

# The Perceived Impact of the Agile Development and Project Management Method Scrum on Team Leadership in Information Systems Development

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## Abstract

This research contributes to the body of knowledge in information systems development (ISD) with an empirical investigation in the form of a case study that demonstrates the positive impact of the agile development and project management method Scrum on team leadership in information systems and software development projects. It also provides a useful operationalization of the concept through six identified indicators for team leadership. Despite the fact that the case unit had challenges with the use of Scrum, the indicators identified the areas where the company had managed to exploit the potential of Scrum and its practices with regard to increasing team leadership. The research results are discussed with regard to the existing Scrum literature and briefly related to complex adaptive systems (CAS) as a foundation for ISD and agile development.

**Keywords:** *Agile development, agile project management, team leadership.*

## 1. Introduction

Over the last decade agile information systems and software development (ISD) has received much attention from researchers and practitioners as an approach for dealing with change and the unpredictable and hardly controllable elements of ISD in a dynamic environment. While numerous publications claim a positive impact of agile development and in particular Scrum on ISD, very little empirical work exists to verify these claims. The literature review, which was part of the study reported here, uncovered some notable exceptions. To further contribute to this body of knowledge we set out to answer the following two research questions: What impact has the introduction of the agile development and project management method Scrum on ISD? What is the effect of any deviations from the guidelines for Scrum? The results we present in the following are part of a larger project where we developed a framework for investigating the impact of Scrum [1]. As ISD has long been understood as a social process with an acknowledged importance of social interaction [2,3,4,5,6,7,8] in this paper we concentrate on one of these concepts which is explicitly related to social interaction, namely Scrum's impact on team leadership in ISD. In the remainder of the paper we first briefly introduce Scrum, and then describe our theoretical background and the research setting and method. Subsequently we present and discuss our findings against the existing literature on Scrum and relate them to complex adaptive systems (CAS) theory, a theory which is considered to provide a theoretical foundation for ISD [9] and in particular agile development [10]. We finish with some conclusions and an outlook to future research.

## 2. Research Background

Scrum is an agile information systems and software development method with a strong focus on project management, which was formalized and tested by Schwaber and Sutherland in the mid 1990s [11,12] Scrum focuses on an iterative and nimble development process, on transparency, visibility and on a cooperative, collegial leadership style and cooperation in and between the development team and the customers. In Scrum the development team is called

the Scrum team. Unlike traditional development projects where analysts, developers and testers are typically separated, Scrum teams are built on an interdisciplinary basis and comprise all these roles in one team preferably in one physical location. This structure, as well as Scrum's focus on self-organization aims at creating team dynamics and a better understanding of the tasks to be performed jointly. Internally, the role of the Scrum master will provide leadership, motivate and facilitate the team in line with the Scrum values, practices and development process. The role of the Product owner has the responsibility to represent the project and product externally to other stakeholders and customers and to handle and manage the tasks that appear in the product and release backlogs [11]. A Scrum development process is structured through a product backlog, which is a prioritized list of required business and technical functions of the envisioned product. It might change in line with the customer's new needs. A release backlog is a prioritized subset of the total product backlog and defines the functions to be included in a release. A Scrum, performed in so-called sprints, is a set of development tasks and processes which a Scrum team carries out to achieve a given sprint goal. The length of a sprint is predefined and typically lasts between 5 and 30 calendar days [11]. What needs to be done during a sprint is determined by a prioritized sprint backlog, which is determined together with a sprint goal before the start of each sprint by the team and Scrum master and others, if necessary, at a planning meeting. Throughout a project a burn down chart shows the amount of work left to do versus time over a given period [12]. In short daily Scrum meetings project members briefly present what they have done during the preceding day, which tasks they take on that day, as well as any challenges and obstacles that might have prevented them from carrying out their work without any solution being discussed. Scrums of Scrums are additional short meetings by the Scrum masters of projects, which consist of several Scrum teams. At the end of a sprint, a sprint review meeting takes place where the Scrum team, the Product owner, other management, and one or more representatives from the customer [11] assess the team's development process and progress in relation to the predefined sprint goal. Finally the Scrum team, the Scrum master and possibly the Product owner hold a meeting, called a retrospective, to secure learning and further improvement in the team where both the process and the product are assessed and discussed by each individual team member.

