A case study research on Scrum Framework

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I. Abstract

Agile methods have been widely implemented in the industry while teaching these methods is a substantial part of Computer Science and Engineering program curricula. Evidence-driven data of agile practices, methods, and tools have been extracted based on empirical studies with students, however, there is an important need for more anecdotal evidence to confirm these findings. In order to fill this gap, this paper explores the perceptions and the applicability of the Scrum Framework in a student research team in an industrial context. Empirical data have been gathered through interviews with the case study participants combined with a survey. The analysis reveals that student experiences are mainly positive and that they can easily grasp the benefits of Scrum Framework. The challenges of implementing Scrum in such a setting mainly concern the balance between coach and self-organization, formulating accurate user stories when researching, finding the most suitable estimation method, as well as planning when conducting research. The empirical findings may potentially be extrapolated in student scrum teams or even in industrial settings. Finally, this research paper should encourage other researchers to investigate the adoption of Scrum in a student setting.

II. Sammanfattning


III. Keywords

agile methodology; Scrum; empirical study; team performance;

IV. Introduction

In order to deliver value rapidly and to operate in an ever-changing environment, certain methods, and solutions that improve efficiency and transparency are needed. Agile practices have proven to be an efficient method to improve management of changing customer demands and market needs [1]. Scrum is described as a framework within which people can address complex and adaptive problems, while productively and creatively delivering products of the highest possible value [2]. Scrum is also one of the key frameworks of agile software development. One of the main functions is setting sequential goals to be fulfilled in a prearranged period of time [3]. Scrum framework was proposed by Jeff Sutherland together with Ken Schwaber in 1993 to overcome estimation faults, when requirements are not fully known, generated by the Waterfall method [4].

Scrum framework is constructed to adapt for customer’s expectations and therefore supports the development of high-quality products [5]. Some of the key benefits over conventional development frameworks are the short iteration cycles, small team sizes, strong communication channels as well as early delivery which allows teams to receive near real-time feedback [6]. Scrum teams simulate evolutionary, adaptive and self-correcting systems in such a way that enables rapid adaptation to change in the business and technical domain [3], [7]. Additional features of Scrum are team autonomy, end-to-end responsibility, transparency and cross-functionality including all the expertise required for every stage of the developing process. On the contrary to traditional management practices which embrace control and predictability, Scrum is motivated by uncertainty and creativity [3].

Although agile practices have been broadly and successfully applied in industry, due to their developmental nature, they still ignite great interest for both academia and industry. Agile methodology is a common working standard today on which research has been extensively conducted [6], [8], [9]. Universities are also starting to teach agile methodology to prepare students how to work after academia [10]. While current studies of applying Scrum exist, the following case has never been tried nor studied. This study specifically aims to identify the main requirements, challenges and key success factors with regards to applying Scrum on a team of students working...
together on a common problem statement. The purpose is to examine whether this framework is suitable when implemented by people who have no previous experience in working agile or together before.

V. BACKGROUND

A. Related research: Implementation of Scrum in industrial and academic context

Agile methodology has not only been implemented in software engineering, but also in various types of product development, both in academic and industrial context [11]. In these cases several success factors have been identified with the following being the most common ones [12]–[15]:

- continuous feedback
- visibility in the process
- decrease in development cost
- rapid adaptation to change
- involvement of multiple roles and simultaneously execution of the work
- training and learning

Additional to that, teams working with agile frameworks have experienced increase in overall communication, knowledge sharing, enhancements in team culture as well as better overview of the stage of the project [16]. Communication is the area where the most improvements are reported due to the daily ceremonies [16]. Nevertheless, issues related to areas of organization and documentation are mentioned [16].

Implementing agile practices is also usually experienced positively by employees. Laanti et al conducted an extensive survey-based research on the opinions of Nokia's employees on agile transformation, containing more than 1000 respondents in seven different countries, indicating that 60% are positive in working in iterative structure [17].

Another study on continuous release at Ericsson describes related challenges and positive effects of implementing large-scale Scrum [8]. Among challenges were overcommitment by external pressure, managing maintenance work and balancing between efficiency, while the positive effects reported were increase in flexibility, decrease development lead time and higher employee motivation [8].

Applicability of agile methodology in a student context for practical uses has been thoroughly assessed positively by Mahnic in a case study using Scrum [10]. Nevertheless, a cross-program investigation of students’ perceptions of agile methods showed that agile method is more difficult to be applied in the academic environment than in the industrial one which usually stems from schedule issues [18]. However, the same study indicates that students are very enthusiastic about core agile practices and that there are no significant differences in the perceptions of students of various levels of educational programs [18]. Another empirical study revealed positive perceptions about Scrum while the empirical evaluation based on surveys confirmed the anecdotal evidence about the strengths of Scrum reported in literature [13].

