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AGILE DESIGN MANAGEMENT – THE APPLICATION OF SCRUM IN THE DESIGN PHASE OF CONSTRUCTION PROJECTS

Selim Tugra Demir[1], and Patrick Theis[2]

ABSTRACT

Design phases of construction projects are usually planned and executed using the waterfall model. This type of planning technique is appropriate for checking the feasibility of a project, but not necessarily for managing the work. A dynamic environment requires an iterative management system based on short cycles and rapid feedback loops in order to continuously arrive at the perfect solution. This requirement has resulted in the development of Agile Design Management, which is the adaptation of the Scrum approach into the design phase of construction projects. The goal of Agile Design Management is to increase coordination, interface management, collaboration and transparency throughout all design phases. This paper is an implementation report, also covering theoretical background. Case study data of five projects – as well as images and workshop findings – will be presented and discussed. The success achieved as well as the challenges still remaining will also be examined.

KEYWORDS

Agile, agile design management, Scrum, lean design, waterfall model.

INTRODUCTION

For more than 15 years, Drees and Sommer has been implementing Lean Site Management [LSM] in the execution phase of construction projects. In the meantime, the company has successfully implemented LSM in more than 200 projects worldwide. This has resulted in significant acceleration of construction processes and a reduction in project execution costs of up to 30%. Although the execution phase of construction projects continues to improve, Sommer (2016) identified that the design phase of construction projects is still characterized by:

- Multipage, confusing schedules
- No common understanding of task sequence
- No understanding of other project participant's tasks

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- Delays in planning and information flow
- Long approval processes
- Misconceptions
- Unnecessary functions
- Design failures
- Continuous changes
- Incomplete design deliverables at the end of the design phase

Even if these problems are attributed to the complexity involved in the development of construction projects, there is clearly a need to improve design.

Given this background, Agile Design Management [ADM] has been developed to address the above-mentioned problems. ADM was derived from 'Scrum', an agile management method for software development. The goal of ADM is to increase coordination, interface management, collaboration and transparency throughout all design phases. However, the scope, fragmented teams and complexity of construction projects – particularly during the design phase – do not allow direct adaptation of Scrum from software development. To counteract this, a multi-scrum approach was developed that systematically adjusts to the project organisation and structure. This paper discusses the successful development, implementation and application of ADM. This is followed by a description of the success stories and current challenges in practice.

AGILE IN DESIGN?

The following sections describe how ADM was developed.

THE WATERFALL LEADS TO FREE FALL

Conventionally, all phases of a project are planned using the waterfall model. This type of scheduling is the current best practice, particularly in project management. Ideally, the waterfall model consists of a sequential process in which the scheduler or planner forecasts all activities prior to project start. But the result can only be seen – and therefore evaluated – at the end of the phase. Transparency can be increased by integrating reviews during the phase. However, systematic and structured response to changes is still difficult. There is a clear correlation between change, cost and time. For this reason, the waterfall model is superior to the representation of the critical path or to checking the feasibility of a schedule. The waterfall model is not suitable for managing work and tasks in the design phase, especially in the early stages, such as preliminary design. Forecasting design work prior to project start is challenging, because the design is very vague during the initial stages. Design evolves over time: Only in later project phases does it become clearer what is to be executed or implemented. Early design phases, in particular, need strong coordination and integration. Applying the waterfall model in such dynamic and uncertain environments as early design phases results in most of the processes or disciplines going hand-in-hand, that is, in numerous parallel processes. This in turn transforms the waterfall model into a so-called 'free fall'. This is illustrated conceptually in Figure 1.

