Transforming Infrastructure Projects Using Agile

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Abstract. Traditional project management processes, also referred to as waterfall processes, have been used for decades to manage infrastructure projects. Agile project management, first introduced by the software industry, and known for its adaptability, targets projects delivery using an iterative and/or incremental approach, thus improve project delivery time and cost.

This research paper explores how road infrastructure projects, historically reliant on traditional project management processes, can attain benefits using the Agile set of principles and methods. With current challenges, high uncertainties and ever-changing and evolving customer requirements, there needs to be a more adaptive approach to managing and delivering road infrastructure projects to address changes in a timely and effective manner, while fostering collaboration among stakeholders. Agile can address these challenges by utilizing cross-functional teams which rely on retrospectives and continuous feedback from customers to improve team performance and enhance project outcomes and product delivery. The full benefits of Agile can only be exploited if there is a supporting organizational culture and active leadership participation.

Keywords: Road infrastructure projects · Agile project management · Traditional project management · Adaptability · Agile teams · Siloed teams · Retrospectives

1 Introduction

Traditional or predictive project management methods have been used for decades to manage Infrastructure Project, which rely on sequential phases and separate teams for the planning and execution of project work. Using these project management methods, the construction industry has focused on delivering projects by meeting scope requirements, however less attention has been paid to the policies and mechanisms required to enhance coordination, avoid costly delays, improve project communications, and ensure effective delivery practices. Additionally, the majority of infrastructure projects stakeholders are not actively involved in the pre-planning and planning phases and, to an extent, during the execution phase of the projects. Infrastructure projects are faced with cost-overruns, schedule delays (Han 2013a), lack of effective data sharing and miscommunication among different teams. These result in conflicts, increased risks and dissatisfaction of stakeholders, and may require project mediation,

and/or litigation. However, due to the importance and critically of infrastructure projects, especially road construction projects, there is little to no tolerance for delays since these projects are highly regarded and valued projects. Their main purpose is to serve the transportation needs of the economy by facilitating the continuous movement of people and goods thus, benefiting the community and impacting the quality of citizens 'daily life. Therefore, there is a need to implement a project management methodology that can continuously and effectively address project stakeholders' needs, enhance decision making, foster better communication and coordination among team members, and enable project plans updates without time-consuming processes of Traditional Project Management (TPM).

Agile Project Management (APM) has been used successfully in the software industry to improve product delivery times, enhance team coordination and stakeholder communication through short and continuous feedback loops. Self-organizing, cross-functional teams which is a main characteristic of APM enhances a team's ability on reaching critical decisions without having to go through the hurdles of the decision-making hierarchy within siloed organizations. Additionally, retrospectives which allow team members to continuously improve team performance enable for faster project delivery and meeting stakeholders' expectations.

2   Agile Project Management (APM) Defined

Agile as a movement started in 2001 with the release of the Agile Manifesto (Beck et al. 2001), which includes a set of values and principles that focus on delivering continuous value to customers as the primary goal of work (Denning 2018). Agility is "the ability to both create and respond to change in order to profit in a turbulent business environment. Agility is the ability to balance flexibility and stability" (Highsmith 2002a). It can also be defined as "a project management methodology that relies on short development cycles in order to focus on the continuous and fast improvement of the newly developed product or service" (Mohamed and Moselhi 2019a). In Engineering, Agility refers to the ability of a system to rapidly adapt to market and environmental changes in productive and cost-effective ways (Sharifi et al. 2001). The main priority of Agile is the customer or end-user satisfaction. Therefore, the focus of Agile is doing and not documenting. (The Project Management Institute et al. 2020).

