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WATERFALL VS. AGILE PROJECT MANAGEMENT METHODS IN UNIVERSITY-INDUSTRY COLLABORATION PROJECTS

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ABSTRACT

In Engineering Education, students ought to gain competences relevant for the requirements of the working life. The CDIO Initiative has defined general goals to engineering education. That is, the aim is to educate students who are able to: 1) Master a deep working knowledge of technical fundamentals, 2) Lead in the creation and operation of new products and systems, and 3) Understand the importance and strategic impact of research and technological development on society (CDIO, 2010). Both disciplinary and interdisciplinary knowledge are needed in order to succeed as a future professional. Interdisciplinary knowledge such as project management skills are important in working life regardless to the competence area.

Agile project management has been a rising trend for several years especially in fields connected to Information and Communications Technology. The aim of the agile project management is to reduce failures by concentrating on delivering the most valued parts of the project and making dynamic changes if needed. Several companies use different agile project management ways to manage their projects. Scrum is one of most used ones. In order for a student to gain competences relevant for the requirements of the working life, both traditional and agile project management frameworks should be a part of their studies – in theory and in practice.

This case study compares waterfall and agile project management methods utilized in a set of university-industry collaboration projects. The study focuses on “theFIRMA” that is a learning environment at Turku University of Applied Sciences, Finland. The student-driven project office theFIRMA operates like a small company providing development projects to both university internal and external customers. TheFIRMA uses Scrum as an agile project management method. Typical customer projects are related to web development, graphical design, end-user trainings, user-testing, application implementations and Lego camps. In addition, theFIRMA participates in several externally funded R&D projects.

KEYWORDS

Waterfall, Scrum, project management, ICT, R&D learning environment, CDIO Standards: 3, 6, 7 and 8

INTRODUCTION

Currently, there are two major project management domains: waterfall and agile. Agile project management has taken its place especially in ICT field projects where the continuous development takes place. Technical solutions and customer requirements change fast and thus, the need for agile methodology has been obvious. The aim of the agile project management is to reduce failures by concentrating on delivering the most valued parts of the project and making dynamic changes if needed. Various ICT companies use different agile project methodologies to manage their projects. Scrum is one of the most popular methodology applied in the companies (Scrum Alliance, 2015). Scrum methods are based on the Manifesto for agile software development: individuals and interactions over processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation and responding to a change, over following a plan (Manifesto for Agile Software Development).

Waterfall project management focus on careful and detailed planning so when the project is ongoing, it is easy to just follow the plan. Waterfall is a linear approach where the phases of the project follow each other. In some sense, conceive – design - implement – operate (CDIO) follows same kind of systematic and linear progress.

In Engineering Education, students ought to gain competences relevant for the requirements of the working life. The CDIO Initiative has defined general goals to engineering education. That is, the aim is to educate students who are able to: 1) Master a deep working knowledge of technical fundamentals, 2) Lead in the creation and operation of new products and systems, and 3) Understand the importance and strategic impact of research and technological development on society (CDIO, 2010). Both disciplinary and interdisciplinary knowledge are needed in order to succeed as a future professional. Interdisciplinary knowledge such as project management skills are important in working life regardless of the competence area.

Students in theFIRMA learning environment gain relevant interdisciplinary skills by participating in the projects in different roles. Multicultural and multidisciplinary teams do innovative work together to meet the goals of the projects and to create added value in customer pilots of theFIRMA. Every project has a student project manager who is responsible for scheduling and coordinating the activities. In agile projects, theFIRMA has chosen Scrum as a project management method and thus, the student project manager is usually a Scrum Master. Depending on the project, either teacher coaching the project team or the customer her/himself is the Product owner and responsible for communicating the needs of the customer for the project team. This approach not only deepens the disciplinary but also the interdisciplinary knowledge and skills of the students, since the project management skills are trained in authentic context.

In this paper, the focus is set to present a case study on comparing waterfall and agile project management methods in university-industry collaboration projects in theFIRMA. First, the activities and the roles of theFIRMA are described and experiences on R&D projects are presented. Thereafter, the customer project processes used in theFIRMA are introduced and compared. Finally, the past and current activities are discussed, and future development thoughts are presented.