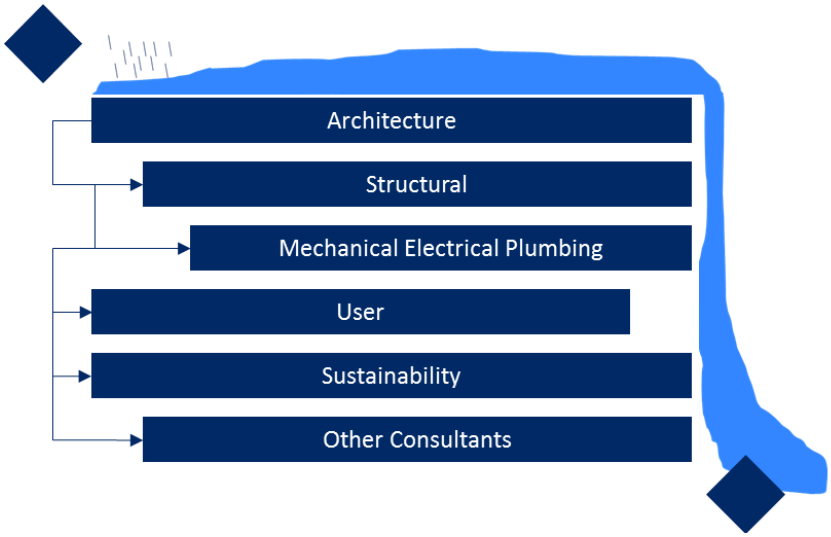

Figure 1: Free fall in the Design Phase

Figure 1 illustrates the difficulty of applying free fall using conventional tools and techniques. It lacks transparency and is unpredictable. This unpredictability results in changes, which in turn cause a dynamic environment. Uncertainty is very difficult to manage with conventional management methods, such as the waterfall model. Adding the high number of design activities and the range of fragmented design disciplines increases the complexity of construction projects during the design phase. For this reason, the current best practice, which attempts to plan design sequentially, is not compatible with the dynamic iterative environment of the design phase.

ITERATIVE VS. LINEAR

The time for a change in the design process is long overdue. The current 'best practice' must be set aside in order to identify the next practice. In the search for the next practice, Agile Management methods have attracted a great attention in the past (Koskela and Howell, 2002a; Koskela and Howell, 2002b; Koskela et al., 2006; Owen and Koskela, 2006a; Owen and Koskela, 2006b; Owen et al., 2006). The commonality between design in construction and software development lies in their iterative character. In a manner similar to the planning of construction projects, IT development projects use an iterative approach (ibid.). This is illustrated in Figure 2.

The figure below shows the procedure for iterative projects in software development (Wysocki, 2006). As in the design phase of construction projects, a version is progressed and submitted to the client. The client (or their representative) provides feedback. The feedback is then incorporated. In the ideal case, the iterative cycle or this feedback loop continues until the client is satisfied. It has, however, been recognized that current management techniques do not enable project success in software development. Lindstrom and Jeffries (2004) explain that this is because conventional project management methods – such as the waterfall model – improve coordination, but reduce variability and consequently customer satisfaction. Moe et al. (2010) explain that Agile methods have

replaced the goal of optimization from conventional models with the goals of flexibility and responsiveness.

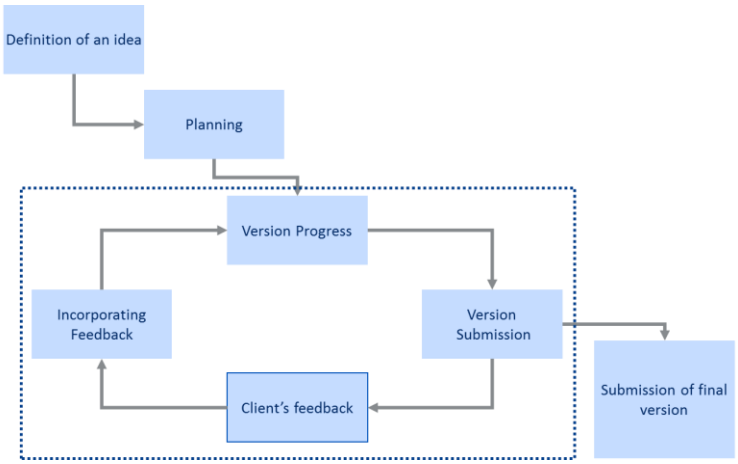

Figure 2: Project life cycle of iterative projects (adapted from Wysocki, 2006)

Agile practices are agile, because they embrace changes, which add value (Hass, 2007). This agility is achieved through feedback loops (Wysocki, 2006), because Agile methodologies assume that variability cannot be reduced, therefore the aim is not to minimize or eliminate change (Highsmith and Cockburn, 2001). Hence the feedback loop allows flexibility and responsiveness, resulting in the ability to respond to change in a systematic and structured way (Hunt, 2006). These feedback loops are called 'iterations' (Chin, 2004; Hunt, 2006; Wysocki, 2006; Fernandez and Fernandez, 2008; Moe et al., 2010; Dingsoyr et al., 2012). The iterative concept of Agile results in a different project life cycle model, as illustrated by Wysocki (2006) in Figure 2 above. In the execution phase of construction, it is desirable to have rigid and stable processes with few changes. However, design is much more uncertain, therefore it is desirable to be agile or flexible to enable systematic and structured response to change. Agile methods focus on the team as an important expertise factor, with the aim of satisfying the client and embracing change (Chin, 2004; Hunt, 2006; Dyba and Dingsoyr, 2008).