One of the main requirements to achieve high competence in a Scrum team is the compliance and adoption of the agile values: transcendence, autonomy and cross-functionality [3]. A team focused study conducted by Moe et al showed that teams had difficulties managing themselves since all the team members were familiar with high individual autonomy, but not team autonomy [19]. Additionally, lack of trust prevented them from shared leadership and feedback, values essential in all agile practices [20].

Agile practices have primarily positive impact, even though challenges when using them were revealed. Further research to bridge the gap between theory and implementation is needed, since most of agile method effectiveness available has anecdotal foundation [20]. According to Dingsoyr et al, on particular agile methods such as Scrum, the current state of theory and research lies in its nascent phase [20]. Therefore, further empirically validation of agile applicability is vital [10].

B. Scrum Overview

According to the Scrum Guide, Scrum is founded on empirical process control theory and constitutes a repetitive and incremental approach aiming at controlling risk and increasing predictability [2]. The framework is grounded in three pillars: transparency, inspection and adaption, meaning that the process is visible and understandable to those involved, artifacts are inspected towards the Sprint goal, while the process is flexibly and rapidly adjusted [2].

1) Scrum Terms:

- **Product Backlog**: is a dynamic list of every known item required for the final product. The items decided to be developed in the current Sprint called Sprint Backlog [2].
- **Sprint**: a consistent time frame of short period of time, usually 2-3 weeks, during which the team works towards achieving a releasable "done", increment of the final product [2].
- **Estimate**: provide an approximate calculation of software development size, effort, complexity and duration for a particular agile project [21].

**Story points**: are units of measure expressing the relative size of a task in terms of complexity and effort [21].

**Ideal Time**: expresses the actual amount of time invested to complete a task, subtracted by the additional everyday activities [21].

2) Scrum Practices:

Scrum evolves around four time-boxed events, providing the opportunity for inspection and adaption [2]:

- **Sprint Planning**: during planning the team decides and estimates upon the Sprint Backlog and goal. It is the activity that initiates the sprint.
- **Daily Scrum**: is a 15-minute daily meeting in which the team discuss the status of work done since the previous daily Scrum and forecasts the work to be done until the next one.
- **Sprint Review**: is held at the end of every iteration, during which the increments and product backlog are inspected and adjusted for the next sprint.
- **Sprint Retrospective**: is the event during which the team examines critically itself and creates a plan of actions towards its enhancement.
3) Scrum Roles:
A Scrum Team consists of the following roles [2]:

- **Product Owner**: is the interface between the team and the stakeholders of the product, accountable for maintaining the value of the product, as well as managing the product backlog.
- **Scrum Master**: is a servant leader charged for managing the practices, ensuring that everyone follows Scrum rules as well as facilitating the events.
- **Scrum Team**: is composed of professionals who work towards delivering an increment of the product at the end of each iteration.

The Scrum team is characterized by self-organization and cross-functionality. These characteristics create the foundation for the team to organize itself, as well as to consist of all the required competencies to execute the necessary work. This specific design empowers flexibility, ingenuity, and productivity.

C. Purpose and Research Question

The purpose of this research is to explore the Scrum framework and in what way it promotes the team performance and engagement of a student team compared with other non-agile projects or ways of working. The intent is to clarify whether alternative practices could be implemented in the traditional Scrum method when it is applied in a team that has not previously been exposed to Scrum. Finally, the goal of this exploratory study is to point out these practices for the implementers of Scrum, in order to enhance team’s performance in terms of productivity, cohesion, learning, and integration. Thus, the main research question of this study is the following:

How does Scrum framework impact the performance of a student team compared with non-agile ways of working?

Additionally, the following sub-questions are investigated:

1) What are the applicable practices promoting team performance and motivation in the context of a student Scrum team?
2) What alternatives can be implemented in order to render Scrum more suitable for this specific context?

D. Defining Team Performance

Team performance is a multidimensional notion. A visible goal can fuel a team but it cannot guarantee success. Team performance can be evaluated from an end user’s customer perspective, but also from the individual’s interaction aspect as well. Whether the team members enjoy working on a common goal or not can define the productivity in the long term [22]. Therefore, aligning internal dynamics with external relations could empower team performance. Teams are ruled over by the principle of “equifinality”, meaning that a team can reach its goals by a variety of means and under different conditions [22].