THEFIRMA – ACTIVE LEARNING ENVIRONMENT

TheFIRMA learning environment is student-driven project office that serves mainly small and medium sized enterprises (SMEs) in Southwest Finland. Typical customer projects are related to web development, graphical design, end-user trainings, user-testing, application implementations and Lego camps. Students work in the project office learning by doing and work done in theFIRMA is integrated in the curriculum so that the students gain credits for the introductory course, work placement, thesis or separately agreed courses if the contents of the customer project is similar to contents and learning objectives this certain course (Säisä, Määttä & Roslöf, 2017). In addition, it is possible to complete tailored advanced professional studies in theFIRMA as well (Säisä et al. 2017). In 2016, over 150 students worked in theFIRMA learning environment and gained over 1500 ECTS credits (Määttä, Roslöf & Säisä, 2017).

Student-driven project office has an internal organization: the student CEO is responsible for general administration, staffing and selling activities. The student project managers coordinate the customer projects and lead the teams, and team members are focused on implementing the projects. Depending on the individual interests and competencies, the students can focus on different ICT engineering topics, such as website design, network administration, graphics design and software testing. TUAS staff mentor the students when needed, help with the negotiations with customers and make sure that the learning goals are met during the projects. (Roslöf, 2016)

There are three staff roles from TUAS: staff project manager, responsible teacher and technical consultant. A staff project manager has the overall responsibility of theFIRMA and its operations. S/he participates also in customer negotiations and helps defining feasible project goals, pricing levels and formal contracts. Responsible teacher takes care of the learning process and defines the learning objectives for the students and the projects. In addition, the responsible teacher agrees the amount of credits and assessments for the students. Technical consultants mentor the students in difficult engineering tasks that students are not able to solve by themselves. (Roslöf, 2016; Säisä, Määttä & Roslöf, 2017). TheFIRMA management team consists of staff project manager, responsible teacher, technical consultant, theFIRMA student CEO and the student project managers. Figure 1. depicts students working in groups in theFIRMA projects.



Figure 1. All of the FIRMA projects are done in groups where senior-level students mentor the junior level students.

The FIRMA participates in several externally funded R&D projects, where the focus is, for example, on digitalization of SMEs and digitalization of circular economy. The “Hot Potato” project implements 50 customer pilots with Finnish SMEs and based on the experience gained in the pilots, creates guidelines for the companies interested in digitalization, gamification and knowledge management. Pilots are focused on rapid experimenting in companies that are eager to develop their performance further, increase productivity and enhance well-being at work. Pilots are done in co-operation with 50 Finnish SMEs, TUAS and University of Turku. The project is funded by partner universities, companies and European Social Fund. (Säisä et al., 2017). The main goal of the rapid experiments in “Hot Potato” is to try something new with the customer company, and if the experiment seems fit well for its purposes, then it can be adopted into companies processes. On the other hand, if the experiment reveals that it does not fit the company’s business nor processes, it can be quickly abandoned and changed to a new rapid experiment. In some cases, instead on long-lasting planning phase, it is just good to try new process, new prototype or new service and see how it fits. The scrum methodology suits well with rapid experiment projects.

IMPLEMENTATION OF CDIO

The CDIO Initiative has defined 12 CDIO Standards (CDIO, 2010) to describe the features of CDIO programmes. The FIRMA learning environment meets standard 3. “Integrated curriculum” by integrating regional customer cooperation as well as externally funded R&D project to curriculums of ICT engineering students and thus, enhances the learning experiences that lead to the acquisition of personal and interpersonal skills, and product, process, and system building skills. The standard 6, “Engineering workspaces”, accentuates the importance of physical learning environment. The FIRMA office is located in the campus with dedicated facilities. The physical project office provides room for the teams work

together in peace and also to meet the customers. In addition, joint facilities provide opportunities for networking and wider co-operation. The standard 7, “Integrated learning experience”, engrosses on acquisition of disciplinary knowledge simultaneously with personal and interpersonal skills. Authentic customer pilots produce fruitful platform for simultaneously learning of disciplinary knowledge. TheFIRMA actively encourages students to be self-driven, thriving to learn more and eager to solve troublesome assignments, which are also described in the CDIO standard 8 (Active learning).

THE CUSTOMER PROCESS IN THEFIRMA

Most of the customers of theFIRMA are small and medium sized companies located in Southwest Finland. Potential customers contact theFIRMA in various ways, such as via theFIRMA website or through TUAS RDI-service. The first meeting with the customer is about understanding the needs and the business processes of the customer as well as discussing the potential co-operation opportunities. Usually this meeting is between the customer, the staff project manager, the student CEO and/or student project managers of theFIRMA. If the potential customer is interested in co-operation, theFIRMA management team prepares a project offer for the customer. The offer includes description, schedule and the price of the project.

