a larger number of stakeholders, there is room to integrate Agile elements within this process. Also, Agile would require to integrate some contractor presence within this phase to provide crucial input and advice for revisions of the drawings. This is crucial to save money through selection of better equipment, and enhancing constructability techniques of putting together building components during assembly, and advising on products more suitable in certain situations.

Construction Documents

The construction documents process deals with providing details to the product level and material specifications towards the procurements process that will be done by the contractor. Drawings will be elaborated in the highest level of detail to allow the contractors maximum information needed to assemble the different areas of the building. Also, engineers will establish the system performance requirements and types that are needed in the building, all in order to allow the building to operate with the efficiency, with the quality and effectiveness that the contract documents subscribe.

Bidding

Once the contract documents are complete that include the drawings by the different trades (architect, structural engineer, mechanical engineer, plumbing engineer covering fire protection systems as well, electrical engineer, and related consultants), specifications, and other project manual related items, these will be sent to a bidding process. The contractors invited according to an Request For Qualification/Request For Proposal process, will receive the information and will be required to submit a pricing. Once this is reviewed, they will send back their bid offer, and eventually be selected to begin the procurement process and building construction. This phase is merely formalities of selecting the contractor according to the different offers made. This is a short phase, which requires minimal interaction between the client, the architect, and the chosen contractor. After the contractor is selected the procurement process commences. Requests for Information (RFI) will be submitted by the contractor to the architect to clarify errors in the contract documents, or elements that could be refined. This process requires an extensive effort by architects to coordinate RFI solutions, as well as approve submittals which include all data, products, and materials samples that are conforming with the design intent set by the architects for the building.

Construction Administration

The RFI process continues in this phase in addition to submittals issued, requiring architects to have available staff to assure continuous supply of answers to avoid interruptions in contractor schedule. Also, and this varies by project to project, but the architect will visit the construction site not to inspect construction, but to assure construction is meeting design requirements (intent), and that there are no issues to be reported to the client. The architect acts as an 'owners agent' according to the contract documents. The team can be minimized in this

phase compared to the construction documents phase, but there are still requirements which will require the team to work on with a relatively high intensity and communication between the stakeholders. Thus, due to RFI and submittal coordination that require a relative high communication intensity needs, there is room for Agile adoption elements, and will be elaborated in the next chapter (discussion).

Building Design and Construction Project Phases Communications Summary

Figure one below summarizes the communication requirements that occur in the traditional methodology when implementing a building design and construction project throughout the different phases. As summarized in previous sections, in the programming and schematic phases, there are minimal stakeholders and communications that are needed in order to get tasks done during these phases. In design development, construction documents, and some level of construction administration and bidding, the number of communication attempts that are needed in order to execute tasks, between a larger number of stakeholders impact the overall efficiency of the project's implementation. Thus, there will be an need to implement Agile adoption elements, in order to ease the workflow of these phases, and increase overall efficiency. This will allow to eventually cut production time, improve communication and will inhibit double efforts which occur frequently in large teams where the individuals are not fully coordinated. Also it will allow eventually to lower costs and allow for more profit, as fee expenses can be lower with highly efficient workflow.