In order to evaluate the team’s effectiveness and how this is influenced by implementing Scrum, it is required to formulate the performance criteria. According to Team Performance Analysis suggested by Thomson (2013) [22], performance could be measured on the following criteria:

1) Productivity depends on the existence of a clear goal as well as on the team’s ability to adapt to change. However, this criterion is also determined on whether the output resulted from team’s work meets the demands of the stakeholders and on their performance standards (e.g., quality, quantity, innovation).
2) Cohesion reflects the nature of team members’ relationship. An effectively functioning team is more possible to be maintained and strengthened for sustainable future work.
3) Learning indicates the opportunities a team provides to its members to grow and develop. That does not imply that the team should serve the individual needs, rather that successful teams intrigue and challenge their members.
4) Integration disclose team’s ability to be aligned with the interest and goals of the organization that they are involved.

E. Linking Group Dynamic theories with Scrum

Group development theories claim that groups develop in a customary pattern. Group patterns serve as indicators over time for developmental changes. Various models of group development suggest different developmental stages that a group undergoes, however some commonalities can be distinguished. Researchers have identified five stages of group development. According to Wheelan, these are the following: dependency and inclusion, counterdependency and fight, trust and secure against work and, eventually, productivity and termination [23].

According to empirical studies, groups having difficulties in overcoming the first two phases of group development [24]. In Scrum teams, the team passes through the first and second developmental stage of “dependency and inclusion” as well as “counterdependency and fight” in a rapid fashion. Scrum teams, from their nature, have the following significant characteristics: transparency, cross-functionality, and self-organization. These characteristics can be found in the later stages of the group development model. Therefore, a functional Scrum team has a bigger potential to reach stages “trust and secure” and “work and productivity” faster, if the team follows the agile principles and practices. Therefore, Scrum accelerates collaboration and helps to seize the team’s full potential. Scrum practices, on the other hand increase communication and collaboration between the team members as well as embrace openness and trust, required to resolve conflicts. Thus, Scrum teams have the potential to reach the stage of “performing” faster. Further, the cross-functionality and diversity of the scrum team provide all the required competencies to execute the team’s goals, but also to be more creative and collaborating.

According to Wheelan’s developmental stages, teams can not stay in the fourth phase of “Work and Productivity” eternally. The performance growth of the team is eventually slowing and declining towards a new steady state. Research confirms that this phase is depending on careful management and on the smooth transition to the next steady phase. If the transition is delayed, performance growth will be terminated [25].

That
happens when members forget to cultivate what has been achieved and formulate it as a learning. Thus, it is important to change tasks, roles and raise the expectations. Giving feedback and managing the rules for how to collaborate are vital practices to continue develop. Scrum empowers continuous improvement through the practices of review and retrospective which provide a formal circumstance for inspection.

Empirical researches on group development also showed direct connection between the developmental stage and the leadership style [26]. For a team to be effective the proper leadership style is needed to meet the requirements of the group. The performing stage of the group development goes along with less directive leadership [23]. Scrum teams are directed by the Scrum Master which acts as a facilitator or a servant leader to the teams needs.

F. How does the stage of the group influences team productivity?

According to Wheelan there is a link between perceived group maturity and performance, as well as a link of performance with the structure and organization of a group [24]. Wheelan (2005) found that in order for a group to reach the full potential which happens during the "Work and Productivity" stage it takes approximately 6 months. Another important factor revealed from empirical studies indicate that small groups are able to reach mature levels of group development faster than larger groups [27]. Factors such as culture, diversity, complexity of tasks, etc., play a significant role. Group development studies also show that the nature of the relationship between the team members plays a determining part in teams performance [27]. Tuckman's "developmental method", Carnall’s "coping cycle" and "Johari window" reflect that increasing the communication, self-awareness and understanding between individuals has positive effects in teams performance.

G. Scope of the Study

The aim of this study is limited to the application of Scrum Framework in this specific team. It focuses on what sort of effects this framework has on the team performance and what challenges emerge. The goal was not to find out if Scrum can have an impact in teams effectiveness, but what kind of effects in this specific context. However, this research will only highlight different options in terms of combined practices trying to conclude on which of them are applicable on that specific case. Further, topics such comparing the team’s performance with other teams within the organization, developing metrics and measurement methods for assessing Scrum as well as assessing the software product itself are not included in the scope. This study will only cover this specific team and not anyone else in the organization.

VI. METHODOLOGY

A. Case Study

For this study a qualitative approach was chosen, through a case study including observations, interviews and questionnaires. The case study approach was selected for analysing the practices, ceremonies, dynamics and outcomes of applying Scrum in a real-life context. According to Yin [28], case study is regarded as the appropriate approach for research questions formulated in an exploratory way in order to understand the setting and how systemic actions are linked to the results [29].

