

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

**Karlheinz Kautz**

*Faculty of Business, University of Wollongong, Australia  
Wollongong, Australia*

*kautz@uow.edu.au*

**Thomas Heide Johansen**

*Progressive AS,  
DK-2730 Herlev, Denmark*

*thj@progressive.dk*

**Andreas Uldahl**

*Ernst & Young Denmark  
DK-2860 Søborg, Denmark*

*Andreas.Uldahl@dk.ey.com*

## Abstract

This paper contributes to research on information systems development (ISD) with a case study that demonstrates the positive impact of the agile development and project management method Scrum on process transparency in ISD projects. It is part of a project for which we developed a framework comprising of the six concepts productivity, quality, team leadership, employee satisfaction, customer satisfaction, and process transparency for investigating the impact of Scrum. It provides operationalizations of the latter concept through five identified indicators. Despite the fact that the case unit had challenges, the indicators identified the areas where it managed to exploit the potential of Scrum with regard to increasing process transparency. The research results are related to earlier findings concerning the other concepts. They are discussed both with regard to the existing Scrum literature as well as to complex adaptive systems (CAS) - a foundation for ISD and agile development.

**Keywords:** Scrum, process transparency, complex adaptive systems theory.

## 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, only little empirical work exists to verify these claims. The literature review, which was part of this study, 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 comprising the six concepts productivity, quality, team leadership, employee satisfaction, process transparency, and customer satisfaction for the investigation of the impact of Scrum [1]. As ISD has long been understood as a social process with an acknowledged importance of social interaction [2-4] in this paper we concentrate on one of these concepts which is explicitly related to social interaction, namely Scrum's impact on process transparency in ISD. In the remainder of the

paper we first briefly introduce Scrum, and then we describe our theoretical background and the research setting and method. Subsequently we present and discuss our research results against the existing literature on Scrum and relate them to our earlier findings concerning the other concepts of our framework which were explained in more detail in [5-7] as well as to complex adaptive systems (CAS) theory, a theory which is considered to provide a theoretical foundation for ISD [8] and in particular agile development [9]. We finish with some conclusions and an outlook to future research.

## **2. Scrum – An Agile Method**

Scrum is an agile ISD method with a strong focus on project management, which was formalized and tested by Schwaber and Sutherland in the mid 1990ties [10,11]. Scrum focuses on an iterative and nimble development process, emphasizing among others transparency, both in the sense of clarity and visibility and 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. It 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. The work process during a sprint is visualized on a public Scrum board which contains information about task status such as not started, in progress, finished. Throughout a project a Burn down chart shows the amount of work left to do versus time over a given period [10]. 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.

## **3. Literature Review and Theoretical Background**

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 [12] and applied backward referencing of sources. Our 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 8 dealt more precisely with our research problem. An additional 8 sources were identified through the other mechanisms. From that literature we derived a number of concepts and for these concepts indicators for the impact of Scrum on ISD processes and projects. The resulting framework consisted of the identified, interrelated concepts, process transparency, team leadership, productivity, quality, employee satisfaction, as well as customer satisfaction and 38 indicators, which defined the concepts on a more detailed level. Here we are focusing on Scrum's impact on the first concept. We have reported Scrum's impact on the other concepts elsewhere [5-7]. Process transparency refers to one of the areas that distinguish Scrum noticeably from the typical waterfall model development processes. It is argued that Scrum only works as intended if the whole process is at every point in time transparent both in the sense of clarity and openness as well as in the sense of visibility for everyone involved including those in leadership roles, the developers and the customers [10,11]. This view is shared by Moe and Dingsøyr [13] who emphasize the relationship between process transparency and team collaboration and effectiveness. Schwaber and Beedle [11] in this context stress the effect visibility has on conflict resolution when disagreements or misunderstandings arise in teams. These authors agree that practices such as sprints, different kinds of regular planning, information and review meetings as well as artefacts such as Scrum boards, Product backlogs and Burn down charts promote visibility and provide an overview and a status of the ongoing work. Sutherland and Altman [14] also make a case for the impact enhanced visibility of task and process status has on developers and their collaboration as they as members of development teams are constantly aware of their own and others tasks and responsibilities and thus are able to reduce waste time. We use these sources to investigate the indicators task status and overview and team collaboration. Another emphasis related to transparency is put on the planning activities in particular the introduction of an iterative, participative and frequently applied estimation process and the connected reliability and credibility of the resulting estimates [11]. We adopted both estimate credibility and estimation process as indicators for process transparency. Finally, these authors put specific weight on the relationship between customer involvement, customer satisfaction and process transparency as customer involvement both requires transparency, but also supports it. We therefore decided to include customer involvement as a fifth indicator for process transparency in our investigation.