Once the customer agrees the project offer, project preparation is started. Preparation phase consists of finding a suitable project team of the students and mentor from the teachers, writing more detailed project plan and internal project kick-off meeting with the project team members. Project teams are formed in a way that senior-level students mentor the junior team members. The kick off phase includes going through the customer’s business processes, aim and scope of the project as well as learning goals of the team members. At the kick-off meeting the team and the mentor will decide whether the waterfall or scrum is being used during the project.

The implementation part starts with a customer meeting where all the team members finally meet the customer and are able to ask clarifying questions from the customer. Students tend to work more systematically and accurately when the teaching of different professional skills alongside disciplinary knowledge is integrated into the business context (Mejtoft, 2016, p. 689). Meeting with the customer face-to-face and understanding the business of the customer also increases the motivation and commitment of the students. Meetings with the customer, mentor and project team occur regularly throughout the project implementation.

In the end of a customer project, a closing meeting will occur, where all the team members, mentor and customer meet and go through the aim of the project, results and customer feedback. In order to make sure that the project really helps the customer in a long run, mentor can schedule another meeting after couple of months to make sure that the customer has conducted the new processes designed in a project. For example, in a website design project, customer is trained to update the contents of the new site by him/herself. In some cases, customer might need some extra training to adopt the new platform to daily/weekly business routines.

There are three different roles in the Scrum framework: the Product Owner, the Team and the Scrum Master. The product Owner is responsible for representing the requirements of everyone concerning the project as well as projects resulting system. In addition, the Product Owner makes sure that the prioritizing the items in Product Backlog. The self-managing and

self-organizing Team is responsible for developing functionality. The Scrum Master is responsible for Scrum Process, for training the Scrum methodology for team members and for ensuring that everyone follows Scrum rules and practices. (Schwaber, 2004; Rubin 2013).

If the project has been decided to be implemented by using Scrum, the sprints are usually two weeks long. Depending on the project, the division of the Scrum roles can be done in two ways: 1. Customer works as a product owner, teacher/mentor works as a Scrum master and team members work as a development team. 2. Teacher works as a product owner, student project manager works as a Scrum master and the rest of the team members work as a development team.

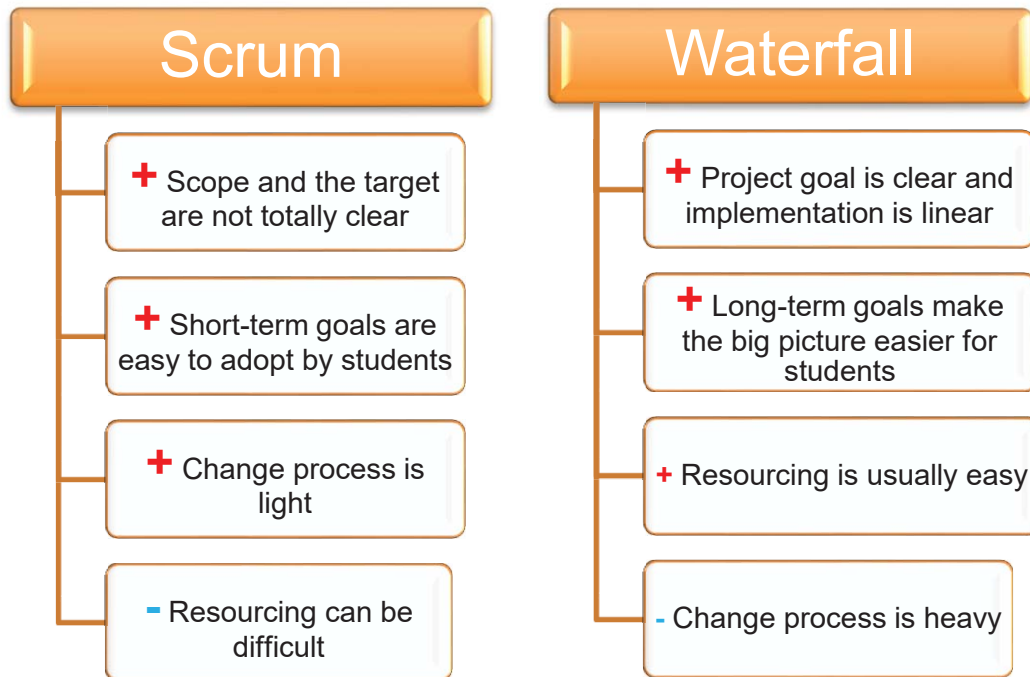
AGILE OR WATERFALL?