The study focused on a student self-organized Scrum team, working on a common problem statement, located at the office of Nordea Bank in Stockholm formed for the needs of this study. The industry party in this case study, Nordea, is one of the leading Nordic financial corporations, working with an agile approach. The case was to have a team of students working together as a Scrum team researching in the area of electronic identification (eID) mechanism. The team was consisted of a Scrum Master, a market analyst and a research team. The size of 5 members and the roles of the team were stable for the whole period. The case lasted from January to May 2019 and the team ran 8 Sprints 2 weeks each. The product backlog was prepared from the team members after discussion with the Product Owner. Each user story contained a short description of the task, acceptance criteria and an estimate on either complexity or time.

Following the Scrum framework, each sprint started with a sprint planning and ended with a review and a retrospective. Every day the team held a daily Scrum meeting. When the time estimation method was used, every individual decided on their own the time to accomplish the assigned task, while when complexity estimation was implemented the estimation was decided by the team.

The Product Owner was the supervisor of the team in the company, interlinking the team with the project needs. The Scrum master acted as a servant leader, facilitating the team’s processes by reducing the impediments found in the team’s way, promoting an agile culture, encouraging the improvement of the team and ensuring the workflow.

The team was cross-functional with the students having various academic backgrounds and research angles. The team has never worked together before, and team members represent different knowledge domains since it was comprised of the Scrum Master with background in management, the market analyst with a combination of technical and business background, and the research team with two individuals, with programming skills and software development background and one with more theoretical and mathematical background. In accordance with the principle of self-organization, the team decided on what they worked with, which platform and tools to use, as well as how to proceed in the implementation.

B. Interviews

Interview as a data generation method is largely applied in case studies [30] and it is a common technique to collect empirical data in qualitative studies [31]. In this certain case, interviews are used both to collect impressions and perceptions of the case participants but also of external actors who have implemented Scrum to track their experience and knowledge in order to establish a reference point according to which challenges, practices and improvement factors can
be identified. The interviewees were two individuals with academic experience of Scrum and one with industrial. Semi-structured interviews were used, consisted of open-ended questions around which the discussion was unfolded. The questions were flexible in order to maintain the flow of the conversation. This type of interviews ignite interviewees’ ability to proceed in details and introduce issues relevant to the topic [30]. The interview guide started with an introduction of the case study main focus and questions to get to know more about the participant and his or her previous experience of the Scrum framework. The main questions followed which were divided in different focus areas such as practices, team performance, engagement, and challenges when using Scrum.

The results are categorized into clusters of progress. Categorization is used to assist analysing data interpretation by clustering findings under relevant categories. Interviews were used in combination with observations. The observations made by actively attending the setting and participating in the team planning, daily Scrum, retrospective and review sessions. Active participation in the research was vital in order to provide with alternatives and improvements of the Scrum framework.

C. Questionnaire

Team participants’ opinions were gathered through a questionnaire as well. The questionnaire included 28 questions, some of which were open questions, some were statements to confirm or reject and some were assessments on team performance criteria according to Thomson (2013) [22]. The questions dealt with the use of Scrum and its practices, but also the team performance criteria which were introduced to the participants based on the aforementioned definitions. In the question formulation, the baseline for comparison was not explicitly defined. The questions were open for interpretation by the respondents assuming that they would compare with their prior experiences or any non-agile project.

VII. EMPIRICAL FINDINGS AND ANALYSIS

A. Observation of Scrum Team

Through being present on a daily basis during the five months case study a nuanced comprehension of the team’s behaviors, perceptions and positions were generated. During the project a total of 8 sprints were examined, planning and retrospective meetings were attended and notes were taken. During the case study, the following parameters of progress were observed: product backlog, Scrum practices and self-organization principle.

From an analysis of the Scrum practices it became evident that all of them were improved during time and practice. Scrum planning started as quite a time-consuming practice. The first Sprint lasted two and a half hours, while the last one only one hour and 15 minutes. This can be attributed to the familiarity with the process which in turn had an impact on the duration and the confidence of the team, resulting in more efficient meetings. More precisely, the team needed 3 sprints in order to get familiar and optimize the processes according to its needs. Since this case was a trial and error study, the team tried several alternatives in terms of estimation methods. The team tried both story points estimation and time estimation method. However, the analysis of the estimation methods opened some dilemmas regarding the applicability of Scrum in research teams.

1) Product Backlog:

In the start of the project, the Product Owner prepared the initial Product Backlog containing a list of prioritized requirements. Consequently, in the next sprints the team started preparing and planning the sprint backlog. A recurring issue on planning sessions was the vague nature of the acceptance criteria and the definition of what is considered as completed, deriving from the uncertainties and the nature of research itself. That was particularly evident in the first 3 planning sessions, when the team was still trying to get familiarized with the Scrum framework. Thus, the practice was both time-consuming and inefficient. In order to make the planning meetings more efficient, individual meetings with the Scrum Master and Product Owner were introduced. The goal of this meeting was to discuss the user stories in depth, set new requirements for the project, but mainly assisting in formulating the acceptance criteria of each task and thus optimizing the planning meetings.