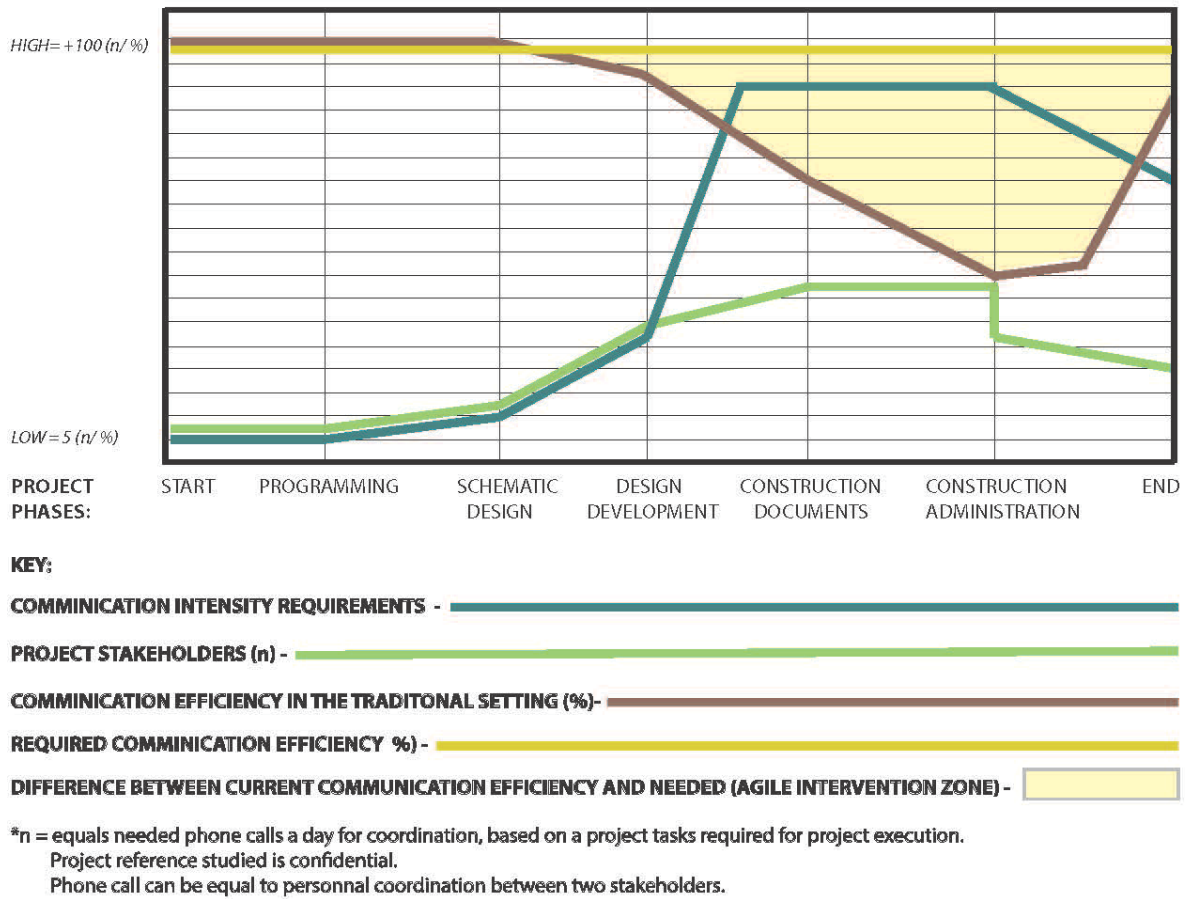


Figure One-Moriel, R. (2017). *Building Design and Construction Project - Summary of Traditional Project Methodology Communications During the Different Phases Common in the Industry.*

The major reason this thesis paper argues that these phases become inefficient are because of the **task** workflow and process according to the traditional methodology, that are required in order to complete these phases. As illustrated in the figure one, and previous sections, the phases that require a larger amount of communication between many more stakeholders (architects, client, engineers, consultants, government officials, etc.), through short amount of time, become congested in large projects and inefficient. Thus, the area where there consists with a large difference between the communication efficiencies (current in the traditional setting,

versus required in the diagram in the previous page), there will need to be Agile adoption to improve the current project structure. To further enhance the bulkiness of the phases which the efficiency drops, figure two below illustrates what is needed in order to carry out a **single** task during these phases with maximum deliverable and communication intensity, along with multiple stakeholders.