WHAT CAN CONSTRUCTION DESIGN LEARN FROM RUGBY?

The 'Scrum' is able to satisfy the requirements described above. Moreover, it is the most widely used agile management method in software development and is already used in other industries (Hecker and Kolb, 2016). Scrum is a term in rugby. It is a way of restarting play after the ball has gone out of play. The inspiration for naming the methodology Scrum came by an article by Takeuchi and Nonaka (1986), in which they compared these modern methods with rugby. Scrum was developed by Schwaber and Sutherland (Schwaber, 2004). There is a wealth of literature on Scrum (see for example Schwaber, 2004; Hunt, 2006; Fernandes and Sousa, 2010), and information on the methodology of Scrum can be found there. Figure 3 shows how Scrum works and on which Scrum artefact problems can be found when applied directly to the design phase of construction projects.

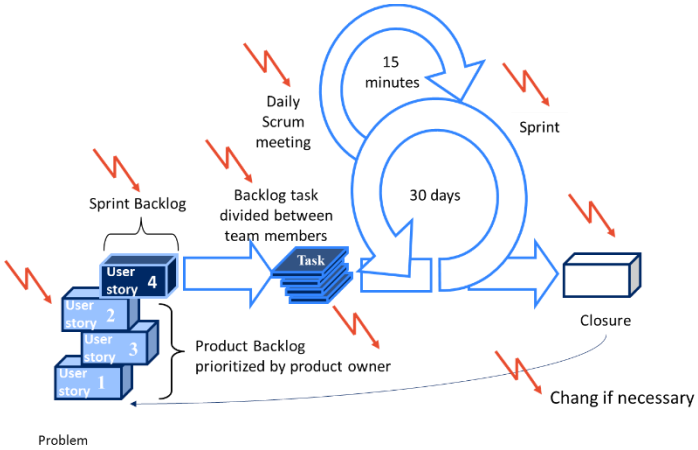

Figure 3: Problems with the direct adaptation of Scrum to the design phase of construction projects

As shown in Figure 3 there are various problems when Scrum is applied directly to the design phase of construction projects. Firstly, it is unclear who the product owner is. If it is the client, the ability to prioritize user stories is debatable. Secondly, in a design phase, there are various deliverables, work packages and tasks. The detail of the user stories in the backlog is unclear, as are the tasks on a Scrum Board. The whole process can become confusing and messy with work packages and tasks. Planning teams usually consist of a range of different disciplines. It is recommended that Scrum not be used with more than 20 team members. This limit can be quickly exceeded even in small construction projects (investment less than €10 million). In addition, the planning teams work in different places, so it is difficult to meet for the daily sprint. Last but not least, design changes are not welcome. With conventional and common design approaches it is almost impossible to divide the project into modules that enable independent processing. Changes are nearly always large in scope and result in increased work for the designers. Even though there are modern approaches such as modularization and standardization, the number of projects applying these approaches is relatively low. It can thus be concluded that the Scrum approach from software development cannot be transferred directly to the design phase of construction projects. It requires adaptations that retain the fundamental principles in a way that the approach is tailored for the design phase of construction projects. The focus needs to be on agility.

AGILE DESIGN MANAGEMENT

Given that the design phase of a construction project is a dynamic environment, an iterative methodology using takt-based work distribution allows complexity to be reduced. This can in turn result in greater effectiveness and efficiency. Even though direct transfer of the Scrum method is not possible, indirect implementation or adaptation can solve many current problems in the design phase of construction projects. Figure 4 illustrates the methodology of ADM.