2) Scrum practices:

Further, the results of the analysis of the planning sessions displayed that the capacity in estimating how complex a task is rapidly improves as well. The sprint burn-down charts, which project the rate of completion of tasks on each day of the sprint, indicated the team’s ability in estimating and planning improved incrementally from iteration to iteration. The progress of estimating is displayed in the burn-down charts from Sprint 1,4 and 6 shown in Figures 1,2,3 accordingly. The gray line represents the optimal rate of completion while the red reflects the actual one. The distance between those two reflect the work in progress. Thus, it is quite evident that the rate of completion from Sprint 1 to sprint 6 was radically improved. There are other factors that also impact the rate of task completion such as task complexity and external factors, however the team’s ability in planning was apparently improved.

In the first 3 Sprints, the user stories concerned the pre-study phase and literature review. During the sprints 4-6, the coding user stories started, which were typical software development stories, with a combination of theory research when needed. In the final sprints, the stories concerned coding, the results of the studies and finalizing the reports.

Concerning which estimation method was more applicable, that was one of the main challenges of implementing Scrum in an inexperienced cross-functional team. Time estimation method had more accurate results for concrete tasks with specific requirements and tangible results, such as writing the report, as it was something relatable to similar tasks. Furthermore, having such various backgrounds and expertise in different knowledge areas resulted in various perspectives on the complexity of the tasks. On the other hand, estimating highly uncertain tasks, such as developing a model or
The prototype with vague acceptance criteria and no or few requirements, story points estimation was further accurate as it relayed in the simple explanation of complexity instead of the workload. Thus, both methods worked for the team but in various tasks. Time estimation method was more accurate in concrete tasks while complexity estimation was applicable in highly complex tasks. Nevertheless, estimates accuracy was influenced by external factors, e.g. deadlines from schools, the nature of the tasks it self, change of research scope.

Regarding Scrum practices applicability, every Scrum practice was applicable to some extent, however the most valuable one was the planning as it facilitated the structure of the workload instead of working ad hoc. The daily Scrum, further, was a pleasant experience as it brought insights in the team members work, creating space for discussions and feedback. It also raised the confidence and motivation to meet the Sprint goal when the team members started updating each other on their personal progress. Review and retrospective meetings were a good opportunity for the team to discuss on the acceptance criteria and try to further refine the definition of "done", as well as suggestions for potential refinements. These meetings also increased the communication flows among the team members and gave the chance to provide feedback. Retrospective and and planning brought value to the overall team performance, by prioritizing the work and setting some standard ways of working which typically increases the performance.

3) Self-organization principle:
Considering the principles of self-organising, the team was completely responsible for the progress and the Product Owner was more like a mentor, monitoring the project. The team was not provided with a detailed requirements specification, but an overview of the project thus the team members organised and managed their workload by themselves. However, that created some confusion and uncertainty which was also expressed during the planning sessions.

Additionally, when the team realized their autonomy to adjust the work to meet the Sprint goal, the practices and mainly the daily Scrum changed from a structured to an unstructured fashion. The team was able to self organize, identify what kind of daily Scrum discussion was more suitable in order to work together as a team. They were also able to revise the plans towards reaching the Sprint goal.

B. Interviews and Questionnaire

The empirical data from the interviews combined with a questionnaire answered by the case participants revealed the following results, clustered under the categories: communication, motivation and engagement, additional value and satisfaction to work, scrum benefits, difficulties and challenges and team performance.

1) Communication:
The Scrum practices had a positive impact in the team communication as the regular stand-up meetings provided with an overview of everyone’s workload, enabling for greater communication flow. Additionally, the daily meetings, together with the sprint planning and retrospective facilitated the on boarding as a team and boosted the first two- dependency and inclusion, counterdependency and fight- developmental phases with faster pace. Nevertheless, the team turned out to be quite separated in their work, thus Scrum practices did not have great impact on the collaboration of the team members.

2) Motivation and Engagement:
The Scrum framework had either positive or neutral impact on the motivation of the team members. Some of them expressed that they felt motivated due to the constant structure of the workload into smaller tasks akin to a to-do list and by setting goals for the upcoming weeks. However, some of them were quite skeptical whether it was the Scrum practices that made them feel motivated or the team setting and the ability to brainstorm together. Some of them also mentioned that moving a post-it as from work in progress to complete, had a positive psychological effect.