Similarly, Agile project management is defined as the ability to respond in a timely and effective manner to both anticipated and unanticipated changes created by customer and competitors. To be able to respond effectively to changes, the project team needs be innovative, adaptive, has the required knowledge and be accountable. Agile includes several frameworks that have been developed over the years such as Scrum, Scrum of Scrum, Extreme Programming, and Agile Unified Process. With Agile, less planning is done upfront. The project team plans and replans as more information becomes available from review of frequent deliveries. (Agile Practice Guide 2017a). Two main characteristics of Agile are 1) self-organizing, cross-functional teams, which consist of team members with the skills necessary to produce a working product, and 2) retrospectives which help the team to learn from previous work on a product or a

process (Agile Practice Guide 2017b). Self-organizing, cross-functional teams are involved in project work from inception to completion. The composition of the team which should include members with all the skills necessary to produce a working product can streamline the delivery process of the project without having to go through the hurdles of siloed teams.

While Traditional Project Management (TPM) can be defined as "the project management techniques predominant today, that is, the method focused on centralized decision making and control within a hierarchical organizational structure. TPM has been proven successful in projects whose solutions can be relatively defined, scoped, and estimated (both time and cost)" (White 2008). It follows a more linear approach, where the majority of the planning is completed upfront. Any changes in the project management plan follows a very definitive, structured, and lengthily process which goes through different departments or entities. Planning is an essential part of TPM and APM, however, the difference lies in how much planning is done upfront and who is involved in the planning process throughout the different stages of the project. Table 1 provides a comparison between APM and TPM.

Table 1. Comparison between APM and TPM

Agile Project Management (APM)	Traditional Project Management (TPM)
Relies on cross-functional teams	Relies on siloed teams
Welcomes and accepts change	Avoids change whenever possible
Quick response to change	Slow response to change
Proactive response to uncertainties	Reactive response to uncertainties
Allows for continued innovation throughout the project	Planning is done in greater detail at the beginning and execution is done according to plan
Constant customer interaction	Less customer interaction
Retrospectives during project work	Lessons Learned after completion of project

3 Utilizing Agile Project Management for the Enhancement of the Construction of Road Infrastructure

Infrastructure projects especially road projects affect millions of people every day. Road construction is presumed to have an important impact on population and urban development. It affects multiple stakeholders, which can lead to significant changes in adjacent areas. (Khanani et al. 2021). Therefore, the importance of roads as essential economic arteries that connect people and trade routes and the value derived thereof cannot be overemphasized.

A traditional road infrastructure project follows a linear and sequenced process. Each stage of the project is handled by its own team. The majority of the planning is done upfront and in greater detail. An agile project is designed to be more dynamic and

adaptive to change. It shares the same characteristic of having deliverables clearly defined with a traditional project. However, the adaptability and dynamic nature of the agile project allows for a quicker reaction to address changes and uncertainties which allows for project work to be completed seamlessly through each project stage.

Due to the criticality of road construction projects, delays are not tolerated, however, they occur often. Some of the main causes of delays are change orders, rework due to error in design, ineffective planning, mistakes in the design documents, and delay of obtaining permits, (Han 2013b).

Agile relies on a set of principles and methods that can be applied to different stages of road construction. These set of principles and methods can help manage the design and construction of different processes and activities. Empowered self-organizing, cross-functional teams, which are at the core of Agile Project Management, can help alienate the hurdles of siloed teams and organizations. Cross-functional teams on road infrastructure projects can include designers, architects, engineers (traffic, civil…etc.), contractors, consultants, subject matter experts and other stakeholders as appropriate and necessary. The composition of the team allows for more innovative solutions to design and construction problems even before the actual start of the construction phase of the project. Highly iterative and incremental processes of Agile Project Management allow the project team to constantly evaluate the evolving product, revisiting plans, reviewing designs and getting immediate and continuous feedback from the stakeholders or customers. This enables the project team to constantly enhance the construction plans which provides greater value to the customer or end user.