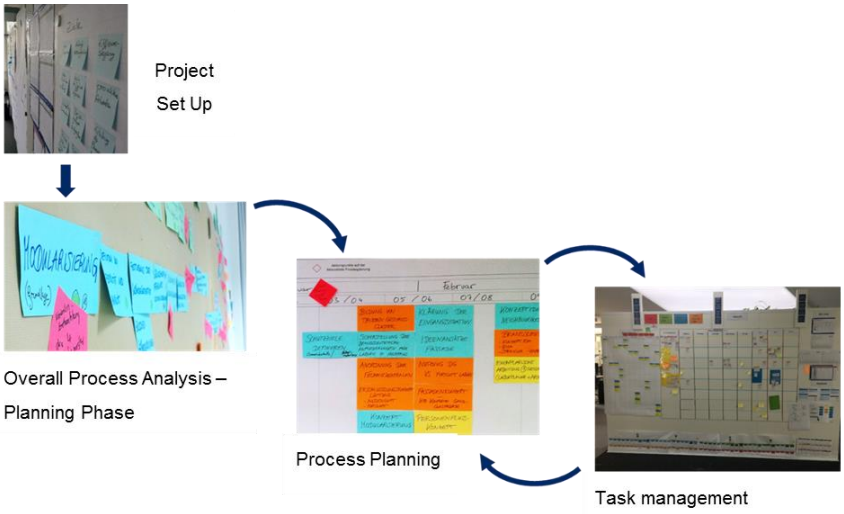

Figure 4: Agile Design Management

Well-known scholars of the IGLC community have provided initial concepts for the potential adaptation of Agile methods from software development into the design phase of construction projects (Koskela and Howell, 2002; Owen and Koskela, 2006; Owen et al., 2006). Previous work established that Agile management methods from the IT sector can be applied to construction design, but not to the execution phase (ibid.). However, none of this research has provided practical approaches for implementation. This gap will be addressed by discussing the methodology of ADM in the following sections.

PROJECT SETUP

Those who want to use Agile need to become agile first (Knittel and Seckinger, 2014). Existing rigid structures do not support the implementation of any Agile methodology. Information flow and instructions must be organized to be in the right place at the right time with the right level of detail. Therefore, the first step is to integrate ADM into the existing structures. In a workshop, the existing project organization is divided into four levels as follows:

Decision-making body

Project management

Planning team

Workgroups and technical planners

The required methods and tools and their level of application are then defined. Depending on requirements, the focus can either be on a design team or on providing a comprehensive solution for the whole project. The results of such a workshop are illustrated in Figure 5:

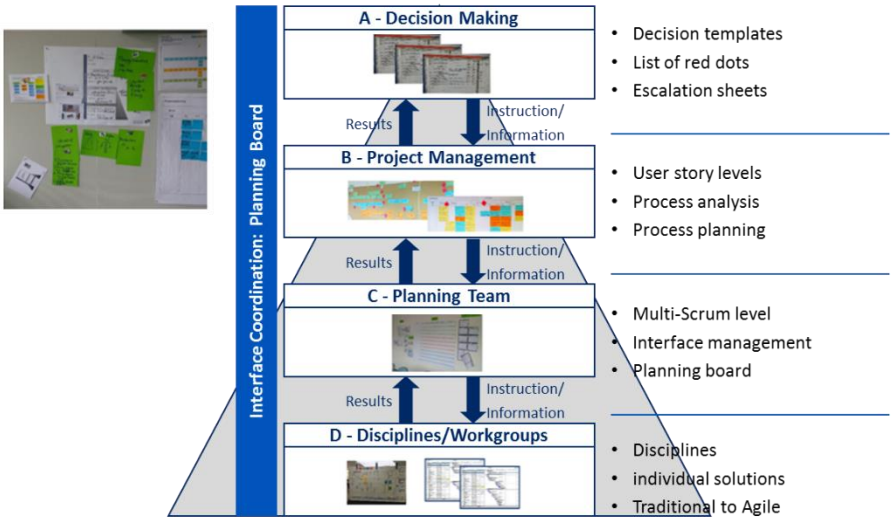

Figure 5: Adaptation of the organizational and operational structure

The levels and the related meetings and workshops are scheduled in a takt-based manner. In the example above, the following meetings were held: a steering committee meeting every three months, a process planning meeting (to identify and prioritize the work packages) every four weeks, and a design team meeting (in front of the planning board) biweekly. In this case study, the planning board – which is derived from the Scrum board – is applied at the design team level. Individual solutions were suggested by the workgroups and technical disciplines. One team agreed to use a planning board and another insisted on using the conventional schedule. This is associated with cultural change. It takes time for all designers to get used to managing and organizing their work with ADM and with their own individual planning board. However, projects usually have tight schedules, so in this project it was optional for the workgroups and designers.

Overall Process Analysis of the Planning Phase

When using the conventional Scrum method, the user stories are defined by the product owner. Unlike software development, design requires a number of experts to design the various properties of the object. The increasing demand for technology in construction projects leads to greater fragmentation and complexity. This makes it very difficult for the client or their representative (project management) to define the user stories.