"By expecting me to vote and participate in the planning sessions, it automatically made me engaged in what the other team members were doing. We could then share our thoughts and ideas on each other’s work and help each other improve the quality of the work.” -Case Participant 1
TABLE I: Questionnaire Results

<table>
<thead>
<tr>
<th>Statement</th>
<th>Positive</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>The product becomes a series of manageable chunks.</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Progress is made, even when requirements are not stable.</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Everything is visible to everyone.</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Team communication improves.</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>The team shares successes along the way and at the end.</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Stakeholders see on-time delivery of increments.</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>A culture is created where everyone expects the project to succeed.</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

Scrum benefits stated by Rising L. and Janoff S. (2000)

3) Value and Satisfaction to work:
Scrum benefits in the specific case were mostly about structuring and organising the work, creating a do-to list, reflecting on what has been done contributing in constant improvement of the work and bringing the team together. According to the case participants Scrum brings additional value to the team work as it forces communication, facilitates some processes due to the dependency on each other and empowers the information sharing between members. They also reported additional satisfaction to work when it comes to checking out user stories and positive impact on the enjoyment, as they would describe the overall experience with Scrum affirmative. Further, the team participants would recommend the framework in students teams working on a common goal or problem statement, or to a research team working on the same research question/ hypothesis.

“It let me create a to-do list, which helped me to know what to do next when I’m finished with my tasks. It also put pressure on me to finish it before the end of the sprint. Another factor was the social part of it, it made us all learn the new methodology, giving us another reason to stick with the plans of each sprint.”-Case Participant 2

4) Scrum Benefits:
The second part of the survey included seven statements concerning Scrum benefits stated by Rising and Janoff [32]. The case participants were asked to either confirm or reject the statements based on their experience. The results are displayed in Table I and they disclose an importantly positive level of confirmation with all statements.

The case study participants strongly agreed that progress is made even when requirements are not stable, the team communication channels improve, the framework assist in breaking down complex tasks in smaller manageable ones, everything is visible to everyone, the team share successes along the way, on time delivery of increments and development of a success culture.

Besides these statements Scrum benefits mentioned in the literature study were also confirmed in the interviews with the case study participants. Among them were the frequent team communication to develop a shared understanding and peer pressure, sharing knowledge, expertise and experience, transparency in the work management as well as the structured nature of the method ensuring that the team actual produces value, are only some of them [12]–[15].

5) Difficulties and Challenges:
The greatest challenges emerged in the case study were formulating precise user stories, deciding on accurate estimates and finding the most suitable estimating method, finding the balance between self-organization and coaching as well as planning for two weeks ahead while doing research.

“In the research part, sometimes it has been holding me back because I need to research an area and then another topic comes up which I need to investigate.”-Case Participant 3

As mentioned above the case participants were skeptical whether the framework is suitable when one is conducting research. In research one might change track completely or realise that the intended result is not feasible. Trying to investigate undiscovered areas may deviate one's course as well. Nevertheless, the framework is quite result oriented, since the intended goal of every user story is to produce and provide increments of the final product. When researching though, some steps function as enablers to proceed in the actions that would actually provide value. For instance gaining knowledge or exploring new areas is an inevitable part of the process in order to implement something concrete afterwards. However, the team members had to work ad hoc at times, as it was required in order to execute the planned tasks.

“I am not sure if it is the best method for research in general, since it seems that Scrum is very result based and it does not have the right scientific "mentality”.-Case Participant 4

The estimation part of the framework was the most challenging one. The under investigation area was quite vague and complex and resulted in great uncertainty when estimating. It also turned to be quite challenging to formulate proper acceptance criteria and predict the duration or effort required to execute them. Another challenge that has brought up when working with Scrum was the non-compliance with the concept of “done”. There were user stories that were not precise enough in describing the requirement details. Research is not a predictable or linear process, so predefining the detailed requirements in the first place was challenging or even impossible. Thus, there were user stories which were quite vague since the under examined research area was unknown and others that the acceptance criteria were different than the outcomes. Nevertheless, difficulties stemming from scheduling issues reported in literature were also evident in this case, since the team had to face change the research scope, different school deadlines which influenced the process of estimation and the accuracy of the estimates [18].

“Research is pretty vague, so it is very hard to make proper acceptance criteria for the user stories, which also makes it very hard to estimate time and complexity.”-Case Participant 4

At that point it is essential to highlight the agile estimation methods’ subjectivity. Estimations are based on individual’s intuition and hence may lead to creating a biased situation. At the same time, these methods may lead to errors in case of an inexperienced agile team. Therefore, there is strong need of an experienced person in the team. Implementing Scrum in a team without previous experience requires active guidance and coaching. However, given the principle of
self-organization that Scrum framework demands, there is a need to find the proper balance between coaching and self-management. Additionally, time and experience are required until a team can grasp the full potential and benefits of implementing Scrum.