In our study we were interested in the impact of a specific method, namely Scrum on ISD. Our literature review was therefore focused on that particular approach and not in general on project management methods' or agile methods' impact on ISD. This limited our sources to writings which take their starting point in agile software development. We combined a concept-centric with an author-based approach [13] and applied backward referencing of sources. Our original search with keywords such as 'impact of Scrum', 'effect of Scrum', 'impact of Scrum implementation', and 'effect of Scrum implementation' primarily in Google, Google Scholar and IEEE sources lead to about 90 sources of which eight dealt more precisely with our research problem. An additional eight sources were identified through backward referencing. From that literature we derived a number of concepts and for these concepts indicators for the impact of Scrum on information systems and software development processes and projects. The resulting framework consisted of the identified, interrelated concepts team leadership, process transparency, productivity, quality, employee satisfaction, as well as customer satisfaction and a total of 38 indicators, which defined the concepts on a more detailed level. Here we are focusing on Scrum's impact on the concept of team leadership. We have reported and discussed Scrum's positive impact on productivity, quality, and employee satisfaction and its contribution to creating business value elsewhere [14,15].

Schwaber [12] emphasizes the importance of project and team leadership for ISD projects. In the literature on Scrum the concept of team leadership focuses on the role of the Scrum master and to some extent of the Product owner to support the functioning of Scrum teams; this includes the social aspects of project management and how social interaction between the individual team members is balanced against development processes, practices and tools [12, 16, 17]. Schwaber [12], Moe and Dingsøy [16] and Appelo [17] agree about the Scrum masters' importance to create engagement and working conditions that in a

professional environment allow for collegial relationships, cooperation, and creativity. Appelo [17] accentuates that a Scrum master should take care of the developers' wellbeing and address any conflicts in the teams. Teambuilding and reducing internal conflicts in the team is the indicator we locate here. Moe and Dingsøyr [16] and Appelo [17] put forward too that the Scrum master should remove barriers between developers and the Product owner and other teams, stakeholders, and units. They further contend that the role comprises to act as a problem solver, coach, facilitator and guardian and to protect the Scrum team as much as possible from unnecessary disruptions and disturbances, which assists in establishing a setting with uninterrupted workflow and peace to work. Marchenko and Abrahamsson [18] agree to this. We use these sources to investigate the indicator problem solving, and shielding staff and the workflow, and the indicator guarding and reducing external conflicts. Appelo [17] also in particular emphasizes the creation of motivation for the development team as an essential element of the Scrum master's leadership tasks. We use this as our fourth indicator for team leadership. Landaeta et al. [20] highlight the importance of continuous and organizational learning for Scrum projects and the role the Scrum master plays in ensuring that learning for the benefit of the organization and the developers takes place in these projects. We take the degree to which learning is supported by the Scrum master as another indicator for team leadership. A final indicator, providing of technical direction as part of team leadership, was identified through one interview during our pilot study with the case unit manager.

### 3. Research Setting and Method

We chose a case study approach to research the impact of Scrum on ISD processes and projects. The chosen case organization has approximately 40 years of experience in solving complex IT tasks. Some years ago it changed from being publically owned to a private company. It has about 3,000 employees, who are involved in the development of administrative and statutory software solutions. The investigated case department falls into the latter category and has 45 employees. Its sole product is a case management system for municipal job centers, which gives administrators the opportunity to work across different platforms. For the development of the case management system, the department previously followed the traditional waterfall model. In 2011 it launched the implementation of Scrum as the preferred development model. At the time of our investigation, the department had completed three full releases with the use of Scrum. As such, the department had the profile of the unit of analysis we were looking for: an organization that had recently, within the past year, chosen to implement Scrum, and that had previously utilized the traditional waterfall model. With the former model still in their minds we expected the employees to make candid assessments of the impact of Scrum as compared to the past.