#### **4. 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 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 in 2012, 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 used 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 neither make direct observations concerning task status and overview, team collaboration or estimation process nor measurements such as number of encountered and resolved conflicts or tasks finished on estimated time, 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 before putting them to the 11 interview partners, who were available for the study. We developed 3 largely overlapping interview guides for the three stakeholder groups, with 6 developers as respondents, 4 respondents in leadership roles such as Scrum master, Product owner or unit managers and one representative from the service department, which is 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.

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 process transparency. 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 [15]. 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 for the individual concepts were then compared and discussed with regard to published Scrum guidelines, findings from the literature, their relation to each other and to CAS theory. It is worth pointing out that the numerical element of the collected data should be considered secondary. The interviews were intended as 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 over any specific area.

## 5. Findings – Scrum’s Impact on Process Transparency

Table 1 summarizes the respondents’ assessment on Scrum’s impact on process transparency.

**Table 1:** Scrum’s impact on process transparency

	<b>Improvement</b>	<b>Impact on process transparency</b>	<b>Range of score in both dimensions</b>
<b>Task status and overview</b>	0.4	0.3	-5 - 5
<b>Team Collaboration</b>	2.9	2.1	-1 - 5
<b>Estimate credibility</b>	1.8	1.4	-2 - 4
<b>Estimation process</b>	3.0	1.5	0 - 3
<b>Customer Involvement</b>	0.25	0.25	0 - 2

### 5.1 Task Status and Overview

There was considerable disagreement among the respondents as to whether there had been an improvement or a deterioration concerning this indicator as the responses on both dimensions ranged from -5 to 5 on the scale. None of the respondents perceived this parameter as unchanged and everyone had an opinion. The answers were distributed more or less into two factions, one in which both dimensions were perceived exceedingly positive, and one where both were considered highly negative. A number of different reasons were provided for the negative assessments; however one issue was mentioned several times, namely that while the overview over the tasks and features that individuals worked on within the smaller sub teams had been improved, the general overview over the status of the whole actual release had decreased. The following responses illustrate more specifically what the respondents said about this issue:

"(...) Well, there may be a next delivery, it may consist of two PBIs [Product backlog items], or it may consist of 20 PBIs. There is not a chance to keep track. I go and check in the product backlog, but I have not found any system in the Product backlog yet to see it. And when I ask the others, then there is no one else who knows it (...)."

"(...) it is much harder now to get an overview of what is going on in the individual teams regarding the PBIs because there are many more small clumps, many more clumps across the teams. Unless you go to all Scrum meetings and you can actually figure out our very inextricable Product backlog, then it did not become easier. (...) or you have to walk down to the POs [Product owners] and look at their board, which is not very clear, so I do not think it has become easier."

"(...) before Scrum I would say that it seemed as if we had a better overview over what actually was going on, and we do not have that now, because now there are the teams which sit and work with small PBIs or something like that, so it has just become worse (...)."

The decomposition of functions into deliveries, sub-deliveries, and ultimately into Product backlog items had its negative sides both for some developers and leaders. The tasks had become small and were perceived as very confined so that overview and track were lost. It was possible to get an overview by looking into the Product backlog, but apparently this was such an arduous process — the Product backlog was perceived as poorly organized and implemented - that this was omitted by most respondents with the consequence that they lost their overall view of the task status. The following statement is worth highlighting as it places its somewhat negative assessment into the context of the new work practices:

"(...) It's more because now that you sit very good here with a PBI, and you really do not have to be concerned about what all the others (...) are doing, the less it is something which interacts with your area, but often when we are approaching a release, I'm actually quite curious and wonder what the others have done, because usually there is not that much time, and I only hear about it when we have our weekly meetings."

This respondent expressed that it actually was not necessary to know what the developers were doing, but that his unsatisfied curiosity still had the effect that he sometimes missed the lacking overview. Those who provided positive ratings emphasized that previously there had been no methods or tools to create an overview. Several of them also agreed that the decomposition of tasks had improved the general overview over the ongoing work significantly. The breakdown of tasks was thus perceived both as positive and negative, as it also had been blamed for a lack of overview, but for some respondents this was compensated for by Scrum's aptitude and capability to visualize things in physical form which was stated as one of the most important factors to establish an overview over the task status and thus contributed to process transparency:

"Well it is because some of the artifacts that come with Scrum, they get things out into the open; there is the one that you have the product backlog items, that you have bought into for the actual sprint are on the Scrum board. (...) And then there is that one that you get information out of the computers and onto the walls, this practice has just spread so much more than when we had the waterfall approach, so that's what I think."