The interviews with the team members also raised some questions regarding how active should be the presence of the Product Owner. Despite that the research team developed some solutions that were in accordance with the initial project specification, these individual solutions never came together to provide the final end-product, i.e. the proof of concept. Rather, different aspects of the under examined problem were investigated and individual functions were produced. However, the team did not manage to integrate them in one practical solution. This might have been solved with a more active participation and interaction with the Product Owner or with stricter project specification requirements. However, since the project was in the scope of different thesis, each individual had various requirements and deadlines from external stakeholders and institutions. On the other hand, greater guidance from an external supervisor might had sacrifice the principle of self-managing. Thus, it was left up to the team members to be completely responsible and decide on the progress, the direction and the methods for the implementation of such a solution. Nevertheless, learning through experience and exploration was greater in such a way.

6) Team Performance:
Finally, the team performance was evaluated based on four criteria suggested by Thomson (2013) [22]. The case participants were given a definition of productivity, cohesion, learning and integration, according to which were asked to answer whether Scrum framework had an impact and in which way.

All the participants were affirmative that the framework has a positive impact on the productivity. From an analysis of their answers resulted that Scrum improves productivity by facilitating the process of creating a structured and clear two-weeks plan that brings value towards the final goal to a great degree. It also increases the productivity as tasks and goals get further concrete, as well as increases the chance of meeting the demands of the stakeholders. However, to a certain degree the framework limits the ability of working ad-hoc which students usually do work in this fashion. Nevertheless, there is some uncertainty whether Scrum increases the chances of meeting the demands more than other frameworks do.

Concerning cohesion the participants were also positive that Scrum practices increase the cohesion of the team. They stated that Scrum practices have a substantial social aspect which increase the cohesion automatically as they force constant communication and information sharing contributing to a healthy team culture and mutual understanding.

Learning defined as the opportunities provided to the team members to grow and develop was recognized as the most considerable aspect of Scrum. Some team participants expressed that constant learning is the major benefit of Scrum, where the retrospective is a particular effective practice. The practice enables open discussion, where everyone can contribute on things to improve including oneself. Nevertheless, considering that the case was a research project some participants were skeptical that Scrum due to its result-oriented nature might hinder scientific learning since it forces to produce concrete results.

Finally, integration considered as the team’s ability to be aligned with the interest and goals of organization, was a challenging criterion for the certain case. Given that it was a case study, the team members worked independently from the other teams in the organization. Thus, the framework did not bring integration towards the interest and goals of the organization as the participants were executing the tasks needed to fulfill the expectation of the institutions.

VIII. Discussion

The purpose of this research was to explore in which way Scrum framework impacts the performance of a student team. Additionally, the following sub questions were also investigated 1) what are the applicable practices promoting team performance and motivation in the context of a student Scrum team and 2) what alternatives can be implemented in order to render Scrum more suitable for this specific context. Results of the study confirmed both anecdotal evidence from empirical studies and from the literature review about Scrum benefits, however important aspects when implementing Scrum in a student team were also highlighted. Analysis of the results revealed some important challenges when implementing Scrum in inexperienced people.

Results of this empirical study showed that Scrum do impact the performance of a student team in a positive way. Scrum practices play an important role in the bonding of the team, particularly in the first two developmental stages. The daily practices promote greater communication flow, better overview of the stage of the project while structuring a complex project into smaller and concrete tasks increase productivity. Students reported positive perceptions on the scrum practices. Interviews with the case study participants indicated that the students felt motivated and engaged with the project due to the constant structure of the workload into smaller tasks, while they also reported that scrum practices bring additional value to work and have a positive impact on the team culture.

Scrum practices, on the other hand increase communication and collaboration between the team members as well as embrace openness and trust, required to resolve conflicts and pass through the phase counterdependency and fight. Thus, Scrum teams have the potential to reach the stage of "performing", according to developmental theories, faster. Further, the cross-functionality and diversity of the scrum team provide all the required competences to execute the teams goal, but also to be more creative and collaborating. Discussing in person every day and using the whiteboard improved the team's amiability and openness while people seem more inclined to relay valuable information quickly, thus the trust among the team members increased faster. Additionally, the use of post-its rendered identifiable each individual's task, while one's contribution and performance was also displayed. The presence of the whiteboard created
a healthy peer pressure and boosted the overall performance and motivation of the team. "Gamification" of the practices, such as moving post-its and voting on estimation, provided an enjoyable aspect that resulted in greater work satisfaction, motivation and thus better performance. However, some dilemmas regarding the applicability of Scrum in the specific context were revealed. Team’s common understanding on the end-product and requirement specifications is vital. It is necessary that the team has found the right level between abstract and detailed when it comes to formulating the requirements. This fact intensifies the importance of the presence and active participation of the Product Owner in order to keep a consistent line when formulating the requirement specifications and in their turn the user stories.