As we were not able to make direct measurements such as the number of social conflicts within teams and between units, number of obstructions and uninterrupted development time, of motivating actions, of lessons learned, or amount of technical advice, etc., we chose to directly ask respondents about their perceptions of the given concepts. The indicators, which we had derived from the literature review, were therefore transformed into direct questions for our interviews, which we validated with 2 employees in a small pilot study<sup>1</sup> before putting them to the 11 interview partners, who were available for the study. We developed three largely overlapping interview guides for the three stakeholder groups, with six developers as respondents, four respondents in leadership roles such as Scrum master, Product owner or unit managers and one representative from the service department, who was responsible for customer liaisons. All interviews were recorded, transcribed and handed over to the respondents for approval. The results of our analysis were also presented to the participants of this study and the case organization at large.

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<sup>1</sup> As stated earlier we identified one additional indicator, which we termed 'providing technical direction' through the pilot study.

The data collection with standardized interviews allowed both collections of qualitative and quantitative data. We first asked the respondents to numerically assess, on a scale from -5 to + 5, for each indicator its individual change, improvement or decline, as compared to the situation before the implementation of Scrum and then to evaluate its impact on the concept in question, here team leadership. After that quantitative judgment we asked into the reasons for these assessments, which provided rich qualitative data. This combination of data allowed for data and method triangulation to improve the validity of our findings [20]. The subsequent analysis was based on mean values for the quantitative data within each indicator; these were interpreted on the basis of the qualitative opinions. The results were then compared and discussed with regard to published Scrum guidelines, findings from the literature, and related to CAS theory. It is worth pointing out that the numerical element of the collected data should be considered secondary. The interviews were intended to be the primary source to collect qualitative data with a statistical element - and not vice versa. The quantitative data was exclusively used to create an indication and an overview of any specific area.

#### 4. Results – Scrum’s Impact on Team Leadership

Table 1 summarizes the respondents’ assessment of Scrum’s impact on team leadership. Despite some individual variations the respondents’ mostly positive scores indicate their favorable assessment and an improvement in team leadership after the implementation of Scrum.

**Table 1:** Mean Values of Scores for Scrum’s impact on team leadership

	Improve- ment	Impact on team leadership	Range of score in both dimensions
Teambuilding & reducing internal conflicts	1.1	1.0	0 - 4
Problem solving & shielding staff & workflow	2.8	2.5	1 - 4
Guarding & reducing external conflicts	1.1	1.4	-1 - 3
Motivating the team	1.9	1.4	-1 - 5
Ensuring learning	1.7	1.6	0 - 3
Providing technical direction	1.0	1.0	0 - 4

##### 4.1. Teambuilding and reducing internal conflicts

The results concerning team building, which includes initiating team work and facilitating in case of conflicts in the team roughly fall into two categories: half of the respondents respectively had assessed this indicator as unchanged (0) on both dimensions, whereas the other half saw a significant improvement. A respondent, who belonged to the first group of respondents, stated the following about the Scrum master’s role: "It is a question of getting the team to work. I’ll say there are the same social conflicts than before, some do not go well together, others do; to get all those to work together, I think, that’s what the Scrum master gets a bit little closer to." This view that the same kind of conflicts prevailed was shared by several respondents. The new team composition had not changed this, but getting these teams to work was ascribed to the Scrum master. Others, who had set their assessment to 0 explained that they had not noticed an improvement, but no deterioration either, neither for themselves nor for their colleagues.

In contrast, some of those who perceived a clear improvement in settling personal conflicts credited this to the Scrum masters and their ability to create teams: "(...) there is a personnel manager, and our Scrum master to go directly to, and there is the product owner, who is not so much in touch with staff. There are clear reporting lines and procedures." "Well, it is because we are all busy together. It is not anymore "now I am busy, so we all have to be busy, and they all are busy." It’s that we all are busy together all the time, or we have fun together all the time; or we all are not-so-busy together. In other words, this feeling of belonging together across professional boundaries." "I think there is less conflict because you

sit together with the same people, across the different professions; the mutual understanding of what everyone is doing, increases. I think it's a definite improvement."

These three statements were made by the three respondents, who considered this indicator's improvement highest. The occurrence of fewer social conflicts is attributed to the fact that there is a designated leader staff can go to when a problem comes up. This counteracts the uncontrolled escalation of problems, while simultaneously a new sense of community grows that also prevents social conflicts from arising. Thus, although there were divergent opinions whether the number of social conflicts had changed and whether the new team feeling had an impact on this, an overall improvement had been perceived.