The decision whether to use agile or waterfall as project management in a customer project depends on the aim, scope and schedule of the project. In addition, customer's commitment and schedule has to be taken into account since customer has to be highly involved with the project team if the project is run with Scrum. If the customer project is related to end-user training, such as MS Excel training or MS Outlook training, the aim and the scope of the project is rather straight forward. If the customer project is about designing new application, the aim and the scope might change during the project and very close customer cooperation is needed throughout the project.

Using waterfall as a project management methodology, project is planned and scheduled carefully beforehand. In a sense, project is easier to lead, when the waterfall methodology is used. Also, according the experiences in theFIRMA, students understand the whole project cycle better, when it is designed and implemented with waterfall. In addition, planning the resources is much easier. In a project office, where the main workforce is the students, the schedule of each student varies depending on their classes. On average, students work in theFIRMA 10-15 hours per week. This has to be taken into account, when the project is being scheduled. However, the down side of the waterfall projects is that quite often the schedule of the project changes, especially in longer projects. Team members get sick, some of team members get a new job and quit the project, or customer is so busy that s/he is not answering the emails. Table 1. demonstrates the pros and cons of scrum and waterfall project management methodologies.

If the scope and/or the final result of the project are not totally clear in the beginning, the scrum is being used as a project management methodology in theFIRMA. Scrum offers variety of tools to easily adopt the change during the project. In addition, less planning is done in the beginning, so team members do not use that much time in features that might not be part of the final solution. In theFIRMA the length of each sprint is for two weeks, so short-term goals are easy to adopt and schedule by students. However, the big picture of the whole project might be incoherent for the students, since the project is built of small pieces. In addition, the resourcing of scrum project can be difficult, if the aim and/or scope of the project changes in between the sprints.

Table 1. Pros and cons of Scrum and waterfall project methodologies



In 2017, there were 54 customer projects implemented in theFIRMA. Approximately one fifth (19 %) of the projects were done using the Scrum. All the Scrum projects were related to web or application design and implementation. Even though Scrum is being adopted to several fields of business, it still seems to be most fluent in its origins, software development. The rest of the projects in 2017, were related to graphical design and editing, testing, training, marketing, hosting and networking, innovation events, gaming and organizing Lego camps and conferences.

DISCUSSION & CONCLUSIONS

In this paper, waterfall vs. agile project management methods in university-industry collaboration projects have been described and discussed. Both disciplinary and interdisciplinary knowledge are needed in order to succeed as a future professional. The ICT project office theFIRMA is a fruitful platform to combine the theory gained in classes to practice in authentic customer projects. Based on the feedback of the students, they feel more confident about their project management skills as well as technical skills after joining different customer projects in theFIRMA.

Even though agile methodologies are rising, still students need to have basic understanding of waterfall and agile project management methodologies. Not only is it important to understand how different methodologies are being used in theory and in practice, but also to understand to project aim, scope and schedule in order to decide the best suitable methodology for a project. In ideal situation, student in theFIRMA participates in different kinds of projects and thus, is able to practice both project management methodologies.

When using Scrum as a project management methodology, it seems that the clear short-term goals and schedules enhance students' commitment to a certain project and thus, enhances

learning and motivation. The Scrum methodology suits well especially in R&D projects where the focus is set on rapid prototyping and experimenting. On the other hand, these results only occur if the team of students have been successfully motivated and engaged to Scrum methodology in the kick-off meeting. There are also experiences, where the team of students do not want to use Scrum and thus, they only do it halfway. In addition, experiences in theFIRMA indicates that the best results of using Scrum are at the time when the whole development team has same or almost same kind of schedules. For example, during the work placement when most of the students work in theFIRMA full-time. Scrum methodology emphasizes close co-operation throughout the project and it is only ideal to implement, if the team has similar schedules.

Waterfall project management methodology is more traditional and thus, more easy to adopt. For linear projects the waterfall methodology suits the best. In addition, clear milestones make it easier for students to understand the big picture of the entire project. However, if the project takes several months to implement, there is always a risk that students change or customer is busy with the daily business. It is harder to engage and motivate students for the project, when they jump in during the project. In a sense, the project timeframe should be planned in a way that there is enough time for the possible delays.

Currently, there are no suitable measurement tools to measure and compare the effectiveness of the project management methodologies used in theFIRMA. In addition, each project and each customer are different, so the comparison of using different project management tools and to compare the effectiveness is quite hard to implement.

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BIOGRAPHICAL INFORMATION

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Katariina Tiura is an engineering student in the ICT unit of Turku University of Applied Sciences, majoring in Information and Communications Technology. Besides her studies, she has been an active student in the FIRMA, working as a student CEO and student project manager. Currently she works as a student project manager in Inside the Box project.

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