Diverse team members can also address changes in a timely manner without the need to go through the structured change request process that TPM supports. These teams can work in shorter and iterative sprints. These sprints "enable the teams to quickly test and adjust ideas, minimizing risk of miscommunication or overdesign…. These principles can be applied across the project life cycle—concept selection, engineering and procurement, and construction and commissioning—to compress schedules and improve productivity while maintaining safety and quality performance." (McKinsey 2020a). During the pre-planning and planning stages, team members can prioritize the features required for the project and what decisions are required. Additionally, these teams have the capability of reducing the time needed to reach a decision due to the availability of individuals responsible for these decisions on the team. This approach can help improve communication and data sharing among team members, reduce the time required to finalize the project plans as well as provide more time for value engineering, which in turn can reduce project costs. A recent report released in 2017 shows that it would be easy for team members to reduce cost by 30 percent by moving to different designs or having the authority to actively participate in the decision-making process regarding those designs. However, if they are given those designs already, rather than being able to influence them, they will have to deliver the more costly project. (McKinsey and IRF 2017).

Figure 1 displays a suggested framework on how to transform the construction management of road infrastructure projects using Agile. It also displays how traditional teams are managed, which provides a comparison between the two methods of managing road infrastructure projects.
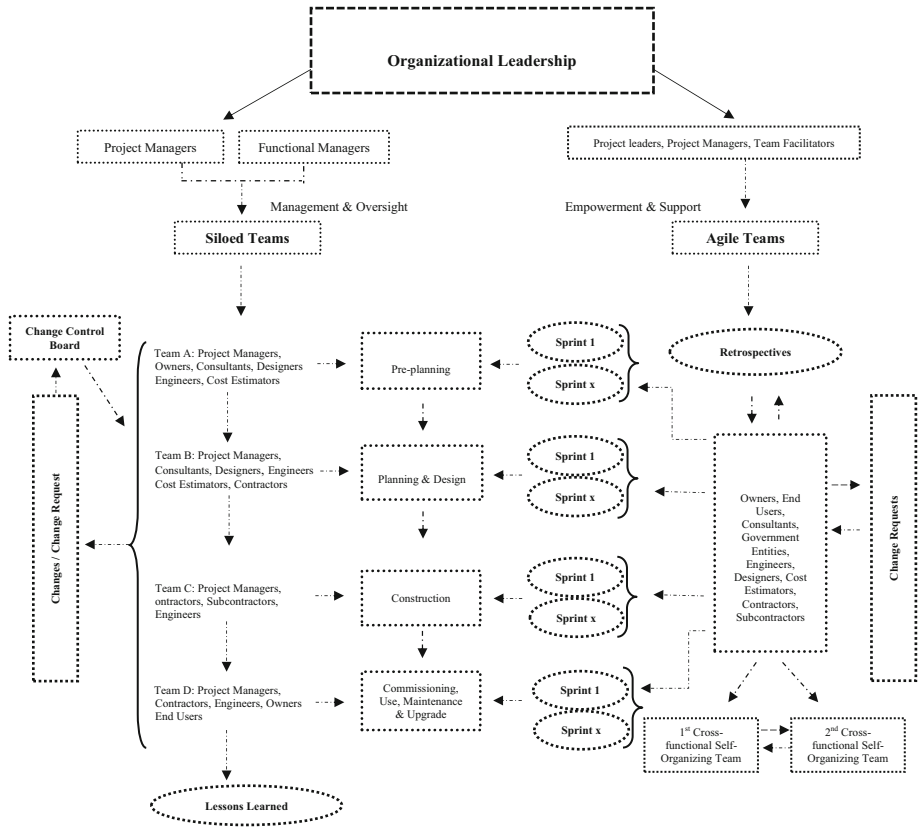
Fig. 1. Suggested framework on how to transform the construction management of road infrastructure projects using Agile

4   Discussion

The main idea of the framework is to utilize self-organizing cross-functional teams during the different stages of the project. On Agile Projects, project managers, team leaders or team facilitators are tasked to remove any impediments to attain project objectives, facilitate the day-to-day activities of project team as well as taking care of documentation (Highsmith 2002b). Their role is to make sure that the team members are dedicating their full time to project work without having to deal with regular formalities. The planning and decision-making exists within the sphere of the agile team. Therefore, any change or change requests are handled by the team members promptly. Eliminating the structured change request process of traditional projects can save time. The key factor for the success of these processes is the composition of the team, i.e., the team should have the members with the required expertise in their respective areas to be able to address challenges and changes and reach decisions about them in a timely manner.