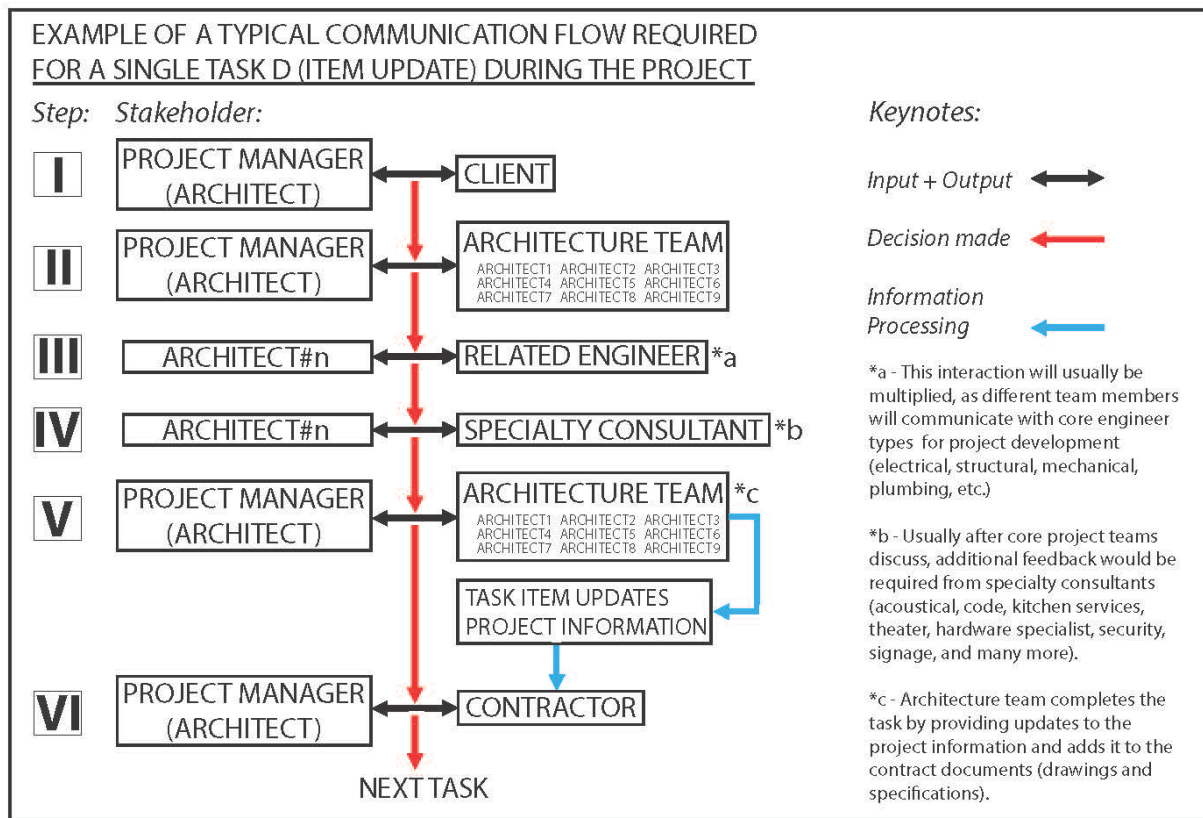


Figure Two- Moriel, R. (2017) Communication Flow required for a single task during one of the project's phases.

This is a common communication flow during the following phases: design development, construction documents, bidding and construction administration with regards to the RFI and the submittal process, where a large communication effort is required with the contractors in order to provide the necessary answers required in the material procurement and construction processes.

This study shows the very long process that currently exists in order to achieve a successful completion in one task (common to large complex projects as the one analyzed in this thesis paper). In these phases, there are typically hundreds or even more tasks that are required to complete the phases successfully. Thus, in the discussion chapter, this thesis study will offer solutions how to recreate the team structure through adopting different Agile techniques. This will be done in order to allow for a better more effective process that will save time, improve quality, and will save costs through cutting unnecessary work, and make effective communications required to complete tasks within the phases of the building design and construction projects.

Discussion and Recommendation - Hybrid Prototype

Overview

The previous chapter has illustrated that when the schedule commences during three main phases in the building design and construction industry, the need for communication and coordination rises, as the content required for processing and study increases dramatically. This occurs especially when the project reaches closer towards the initiation of the construction process. The schedule is condensed by the workload, and much effort is required in order to get these phases completed successfully. The current hierarchical structures that architects need to coordinate the tasks required during these phases with multiple stakeholders, often times limit the efficiency of these processes. This result can be potential frequent delays, cost impacts, efficiency decrease, and potentially the quality of the product or service given can be impacted as well creating needs sometimes for more change orders than perceived.

In order to enhance project efficiency there is a need to differentiate between what works in the traditional setting, as explained thus far, and where Agile should be adopted and integrated

to create a better more efficient process, that would ease the burden created by current team structures and project execution methodologies. Cobb (2015) explicitly mentions that very little has been researched in order to integrate the traditional waterfall methodologies and Agile components with regards to project management approaches, due to a general view that these two systems counteract each other, due to conflicting nature and structures.

The following sections will elaborate on how this process should be intertwined.

Brief Overview of Waterfall (traditional) and Agile Methodologies

Waterfall or Traditional Project Methodology

Waterfall as explained by Cobb (2015) is a linear process, combined with sequences that each would be consisting with goals and deliverables, essentially the whole process is structured through various consecutive phases. The progression is laid out in a way which the project continuously moves forward, with completing tasks that are required, and then moving on to the next ones, and so on. Another essential component within the traditional project management methodology is the thorough planning processes that is formulated prior to the execution of project. This would allow to create highly detailed understanding of the requirements and other information needed to conduct the various assignments throughout the different phases. An elaboration is made regarding schedule including milestones and the relevant dates required to assure the project's progression. Due to this highly developed project structure it used to minimize risk, as unforeseen conditions would have been minimized, allowing to counteract them in advance. In fact, the whole development and planning process in the traditional waterfall method, creates the means towards achieving a predetermined end goal at a given time.

This paper would argue that unlike some aspects in the project management methodology in the IT world, where Agile was completely adopted and the traditional method was abandoned,

the traditional waterfall project methodology is essential for the building design and construction industry. In the IT or high tech world, some projects aim towards an unknown result creating the need for a quick iterative trial and error cycles based on testing and experimenting. This results with the need for a pure Agile process, where the team can quickly adapt and eventually conduct multiple iterations to increase the chances the product will be useful. Nevertheless, constructing a building eventually consists with elements that are known factors, unlike some high tech product development. The building design and construction industry is establishing projects based on well defined end goals which are predetermined in the beginning of the project in the programming phase. Building requirements such as which program it serves, square footages, and main systems used, are listed in the beginning of the project in order to initiate the design process. The initial steps of creating a building is a result of creating known requirements, and by initiating a process that would solve the questions how can these requirements be applied through spatial form and the different program relationships according to the demands of the client. The traditional method was deeply integrated within the design process, and has been incorporated in legal standards which should not be changed. This paper is not replacing such a well established system structure, but will explain what and how Agile can enhance what is existing, and where it could be applied.