#### **4.2. Problem solving, shielding staff and workflow**

All respondents felt that there had been a positive development of this indicator. Managers' ability to shield their employees from disturbances as an important aspect of and positive impact on the developers' general workflow was emphasized. As one respondent put it "(...) on a daily basis, if we disregard those special periods, then I would actually say yes, the managers are really good to watch over us, so we are not bothered unless something has to do directly with Scrum, or something which is regarded as very important (...)"

In this context, the influence of the clearly defined leadership roles of the Scrum masters and Product owners and their ability to resolve problems was also highlighted "(...) I consider this a positive development, due the clearly defined leadership roles (...)." "I think that things got much better, there are some clearly defined roles, well, when there are some obstacles or issues in the team, they are up for discussion every morning, where the Scrum master will say "Well, I'll find that out" or where the Product owner takes it on, the less the team can handle the issue itself. So it has become so much better."

The positive assessment of this indicator and its impact on workflow was also ascribed to the improved team work as described above.

#### **4.3. Guarding and reducing external conflicts**

Generally, there was a very positive assessment of this indicator which deals with the managers' ability to handle conflicts with other organizational units and to protect their teams from conflicts with the units. Yet, some individuals felt that there had been no significant change. One respondent actually thought that there had been a definite deterioration:

"I think there is more conflict now because we develop in one way, and some other departments develop in a very different way. And so conflicts arise, as they cannot put themselves into our situation. Then, it is the manager's task to ensure that conflicts do not reach down to us."

Although this respondent has a negative perception of the overall situation, he also clearly indicates that it is the managers who take care of that the teams are not drawn into these conflicts. Furthermore, it was stated that conflicts with other units were also avoided because the teams under the leadership of Scrum masters were more self-organized, had the necessary knowledge and resources from the different areas in their team, and had developed a better understanding of each other's work which previous had been performed in different units. The managers' guarding skills and the new organization of work in general improved the relationship to other units. A respondent stated "(...) where one previous sat and waited for a specific group to finish their task, one always started talking negatively about them, blamed them, it was always their fault that we were delayed and so on (...)."

This new and dynamic way of working had both an impact on the amount of frustration and number and intensity of conflicts that arose between departments<sup>2</sup>, as these were now resolved by the Scrum masters and their more traditional counterpart project managers. The leaders and managers weighted improvement in this area high and they were content with the

<sup>2</sup> It had also a positive impact on productivity which is however beyond the scope of this paper (see [14]).

way conflicts were handled and kept from the teams, but opinion was divided whether they had improved in preventing these conflicts from happening.

#### 4.4. Motivating the team

The respondents perceived a positive development in the leaders' efforts to motivate and its impact on team leadership. One respondent however was quite negative and backed up this opinion as follows: "(...) with regard to leadership impact I may say -1. Because I think well, there sits a tester out in a team, and performs his tasks there. But I also come and ask him to test some other things for the sake of the whole project, which might go beyond the team's assignment. This must sometimes be difficult, we are several leaders who come at the same time and want some things. That creates probably a negative effect." This respondent believes that the distractions, which now sometimes come from the increased amount of different leaders, who try to draw on the same resource at the same time reduce motivation, but he provides no evidence for this. In contrast another respondent, who has scored both dimensions of this indicator high, the first dimension scored 5 and the second 4 justified his high scoring with the following statement: "With the 'leader' I think Scrum master right now, and our Scrum master is really, really good to keep the motivation up and to keep us going and to take care of that it is super cool to sit here and work." This enthusiastic opinion is based on Scrum's way to handle the leadership role of the Scrum master, but also on the individual Scrum masters' own ways to motivate staff.

Another respondent supports this with "(...) we celebrate the many small achievements, in contrast to before where up to 5 months passed from the time we started until we had finished, or 4 months or whatever it was. Now we have many such things. I do not know, I think management has been at a motivation course; all possible things happen, they hand out candy, they run all sorts of campaigns and slogans, they have theme songs for all the different teams. I think we joke more than usual, even though we are more productive than usual. So it's actually more fun to be here." This respondent was quite pleased with the way management had chosen to motivate staff. The frequent celebration of milestones due to a reorganization of the work, as well as the small initiatives helped to raise motivation and improved the work days. Another respondent shared the perception that motivation had increased since the unit had restructured the way it worked: "Well it's the one where you eat the elephant in small chunks; it is much better to say 'come on, we just have to finish this sprint'. It's much easier."