Traditional siloed teams follow a very structured management and work process, where teams are working in stages and are separate from each other. Agile project teams are cross-functional self-organized teams that include specialists from different disciplines who can work together without having to move a work process from one team to another. The active involvement of end-users or customers with the team allows for more frequent feedback and better communication which enables the team to enhance design plans or procedures.

The suggested framework follows in part the scrum methodology which utilizes sprints for the pre-planning and planning stages of the project. These sprints are time-boxed iterations that are designated to tackle design challenges faced by the team. The framework also allows for utilizing the Scrum of Scrums or Meta Scrum method for teams to cooperate more efficiently. This method can be used when two Scrum teams need to coordinate their work instead of one large Scrum team. "Daily stand-up meetings are conducted among representatives of each team two to three times a week. During these meetings, each representative reports the completed work, next set of work, any current impeding elements, and potential upcoming impediments. The goal is to optimize the efficiency of all the teams. Larger projects may result in a Scrum of Scrum of Scrums, which will follow the same pattern as a Scrum of Scrums." (Mohamed and Moselhi 2019b).

During the construction phase of the project Agile principles and methods can be applied by relying on small work packages which allow for better integration into the overall design and which in turn enable the team to work in sprints that can last for up to two weeks. Smaller work packages allow for "detailed tracking and application of learnings from earlier packages" (McKinsey 2020b). Contractors and Engineers can also utilize Agile principles and methods by making construction processes more measurable and manageable to improve the ability to respond and adapt to changes on the job site, by reducing the time needed between when a risk is detected and when it gets addressed. Utilizing cross-functional teams during the construction stage of the project can help eliminate the silos between the different disciplines, hence effectively manage work packages until completion. The same methodology could be applied to commissioning, usage, maintenance and upgrade of road infrastructure projects. Small, highly efficient cross-functional teams can effectively address changes or challenges that arise during this stage.

Teams working on traditional projects are usually assigned part-time to different projects. However, applying Agile requires the full dedication of project team members. Therefore, they can be fully assigned to a project for weeks and not partially for months or years as with TPM. This can enhance productivity and shorten the time required to complete the project. Meeting twice to three times weekly is highly recommended.

The use of Retrospectives can serve as way of learning from past performances to enhance future performances or as a learning opportunity for all team members. Retrospectives thus enhance accountability and shared responsibility among team members. Retrospectives can be done at specific intervals or when the team feels it is necessary to do so. Retrospectives allow for a continuity of the learning process and performance improvement. Along with continuous interaction with the customers,

retrospectives can help the project team to realize the points of strengths or weaknesses in processes or team performance, and work on improving them in a timely manner.

One of the key factors of Agile success in the construction industry is having a well-trained, empowered and highly motivated workforce. Therefore, training is needed to ensure that team members understand what is requested from them. Knowing and understanding the value-driven agile mindset is essential when working on agile projects.

The success of agile teams can never be realized without the support of organizational leadership. The redefined roles and responsibilities of project managers or project leaders on agile projects can be met with resistance from traditionalists. Organizations can utilize change management techniques to a systemized adoption of Agile into road construction projects. Hiring calibers and providing agile training to employees are key success factors for the agile projects to succeed.

5   Conclusion

APM is a tried methodology that has been proven successful within the software industry. The construction industry is lagging when it comes to the full adaption of APM due to the fact that TPM has been long used within the industry. In addition, the construction industry is known for its slow adoption of new technologies and techniques. APM can help change the way project team work on road infrastructure projects, due to their importance and impact on a wide spectrum of stakeholders. Companies can successfully transform road construction projects by having a well-trained, empowered, and highly motivated workforce, which increases responsiveness to changes and challenges during the different stages of project, enhances team productivity, reduces cost and time required to deliver the project hence providing the highest value to stakeholders. Organizational leadership support is essential for the implementation of Agile. It is essential for managing the adoption of the Agile methodology and transforming traditional teams to be more dynamic and agile.

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