Agile Project Methodology

The technological advances creating new manufacturing processes and the need for new types of projects such as software development, created the need of a new project management system. This was initiated in Japan, where quality assurance methodologies failed to keep up with fast pace product improvements throughout the development process that were needed in the auto industry. There was a requirement to create a methodology that would align with

nonlinear dynamic processes. These processes relied on several variables creating a need for multiple development cycles in parallel to reach certain a target, through uncertainty, and fast paced scheduling as Cobb (2015) explains. The problem that the traditional method introduced, was that errors made along the process were not discovered until phases were completed. These created issues and problems throughout the project's development process and impacted the workflow and progression of the project. A need for an iterative processes, through short increments of project tasks were formulated, based on trial and error, assuring any issues would be addressed at the given moment in occurs. This was complimentary through maximizing team feedback and effort enhancing participation and coordination to allow for a more effective problem solving culture. Many techniques were developed to create fast paced development cycles but in 2001 the Agile Manifesto was created attempting to consolidate all techniques invented during these years, into a single project methodology: Agile. The importance of its content focused on several elements which impacted how projects were executed in industries that adopted such system. To allow for a flexible project management environment, this manifesto allows a project team to embrace its content as guidelines and not written rules enforcing a strict project layout structure, as can be found in the traditional method. The guidelines left room for interpretation, and allowed to adapt to a particular business condition and environment. The manifesto addressed several items that are relevant to this paper. As an example, there was an emphasis on valuing "individuals and interactions over process and tools" as written by Highsmith, J. and Fowler, M. (2001). Meaning, this section meant to address the need to discontinue the hierarchy created by the traditional method, by changing team structure which will be elaborated in the next section. It also addressed the need to embrace adaptability and flexibility, allowing team members to fully participate in the project processes, enhancing

decision making through a collaborative effort. Another issue the manifesto addressed was "responding to change over following a plan". Cobb (2015) explains this statement of transferring from an orientation of controlling the project parameters such as schedule and costs as defined in traditional project planning: creating difficulties in adapting and changing requirements the client wished during the process, into an environment where uncertainties and changes were easy to accommodate, and even accepted as part of the process. This approach essentially allowed to adapt to changes throughout the process, and potentially avoiding change orders through stricter collaboration and better team knowledge creation of the different project elements during the process. This was unlike traditional method, where the project knowledge is focused more on the end product from the beginning of the project.

The manifesto addressed other elements such as creating an acceptable project environment where change was welcomed. Also, all project stakeholders work together daily in order to push ahead the project, through face to face interactions. In addition, creating the need for self organizing teams which allowed for better production during the project's process, with effective an work pace. Through this method, the team would require to re-evaluate its own performance and would become more effective through adjustments, and performance adaptations as illustrated by Highsmith, J. and Fowler, M. (2001). Other elements were elaborated as well, though appear to fit better with Information Technology mechanisms.

Scrum

Rubin. M. (2013) in his book *Essential Scrum* elaborates on the reason the Scrum methodology was established. The main idea was to enhance the efficiency of the process using swift iteration cycles containing a process of trial and error. It relates to situations where stakeholder communications becomes slow an inefficient, creating a potential waste of project's

resources and deliverable outcomes. With this main reason is why Agile Scrum would be a good fit for the condensed phases found in the building design and construction projects. Essentially the communication efforts are upgraded using the Scrum methodology framework as illustrated in the diagram below. The project development structure is split to a series of cycled events (or **tasks** based on this paper's terminology), which are time based consisting a maximum duration.

There are several main type of elements composing the Scrum cycle:

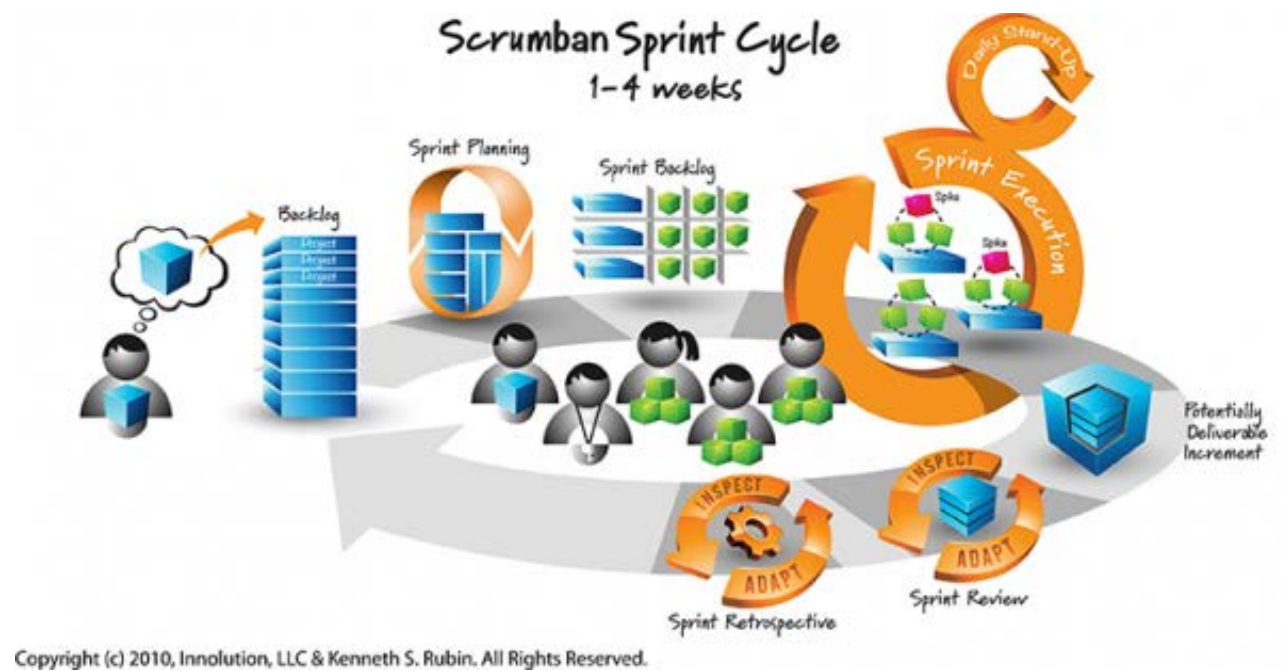


Figure Three- Innolution, LLC & Kenneth S. Rubin. (2010). (see appendices).

Product Backlog

The product backlog will consist of a list composed by the product owner, the team, and various related stakeholders in order to prioritize and formulate a prioritized list of desired features that the product should modify to, it's for repair, and other elements which could potentially enhance the product. The overall content decided in the sprint backlog will be decided based on the features set in the product backlog.

Sprint Planning

Before the beginning of each sprint, a meeting will be held including the team, the product owner, and related stakeholders. The product owner will elaborate on critical items required to be addressed, and a discussion would be made by the team participating regarding what are the goals for the upcoming sprint, and what should take place during this cycle. All items added to the sprint during this discussion will be taken out from the product backlog into the spring backlog. Essentially, the Sprint will be planned by the whole team, not by a project manager. This should spark discussion, and embrace team participation and raise responsibility.

Sprints

Series of events or tasks selected by the team to be executed in the next project cycle, are contained within Sprints. The Sprint's length is predetermined with no changes possible, and could take last for two weeks, a month, or a timeframe that would fit the project and its parameters (different industry will create different needs). The reason for short increments are to better adapt to changing dynamic environments, and would allow the team to adapt with the frequency required (unlike traditional phases which could last for months). Each Sprint will have a certain goal with several deliverables that would needed to be completed by the end of the current cycle. The content of the Sprint (task list) will be also determined by the team as they see fit with guidance by the scrum master and product owner (see below for scrum team), and the cycles will begin. Tasks completed within the Sprints are marked as such, and others will be addressed until the iteration is complete. This will allow for up to date visible information that would help process clarity. During the Sprint, the team is assembled in a single space for better interaction and decision making, as during the task execution there are no exterior intervention (this element will require adaption in the building design and construction project). Creating a a

team in an isolated workspace will encourage open dialog, promote creativity, and will help with resolution of issues in a quicker collaborative manner. This structure breaks a traditional team where a single source project manager assigns individuals within the team tasks. In Scrum there is a product owner who will assist and determine the overall task content of what needs to be completed, but the team self manages these assignments until they are done. The idea is to promote communication and self governing, ultimately creating a more efficient quicker development process. In Scrum, versus a traditional team structure, when executed properly all team members will be aware what others are doing at all times, enhancing knowledge about the project, and will promote resolutions by all team members which are considered a single unit to attempt to complete tasks faster. As the communication effort will improve dramatically, so will the communal effort, as every person more involved will tend to carry more responsibility as he or she will feel more involved personally towards reaching the final goal in a successful manner.

Daily Scrum

In order to keep the team up to date, every morning there will be a meeting where problems will be raised or any other concerns in order to create assure resolutions for outstanding items. Also team members will update their status, and a sense of progression can help the team steer the next steps to assure meeting the Sprint's goals.

Sprint Review Meeting

During this meeting the team will summarize what has been completed, and will elaborate on the new features that were developed during the Sprint. This task should be quick and should not burden the schedule.

Sprint retrospective

In addition to the review meeting there will be a quality assurance process that includes examination of the Sprint performance, and examining certain items that were worked on during the Sprint. The team will provide feedback necessary, aiming to improve the process during the following Sprint. The main idea is to improve performance from Sprint to Sprint, creating an adaptive environment, which allows the team to cope with uncertainties in a better way.