Analysis of the results of Sprint retrospective meetings revealed that the non-compliance with the concept "done", stems from uncertainty and the nature of research itself which in turn results in decreased motivation and cause uncertainty in the planning practice.

Cross-functionality of the team played a twofold role in the project. On the one hand, it raised the confidence to achieve the team’s goal and the motivation of the team members since the team consisted of all the required competences to execute a complex project. On the other hand the cross-functionality complicated the estimation process. It was evident that the team members due to their various backgrounds and knowledge areas did not share the same perspective on task-complexity and size of tasks. This is why trying time estimation method in the first sprints helped the team get familiarized with the process since it is a more concrete method and everyone could understand how to estimate time. Instead, in such a cross-functional team, not everyone could understand how complex a task actually is. Nevertheless, there is always a degree of uncertainty since in the first sprints the team could not accurately predict how long would reading/understanding and writing a paper could take.

Solution to the above problems would be setting a clear goal in the beginning, get an introductory course on how to implement scrum framework and its practices e.g. how to handle planning and estimation, participate in more experienced teams to see how they handle the practices.

The results could be extrapolated in the following ways: from the standpoint of implementing Scrum in a newly formed team in an industrial context, as well as from the introduction of students to the industry. Thus, the findings concerning the case participants perceptions on Scrum are valid under the assumption that Scrum is implemented according to the Scrum guidelines and all the practices which affect satisfaction and motivation are followed. Concerning the success of the project, the roles of Scrum Master and Product Owner have a substantial impact since they can decide on the final outcome. Furthermore, the study showed the active presence of an experienced team member to act as a coach can also impact the success of the project in a positive way.

In order to maximize the validity of the results, the case study was implemented and integrated in an industrial environment. The case participants worked on a real research problem and followed the Scrum guidelines as strict as possible. The case study participants were senior master students in their last year of studies, with some of them having working experience in software engineering projects. Therefore, the results of the study could find applicability in the introduction of Scrum in a company, or in the implementation of Scrum to with limited or no knowledge of Scrum.

IX. Conclusion

Empirical studies with students participants can supply industry and academia with evidence-driven results on agile processes and practices. This case study described one more implementation of the Scrum Framework on a student research team focusing on the assessment of the teams performance and motivation as well as the impact of Scrum practices on the former. The main conclusions of this investigation are related to the research questions of the study.

A. RQ 1: How does Scrum framework impacts the performance of a student team compared with non agile ways of working?

Results of the study displayed that Scrum has positive impact on the performance of the team. The main benefits of using Scrum were observed on the communication, motivation and engagement with the project, satisfaction and additional value to work. Nevertheless, the analysis of the result revealed certain challenges when using the framework in such a setting. Insufficient communication and active presence of the Product Owner, absence of coaching or mentoring from an experienced individual as well as difficulties in formulating and prioritizing requirements when doing research can compromise the success of the project.

However, the result-oriented nature of the framework created a flow in the productivity of the team. Although value was created and progress was made even when there was great uncertainty in the research project, dilemmas about the effectiveness of the result-oriented nature in the investigation and learning have been aroused.

The case participants confirmed with high rate of agreement the following statements on Scrum benefits:

- The product becomes a series of manageable chunks.
- Progress is made even when requirements are not stable.
- Everything is visible to everyone.
- Team communication is improved.
- The team shares success along the way and at the end.
- Stakeholders see on-time delivery of increments and a culture is created where everyone expects the project to succeed.

It should be noted that unanimity was reported in the communication and constant progress aspects.
Scrum practices were in total applicable in such a context. Daily stand up meetings had a positive impact on the communication channels and increased the motivation to reach the Sprint Goal. Planning and breaking complex tasks into manageable chunks created flow in the team performance. Retrospective and Review provided the ideal opportunity to inspect and adapt in more suitable ways of working for the team and gave the opportunity to reflect on the progress of the work. However, estimating the effort or time needed to complete the tasks was the most challenging part. Given the lack of experience and the vague nature of research, dilemmas aroused whether estimating the workload in research is applicable as well as which estimation method provides with better results. Based on the results, tasks with concrete results such as coding, time estimation method is applicable. For complex tasks with few or no requirements, complexity estimation is more suitable.

C. RQ 3: What alternatives can be implemented in order to render Scrum more suitable for this specific context?

Taking everything into consideration, the case study confirmed that students are able to reach the proposed benefits from empirical studies and theory within a time-frame of at least three sprints. However, in order for a team to reach high performance stage six months are suggested. Experience is also an important factor to reach high performance. Therefore, an experienced team member and the active participation of the Product Owner are vital to drive the project forward and grasp the benefits of Scrum in such a setting. Nevertheless, balance between coaching and self-organization is important to be found, so as not to sacrifice Scrum principle of self-management.

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XI. REFERENCES

REFERENCES