As a whole, the results for team motivation were positive, both managers and developers, with the one mentioned doubt, agreed that they were more motivated and that their motivation had increased.

#### 4.5. Ensuring learning

Most respondents shared a common positive perception of improvement in regards to learning and its impact on team leadership, but differed in their reasons for their scorings. The respondents' justifications can be divided into three groups: the first group thought that the assurance of learning through team leadership had improved to some degree; the second group also felt that an improvement had occurred, but that further improvements were needed; the last group perceived the situation as unchanged. As a representative of the first group a respondent made the following statement: "It is because we are running Scrum and my managers at least have realized that I think it's really exciting, and that I want to learn more, and have an aspiration to become a Scrum master myself at one time, and it also means I have been allowed to do new things, and have been allowed to learn things."

For this respondent it was the way in which Scrum was utilized and his aspiration for further professional development, which lead to his positive assessment. A respondent from the second group said "It's better, it's clearly better, but I do not think that everything that should be picked up, actually gets picked up. We mostly look at techniques and workflows, that's what we look at in retrospectives, not so much on everything else, whether it was a good way to develop, or whether there arise errors out of it, or whether we estimate correctly.

These are things we do not hear anything about, I do not get any lessons learned from it. I think we have become really good at that, but we also collected lessons learnt before, but it was well 2 times a year, no or 3 or 4 depending on the releases." This respondent had previously stressed that the retrospective meetings were only used to talk about method, techniques and workflows and not about the developed product as such. In view of this, he thought that there was still room for improvement. This position was shared by another respondent from the service department, who was even more critical: "(...) this, I've called out about long time ago, because as I say, now we spend hours and days with development telling us in service 'now you shall hear what we have built here, it can do this and this and that (...) Bye-bye, go home and do something with it.' Then we go home and write a service letter in collaboration with development and create some services. Then we come home after having been out in the field with these services, and the customers say "yes, yes, and what with this and what about this?" And we now have that knowledge. And I have then gone back here to management and development and said "okay, now we have this knowledge, where do I submit it?" This respondent had a very clear view that with regard to ensuring learning and securing lessons learnt further amendments were needed. From his perspective specifically the coordination and interaction between the development team and the service department was in demand of improvements.

Finally, a respondent from the last group elaborated very succinctly why he perceived the situation as unchanged: "The manager's ability to ensure learning. For my part, not existing before, and not existing now."

On this background we conclude that ensuring that learning was an area where the majority of respondents agreed that there had been an improvement, but where some acknowledged that more has to be done in this area.

#### **4.6. Providing technical direction**

In general, the respondents agreed that the situation with regard to the provision of technical direction through managers, now the Scrum masters, had not significantly improved or deteriorated. The following comment is an example of this attitude: "I'll say 0, for me this has no significance at all, and I do not think do better or worse, no I do not think so."

Most of the respondents shared the opinion that the provision of technical leadership would not necessarily contribute positively to the way the organization utilized Scrum. One respondent differed from the others, he put forward that only executing technical leadership provided a deeper understanding of what the individual Scrum teams are working with; he said: "(...) It requires that the Scrum master has a more technical understanding, where a traditional project leader might be good to manage and can do some Gantt charts, and that kind of thing, but not necessarily understands the technical things deep down; and that is how it is, but when you have to have things going, you need to understand the challenges that are there." This person chose to score the improvement dimension with 2 and its impact with 3. Another respondent was also quite excited about the increased technical leadership: "Well, from almost nothing, to actually get technical support, so I would say that we are up at a 4. Because there definitely has come a better understanding of the technique and how the world really hangs together, so it's not just plans and diagrams, it is actually also what happens deep down behind the curtain. I think Scrum has helped with this, also because the manager can go to the Scrum meetings, and actually get an idea of what is happening."