The Scrum Stakeholders

In addition to the Scrum process, another condition is crucial to secure the success of adopting this Agile methodology. The Scrum team helps creating a highly efficient process by minimizing the number of stakeholder roles within a project. The Scrum team as elaborated by Rubin. M. (2013) consists of three main stakeholders:

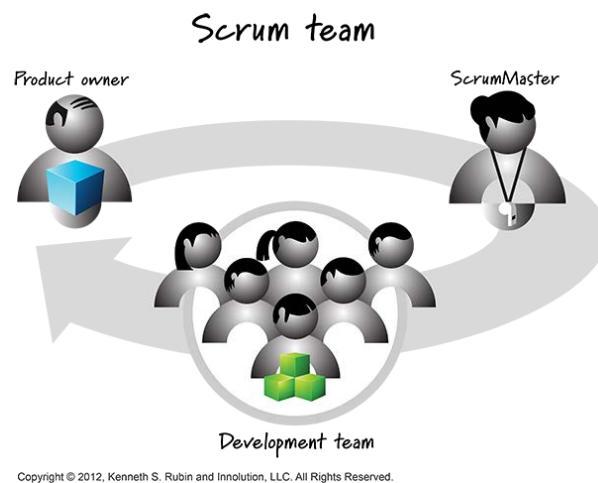


Figure Four- Rubin, K. (2016) Scrum Team (see appendices).

The **product owner**, have certain responsibilities of a project manager found in the traditional method such as responsibility to coordinate with the client, and assure that the goals and aspirations of the project will become indoctrinated within the project team. Also, the product owner along with the scrum master (elaborated next section), will be in charge of

assigning tasks on the sprint backlog, and prioritizing what tasks should be of a priority. The product owner this way can assure the tasks meet the business requirements and the project schedule assigned in a traditional method of the building design and construction project. He or she though, will not interfere with how these tasks are being completed and by whom in the team, but they can assist with coaching and advising to improve efficiency and performance, and assure these tasks will be completed successfully by the end of the Sprint. Tasks that are completed, the product owner will announce their release, and will assign new tasks to the Sprint backlog.

The role of the **Scrum Master** is to assure that the Scrum process is being executed properly with maximum efficiency, with the highest standards and quality to assure the project will be successful. He or she should also provide a quality assurance verification to assure that services or products provided meet the company's standards. The capability of the team executing the tasks will be enhanced by the scrum master which is often present to assist the team. Meaning, the Scrum master acts as a coach, not as a manager and does not have the authority to order the team to do things. The scrum master will facilitate and help resolve issues which can impact the team's effort, and will assure the sprints will be as efficient as possible, but will not have authority over them as explained by Rubin. M. (2013). The Scrum master can guide the product owner also through complex technical Sprint tasks located in a current backlog, and will help prioritize what needs to be assigned to a certain Sprint. He or she will also help to assure a good collaboration between the Scrum team and a product owner. In fact, the Scrum master's main duty is to assure high performance and quality assurance in all Sprint (or iteration) cycles to assure project's success.

The **Scrum Team** which is usually comprising with nine people which fit the number of an architectural team of a large project, will be self organizing, and they will conduct the tasks marked in the Sprint backlog as they see fit according to their priorities. The team characteristics as elaborated in the chapter of the analysis of the literature review, will include motivated individuals with capabilities to adapt quickly, and improvise as needed in order to fit the quick iterative dynamic pace found in Scrum.

Scrum and the Architectural Process

In order to allow the adoption of Agile Scrum to be incorporated within the architectural process during the dense phases in the building design and construction, some adaptation would be required. As seen and summarized in Moriel, R. (figure Two) in page 29, there is lack of a coherent structure between the architects, the engineers, and the consultants. The communication cycles are too bulky, creating the need of dozens of interactions in order to complete a single task extending the overall time required to complete these. Thus, a project organizational structure modification of the project team would need to take place. The differences between the Agile Scrum teams found in the IT industry which includes people from the same discipline such as a software development team, in the Scrum of the building design and construction project a multi discipline team would require to gather, and work together much more often than common in the building design and construction projects found today. Having at least representatives of each of the main engineering trades: structural, mechanical, electrical, and plumbing engineers within the Scrum team can have a substantial impact on the efficiency of the project's progression. These main stakeholders coordinate with architects much more often than just on a daily basis. The whole progression of the work relies on working alongside with these engineers. Therefore, the Scrum team will consist of the architecture team, the main engineers of the project (possible 1

representative for each trade). As consultants may be relevant on occasion and are not needed on daily basis but on specific tasks, they can be added temporarily to the team structure as determined by the Scrum team. Having these disciplines together as a single unit, has the capability of pushing projects ahead in much more efficient quicker manner, unlike the traditional team structure today found on large complex projects. True that there are coordination meetings taking place usually once a week in building design projects found in the traditional setting, but instead of waiting for critical issues to be solved after a week, issues rising up during the sprint will be dealt with possibly on the spot. This will allow project progress in a faster pace than perceived prior to this new team structure suggestion. In terms of client interaction, the product owner will still steer the client coordination in order to promote crucial coherent client communication and effectiveness. In terms of contractor interaction, this will be more efficient but still flexible. The contractor will have the ability to speak to the project team with maximum efficiency as they are all assembled together as a single unit, or have the choice to discuss only with the product owner, allowing him or her to facilitate the information to the Scrum team. This minimizes the communication routes and will allow to adapt the Sprint backlog according to urgency in a quicker adaptable manner. The Scrum master's role as a guide and advisor will be highly efficient because of direct contact with the core team that are in charge of producing the contract documents. As consultants are not needed on any given time of the project, the Scrum team will adapt to incorporate them when needed in peak coordination efforts.