To solve these problems and define the user stories, workshops with subproject leaders are held to select the content of work packages. The overall analysis of the planning phase process is simply the identification of work packages. These are then roughly prioritized in the same workshop. Examples of work packages are ‘coordination of shafts’ and ‘determining the degree of modularity’. Prioritization of the work packages is performed during process planning.

Process Planning

Process planning defines when each of the work packages must be completed. The prioritization of work packages is done using a time reference. This is usually done every

three to four weeks in a workshop with all subproject managers, but workshop frequency is determined by the project participants according to requirements. An overall review updates work packages and checks their end dates. The result of such a workshop is illustrated in Figure 6. When undertaking this workshop for the first time, it is remarkable that the completion dates for work packages are usually chosen to be either at the beginning or at the end of the phase. There are normally no submissions between the start and the end of the phase. This then leads to bottlenecks and transforms the waterfall into free fall, which may result client dissatisfaction. Once the initial results are available, the work packages are scheduled in a takt-based manner, the buffer is eliminated, and interim reviews are integrated. This creates greater agility, allowing the planning team to deploy their own resources better. In addition, action points are identified and included in the 'Red Dot List', which shows issues and risks. The results are then digitized and sent to all the participants.

Figure 6: The result of Process Planning

TASK MANAGEMENT

Each work package has a workgroup. The workgroup defines the related tasks based on the prioritized work packages. The content of the work packages is flexible and can be changed at any time. This is because new tasks may arise as design progresses and existing tasks may become redundant. For this reason, the content of work packages is defined and displayed on the planning board.

Unlike the conventional Scrum in software development, it is very difficult to hold daily meetings for construction design. The different disciplines are usually at different locations.

However, when introducing ADM, the designers have to meet for at least two days in an office provided by the project owner, where the multidisciplinary meetings can be held in front of the planning board. Figure 7 shows such a meeting.

The duration of meetings is immediately reduced. For instance, within the preliminary design phase of a plant project, the regular meetings were cut from five hours to one. This is due to the systematic structure of the meetings. The meetings at the planning board are process-focused. They only deal with tasks that currently have issues. These are marked with a red dot. This high level of focus makes the regular meetings more effective.

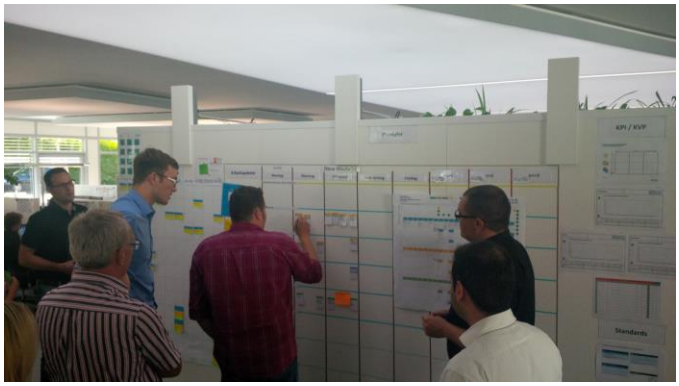

Figure 7: A meeting at the planning board

RED DOT SESSION AS A RETROSPECTIVE

Instead of having discussions on lessons learnt, in ADM the retrospective includes a 'Red Dot Session'. The results of the sprint – such as drawings, reports and visualisations – are printed and presented. All project participants are invited and they have the option of giving their feedback using red dots. A red dot may refer to a problem, a comment, or an action. The results are recorded and the minutes of the Red Dot Session form the basis for the next design phase, for example from the preliminary design phase to basic design phase.

CONCLUSION

By implementing ADM the following improvements were achieved: transparency of in-progress and completed tasks and work packages, collaborative planning of design, joint prioritization of work packages and related tasks, better identification and communication of problems and risks, integration of users and technical departments, coordination of various design disciplines between themselves, rapid escalation of problems through recurring coordinated meetings, increased team motivation through transfer of greater responsibility especially to junior and unexperienced designers, reduction of employee workload and better deployment of resources thanks to takt-based scheduling, and the right level of information at the right time in the right place. ADM uses the principles as well as the artefacts of traditional Scrum. The focus is on the design process itself. So far, the application of ADM is limited to logistics and production facilities as well as office buildings and laboratories. Projects that have to deal with risk and uncertainty, fast-track projects and projects with a strong link between design and execution are those that stand to benefit most. During this study the authors of this paper acted as consultants and did not intervene in the project success.

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