Moreover, this respondent argues that the Scrum processes and not the specific managers as such are the main reasons for the improvement in technical leadership. The two above cited respondents raised the otherwise mediocre rating for this indicator.

### **5. Discussion**

As mentioned earlier the investigation of Scrum's impact on team leadership in ISD was part of a larger study which both developed and applied a comprehensive framework

consisting of seven related concepts. Although a presentation of the overall result would give a fuller portrait of the method's impact, we have here focused on one of the key concepts mostly due to page limitations. This still provides some valuable insights and where necessary we will relate to the other concepts. As a starting point for our subsequent discussion we summarize the results of our analysis concerning Scrum's impact on team leadership in the case unit as follows:

Concerning the role of team leadership we found that there had been a positive change in the respondents' perception of all indicators. The first three of them refer to resolving different types of conflicts and issues. In relation to personal and individual tensions, the perception was that the Scrum masters had succeeded in reducing disputes and in facilitating in cases of conflicts. The respondents reasoned that this was due to the Scrum master's explicit focus on team building, the clearer reporting and communication channels in the teams, as well as the growing social ties and stronger cohesion in the development team, which was seen as a consequence of their new physical closeness. The problem area of workflow interruptions was perceived as the one, which had had the largest improvement. The respondents were delighted that their leaders fulfilled the clearly defined role as problem solvers and were able to shield the teams from any annoying disruptions to their work. With regard to conflicts with stakeholders and other organizational units outside the teams, the opinions were divided. Most respondents had experienced a positive change, but there were some, who had felt a decline. The reasons for a perceived improvement were related to the explicit guardian role the Scrum masters had taken on, the increased interdisciplinary collaboration in the teams and its accompanying increasing understanding of differing professional positions as well as the raising degree of self-organization in the teams under stable and strong governance from their Scrum masters, which decreased the necessary contacts to other units. With regard to team motivation the respondents' answers indicated a noticeable improvement, which was due to several reasons. The Scrum masters were praised for their explicit emphasis on encouraging staff and for their initiatives to frequently celebrate the achievement of goals and milestones. The restructuring of work as such, in multidisciplinary teams as well as its organization in tasks of manageable size and time periods were also provided as motivating elements. Ensuring learning, in contrast, was the indicator within the leadership role concept, where respondents saw most room for improvement, although overall they had felt some enhancement of that indicator based mainly on an increased number of opportunities to capture knowledge for further advancement of the development processes. These were, however, not yet used to their full potential. Finally, the leaders' ability to provide technical leadership also showed a perceived improvement. This was mainly attributed to the Scrum masters' active participation in the development work was credited as the other reason for the positive change with regard to team leadership.

These favorable results are in line with the results for the other concepts and their indicators, which with the exception of customer satisfaction were all very positive [1]. As with all qualitative studies of this kind we of course have to take the danger of positive bias and a respondents' tendency of reporting future expectations rather than stating actual perceptions into account. On this background, we now compare our empirical data first with the literature on agile ISD and project management and in particular the identified writings about Scrum. According to these sources, there are a number of areas that impact on team leadership, these are: Scrum master, Scrum team, self-organization, retrospectives and Scrum of Scrums.

The Scrum master of course plays a critical role in the team leadership concept. The Scrum master has a wide range of responsibilities to perform. The Scrum master's main function is to act as a facilitator for the Scrum team and to support the smooth operation of the Scrum practices. To rise into a successful Scrum master, an ISD project professional needs to be able to motivate, to shield and to guard as well as to ensure learning for the Scrum team [11]. In two of these three areas the Scrum masters in the case unit had achieved the desired effect. There was the positive advancement of guardianship and undisturbed workflow as well of provision and maintenance of motivation of the development teams. This had also a positive impact on the team's productivity [14] and the quality of the resulting products [15].



With regard to ensuring learning, the Scrum masters had been less successful. They had managed to improve the situation, but had not quite reached the potential benefits Scrum practices could contribute to in this area. The Scrum masters had also played a positive role in providing technical leadership. This indicator was not explicitly mentioned in the literature, but identified through our pilot study. This aspect of their leadership role had some significance for the investigated case unit. It led to a more active participation in the development process which in turn had a positive impact on the decrease of interruptions to the teams' workflow. It also resulted in the Scrum masters' improved understanding of the development process and the product under development. We thus found that technical leadership, not as a primary or sole quality, but in interplay with the other characteristics of a Scrum master appears to be an important contributor to the positive impact of leadership and the management of agile ISD projects.