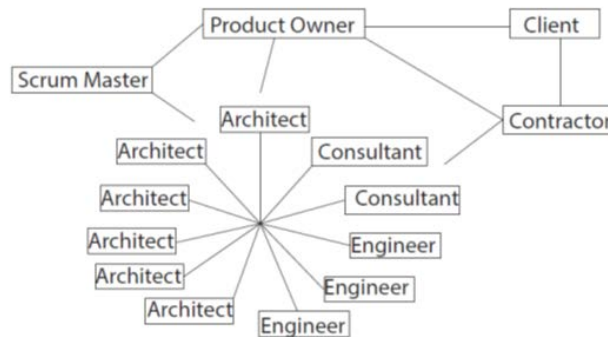


Figure Five- Moriel, R. (2017). New Scrum Team Structure for the Building Design and Construction Industry.

Scrum and the Architectural Design Process - Hybrid Scrum for Architects + Engineering Team (A+E)

Scrum Framework Ceremony	Traditional Scrum	Hybrid Scrum For Architects + Engineering Teams
Product Backlog	Features or Requirements list desired for product.	determining overall goals for quality, deliverables definition of A+E work performance , Projected obstacles, Redefining Programming phase type feedback.
Sprint Planning Meeting	Meeting to prioritize features list & changes for upcoming sprint.	Discussing overall objectives in hierarchy and prioritizing tasks required for spring backlog.
Sprint Backlog	List of tasks to be completed in the sprint.	List of tasks to be completed in the sprint.
Sprints	Fixed duration cycles Usually 1-2 weeks.	Fixed duration cycles Recommended 2-4 weeks.
Daily Stand-up	Daily meeting to follow up on status, and adapt as necessary.	Daily meeting to follow up on status, and adapt as necessary.
Sprint Review	Accomplishment review, demonstration of new features (briefly).	Quality control of production of sprint content (of added documents and design development).
Sprint Retrospective	Feedback on sprint performance, evaluation and lessons learned for improvement.	Feedback on sprint performance, evaluation and lessons learned for improvement.

Figure Six- Moriel, R. (2017) Scrum Process Comparison Chart

The overall layout of the Scrum framework is suitable for the building design and construction projects, however, some modifications are required (see figure six above for comparison). As the architectural team will now work alongside with at least one engineering representative from each trade within the Scrum team, these new team dynamics will need to undergo constant questioning, and discussion regarding how to improve this close collaboration. In the **product backlog** stage, if in the traditional Scrum team developing an IT software or other tech product, the features will be determined and goals related will be decided, the Hybrid Scrum for A+E (architects + engineers) will be to determine the overall quality of the work that needs to be performed. This will help the team understand the overall effort and time that is required to be made for each task. To decide product features is not as focused and relevant in the architectural process, but what can be done is a programming phase level discussion, to see how the current building design can be pushed ahead and improved. This discussion will involve how to remove elements that are wasteful to project resources, and raise questions regarding project resources efficiency. In fact, the product backlog phase is a means to re-question the holistic elements of the projects, something that usually does not occur after the programming phase in the traditional setting. After understanding better the overall approach and goals of the project, the Sprint should be outlined with more efficiency.

The standards and overall deliverables discussion made in the product backlog phase should help the team to decide during the **Spring planning meeting** on current burning tasks that are a priority. This will be done by identifying overall issues that currently requires attention and to be resolved to allow for the project's progression. Essentially the team will decide together on the hierarchy and priorities of current project's issues and understand its status. This

informative meeting will help understand how these tasks should be executed and the different parameters involved.

After the team's understanding regarding the current situation of the project, the extents of steps ahead in terms of quality, time per task, and other useful information that will shed light on the operation required to execute the next Sprint effectively, the team will create a list of tasks in the **Sprint backlog**. During the **Sprints**, although there will be a better project development pace with the Scrum Hybrid comparing the traditional method, some tasks are complex in large building projects, and would still require time to execute. Therefore the Sprints should be longer than of the traditional Scrum such as for IT software projects, where a specific feature will be tested and developed. In the building design project, several tasks will be executed in parallel, and therefore it would be better to allot the Sprint time from 2-4 weeks instead of half the time typically used in the traditional Scrum. The **Daily Stand-up** stage will be similar to the traditional Scrum where the team will assess and assure it is updated with project's status. It is important that this information will be discussed by the whole Hybrid Scrum team. In the traditional Scrum, the **Sprint review** is meant to discuss and understand new software or product features. In the Hybrid Scrum, there should be a quick assessment of what was produced, and assess the quality of the new work. This will help to question current production and issues related, and will allow the team to resolve these problems on the spot instead of waiting for the Sprint to complete before these are noticed and addressed. This stage will provide for a crucial quality control that lack in the traditional project execution at many times. The **Sprint Retrospective** in the Hybrid Scrum should match the characteristics of the traditional Scrum as it is a viable stage to assure improvement on future Sprint performance. It will help the team adapt to new conditions and will assist with Sprint completion successfully.