A well-functioning Scrum team composed of members, who represent different professional backgrounds and co-located so that the individual team members can develop a mutual understanding and get insight into each other's work is important for reducing any individual and personal conflicts in a development team [11]. The team building and motivational measures instigated by the Scrum masters in the case unit had this effect and provide empirical support for the literature and the impact of leadership on the development of a collegial work environment in which conflicts are few and are resolvable.

The degree of self-organization under the leadership of a Scrum master plays a crucial part in the well-functioning of Scrum teams. Self-organization can be so immersed in a Scrum team that the team is experiencing familial conditions in a sense that close and long-term cooperation can create a very specific social atmosphere, which can strengthen the collegiate bonds and increase the team's functionality. This can be positive and negative; positive in terms of better cooperation, but also negative as strong bonds can lead to mutual cover-up and group thinking [11]. The case unit and its Scrum teams had not been quite reached that stage. They did however experience a significant reduction in both internal team conflicts and conflicts with other teams and units, which can be attributed to a functioning self-organization. The Scrum masters' balanced approach to self-organization met the objective described in the literature to protect and relieve individual team members from certain tasks. It created an environment where the developers were not constantly disturbed in their work. We also found empirical evidence that the achieved degree of self-organization supported and increased the Scrum master's abilities to motivate their teams as predicted in the literature. Moreover the case unit's form of self-organization had contributed to break down disciplinary boundaries and supported the development teams' workflows. In a successfully self-organized team, everyone should have insights into the other team members' tasks, while at the same time the Scrum master has a clearly defined role [11]. This means that when there is a need for input from a specific team member, the other team members are not unnecessarily disturbed, as the tasks have been clearly defined, broken down and distributed. If in doubt, the Scrum master is available to facilitate or solve the problem. This had been mostly but not yet fully achieved as the developers were still interrupted and disturbed in their work and further efforts will be needed to progress. However, one benefit of team leadership had been achieved already: the interruptions had decreased and if at all came from the right person.

Retrospectives established and facilitated by Scrum masters are a means to ensure learning where the project participants can benefit both from their success stories, but also from things which have not gone quite so well. According to the literature the benefit of retrospectives is largest when the reflection process does comprise both the more managerial Scrum processes practices, the actual development work, and the resulting outcomes as parts of the final product as a whole [12]. As the exploitation of retrospectives as an instrument to ensure learning through the Scrum masters and Product owners as part of their leadership in the case unit exclusively focused on the Scrum processes, it did not have the sought after extent of learning. It actually also affected the teams' productivity [14]. In the literature the avoidance of repeating errors is ascribed to retrospectives. In the case unit retrospectives had

not yet been applied to their full potential, yet the perception of the respondents had been that the repetition of errors had decreased. This was attributed to the influence that self-organization had because as a consequence of the increased individual developer's responsibility, team members had become more mindful not to repeat the same mistakes [14]. Individual and collective mindfulness have been reported as characteristics of agile development independently of a particular method or agile practice [21]. This supports the lack of exploiting retrospectives to ensure more learning in the case organization to some extent has been compensated by self-organization and mindfulness.

According to the literature Scrums of Scrums are often used in large, complex development projects, which are organized in several Scrum teams [12]. This Scrum practice aims at ensuring learning across the various teams. In the case unit project some participants took part in Scrums of Scrums; but there were no explicit and clear guidelines on how knowledge was to be harvested and transferred to the actual Scrum teams or for their preservation for future projects, ensured by Scrum of Scrum meetings. Thus the case unit did not follow the literature in this area. If the case unit develops such guidelines and sends its representatives to the Scrums of Scrum meetings with a clear assignment to come back with feedback to their team, this most likely will have an effect on ensuring learning across the different Scrum teams in the unit.