Kanban Addition to the Scrum Hybrid

In order to increase the efficiency of the workflow of the team during the Scrum Hybrid, another element of Agile will be added. Kanban is an a project execution tool that helps to create project information management for the team. It helps clarify the current project processes by visualizing the workflow in via Kanban boards. By adding a simple board with sticky notes, discussing the different tasks and elaborating on this status or situation, the team can easily reference current project status. This is a very simple and important tool to increase team communication and understanding of project status as discussed by Carmichael, A. Anderson, D. (2016). In terms of adapting it to the Scrum Hybrid, it would be efficient to add columns of the different Scrum Stages: Product Backlog, Sprint planning meeting main points, Sprint backlog content, daily stand-up summary, Sprint review summary, and sprint retrospective conclusions. Having this viable information will assure the team is fully aware of project status, and will maintain high participation levels.

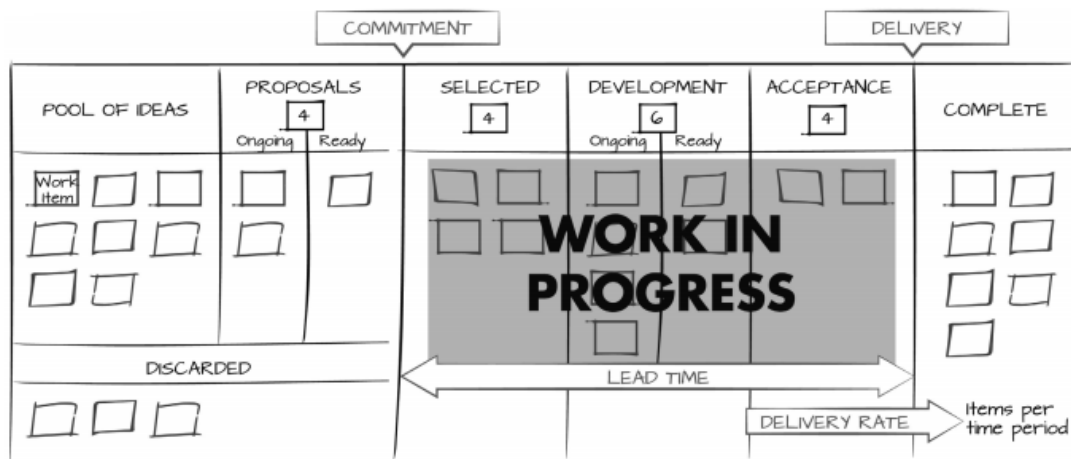


Figure 7 - Carmichael, A. Anderson, D. (2016). Kanban Board Example - Visualizing the Workflow

Conclusion

The traditional waterfall method that is used in the building design and construction projects fails to adapt to communication and coordination intensities found in contemporary large and complex projects. As many industries today have adapted their project management methodologies to fit dynamic, quick paced conditions with adopting Agile, the building design and construction industry should do the same, as current processes used tend to lack effective performance. This thesis paper illustrated how Agile Scrum could be a good fit in some aspects of the building design and construction projects, and help enhance the progression efforts by changing current team structures, and adopting new processes that help improve communication routes that are necessary in order to accomplish the completion of tasks and deliverables in a more efficient manner. By creating a Hybrid Scrum process, using a Kanban visualization technique, the team's processes will become quicker and more effective in order to carry out the various tasks that are required in the building design and construction projects. This paper does suggest to replace the overall structure of the building design and construction projects, but merely suggests to adapt it and enhance some of its processes, specifically in the intense phases where it is needed.

Recommendations of Future Work

As very little literature currently exists regarding the implementation of Agile in the building design and construction industry, more theoretical research is required in addition to conducting experiments in practice in order to develop a highly efficient interaction processes required between the new proposed design team (architects, engineers, consultants) in the Scrum Hybrid. Also, further studies are required to elaborate on specific roles and responsibilities to assure that the scrum master and product owner do help implement the Scrum Hybrid with

success. More research and analysis of this could help understand how Scrum should be better be adapted to serve this new project structure and perhaps more guidelines can be developed and written in order to help architects with the adoption process which is completely alien to the industry. Another important area that should be explored, and was not covered by this paper is the adoption of Agile on the contractor's side. The construction team has a large portion of work involved in the building design and construction industry and not much is known regarding Agile's influence on the contractor and their work.

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Appendices

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