Our overall positive assessment of Scrum on the team leadership of agile ISD and project management confirms empirically the expectations and claims, which are made in many of the conceptual and non-academic writings we had identified in our literature review. It also fills a gap in the area of empirical studies of agile software development [22]. In the absence of quantitative data and with no possibility to make direct measurements and collect such data throughout the project it is however built on subjective perceptions. Nonetheless, on a more theoretical level our study can be related to complex adaptive systems (CAS) theory to find support for the positive impact of team leadership on ISD as one outcome of Scrum. CAS theory underpins agile information systems and software development methods [23] such as Scrum and the case unit appears to be rather successful after its transition to Scrum. On this background the above results can be linked to CAS concepts and principles. If ISD, in our case agile development supported by Scrum, is understood as CAS, certain characteristics of the process are recognized to facilitate good performance and thus productivity, while others inhibit it [10,24].

A number of concepts are frequently used when applying CAS. These core concepts are intertwined and mutually reinforcing. Within the area of ISD they have been summarized and put forward as follows [10,25]: Interconnected autonomous agents are able to independently determine what action to take, given their perception of their environment; yet, they collectively or individually are responsive to change around them, but not overwhelmed by the generated information flow. Self-organization is the capacity of these agents to evolve into an optimal organized form, which results from their interaction in a disciplined manner within locally defined and followed rules. Co-evolution relates to the fact that a complex adaptive system and/or its parts alter their structures and behaviors in response to their internal interactions and to the interaction with other CAS where adaptation by one system affects the other systems, which leads to reciprocal change where the systems evolve individually, but concertedly. Time pacing indicates that a complex adaptive system creates an internal rhythm that drives the momentum of change, which is triggered by the passage of time rather than the occurrence of events; this stops them from changing too often or too quickly. Poise at the edge of time conceptualizes a complex adaptive system's attribute of simultaneously being rooted in the present, yet being aware of the future and its balance of engaging exploitation of existing resources and capabilities to ensure current viability with engagement of enough exploration of new opportunities to ensure future viability. Poise at the edge of chaos describes the ability of a complex adaptive system to be at the same time stable and unstable; this is the place not only for experimentation and novelty to appear, but also for sufficient structures to avoid disintegration; CAS that are driven to the edge of chaos out-compete those that are not. The above analysis has provided examples of interacting interconnected autonomous agents, such as the involved Scrum masters and developers, their self-

organization as individuals and as project teams, their co-evolution through knowledge sharing and learning from each other, as well as for time pacing in the short development cycles, and for poise at the edge of time and chaos, for instance with regard to uninterrupted workflow, which thus empirically and theoretically lend support to the identified perceived positive impact of Scrum on team leadership in ISD projects and project management in our case setting.

## 6. Conclusion

While the usual disclaimers for the shortcomings of qualitative research also apply for our study, our work contributes to the body of knowledge in ISD with an empirical investigation that demonstrates the positive impact of the agile development and project management method Scrum on team leadership in ISD and project management and it provides a useful operationalization of the concept through six indicators. Despite the fact that the case unit had challenges with the use of Scrum, the indicators identified the areas where the company had achieved to exploit the potential of Scrum and its practices with regard to improving team leadership and its effects. Through the analysis we found an interesting area where the case unit differed from the Scrum literature's recommendations. The case unit's handling of retrospective meetings only reflected the actual Scrum process and practices, but not the actual development work and the developed product. This put the unit at the risk of missing out on any knowledge, which could contribute positively to future iterations and development projects. Therefore future research should further investigate the relationship between team learning and interaction of autonomous interconnected team members in retrospectives and how team leadership supported through Scrum both supports, but also results and improves from learning.

Although several authors underline the importance of an open organizational culture for agile development [10,26] and argue that an innovative and open organizational culture is necessary to develop software and manage projects according to agile principles we decided to disregard the concept as such as we assumed that the culture, its elements, the basic assumptions held by all members of that culture, their values and beliefs, and their artifacts and creations [27] and the cultural changes as a result of an implementation of Scrum would have an impact and become visible through the indicators. In other words, for culture as a broad concept we thought it would make more sense to be implicitly investigated through the team leadership indicators. In hindsight the relationship between culture and team leadership in the use of agile methods such as Scrum does however also merit a thorough investigation through future research on its own.

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