## 5.2 Team collaboration

The responses on both dimensions regarding team collaboration ranged from -1 to 5 on the scale. This indicator showed the largest positive change in perception. The responses spanned in both dimensions from a slight decline to a large number of positive assessments from the respondents both across their job positions and their professional background with almost everyone agreeing to this positive development. One of the most important and most mentioned reasons for the improvement was the new way employees were physically located:

"(...) And that after we in the Scrum teams have been moved around, so that now we sit together in a team, and previously one sat with one's own profession, and now one has an integrated team, and is pulled together and we get to know each other much better."

Several respondents also expressed that previously there had been no collaboration across the different professional disciplines, which resulted in that this change was perceived as even more significant. As such cooperation had not existed in the past, this change made a strong impression on the individual employees. The respondents generally agreed that it had provided

a broader perspective and a better overview – one even expressed that he had learned to read code:

"(...) I know so much now about what we do, I can almost read the code myself because I have stood next to the developers so many times. I would not say I ever get around to program anything, but just to understand what it says on the sheets and the screen written in red and green, that is fantastic, isn't it."

This respondent ended up rating this indicator with 5 on both dimensions. A single respondent assessed the change negatively with -1. The expressed opinion and reasons however, indicate that the respondent had interpreted the question differently than the others:

"(...) Of course, it just so happens that when you are not sitting together any more, it gets worse. Socially, it has no effect even if you are not sitting together with the other 10 who work at the backend anymore (...)."

Although this respondent's assessment could or should not be compared with the other respondents due to the possible misinterpretation, in itself this opinion is interesting. It took an angle of the change that none of the other respondents had considered. Where the other respondents assessed whether cooperation across professional groups had improved, this respondent assessed how cooperation within the professional disciplines had changed, which for this employee apparently had not been a positive development.

### 5.3 Estimate credibility

The responses concerning estimate credibility on both dimensions ranged from -2 to 4 on the scale. During our interviews a tendency quickly became apparent concerning this indicator. The respondents mostly agreed that two actions had been the cause for an improvement of the estimates' credibility. These two actions were (1) the change of the scope of the estimation process, and (2) the change of who was responsible for the estimates. The following three quotes are reflections of the first measure:

"Probably it is the more defined and delimited process which is easier to estimate. So before we talked, you know, about 600, 1200 and 2000 hours. You can't really do that, and that was also a guesstimate for most of us, but that's often what happens when one has to estimate, but now it is, (...) we are much closer to estimate correctly. So I will say it has improved."

"It [the task] has been broken down, so now it is possible to estimate correctly. When there are small estimates, there is a difference whether you estimate something over half a year or for 14 days, as we run sprints in the moment, so it's easier to get it right."

"It has become much better because the estimates are regularly revisited, in the old days some analysts and some managers estimated something and then it was simply sent through the waterfall, nothing was ever revisited or revised; now estimations take place all the time."

Based on these opinions, we can conclude that Scrum's iterative workflow, together with a reduction of sprints to 14 days helped to eliminate or delimit some of the uncertainties which typically influence and impede estimates. The second measure regarding the change of responsibility for the estimations is reflected in the following respondent's opinion:

"I do not really think that estimates were actually made before. I do not think so. Well, I think there were some leaders who sat down and made some estimates. And it was a bit those that one followed. But now that it is those directly involved who estimate, it is obvious that estimate credibility has risen. So it has a positive effect on the estimates."

Assigning the responsibility for the estimates to the Scrum teams, according to this respondent, was the cause of increased credibility. A third point of view came from another respondent. This developer looked differently at the issue and thought that the estimates' credibility had decreased. This however was considered more of a temporary challenge as he reasoned that that was the case because the team itself was still quite inexperienced with regard to estimation and therefore had not yet got used to the process.

## 5.4 Estimation process

The estimation process had been identified as an independent indicator. To allow for a comparison the question concerning this indicator had only been posed to the respondents who held a leadership role as it were those who had performed the estimates in the past. The resulting responses on both dimensions ranged from 0 to 3 on the scale and pointed towards a significant improvement, however with a relatively small effect on process transparency. The following explanation given by one of the respondents represents the general opinion provided by this group:

"It is much easier than before, that is certainly a +3, I think, but then it is still really quite cumbersome and difficult, we have improved, but it is still not good."

When asked directly whether the improvement could be attributed to the implementation of Scrum the response was:

"Yes absolutely, but as we now have entered the Scrum arena, we are definitively not benchmarked as the best in class, we certainly can get much better."

These two answers indicate that the respondent had a feeling that the estimation process had improved, but that there was still room for enhancements before the case organization could compare itself with more successful and well functioning Scrum teams in other organizations. The reason that the effect on process transparency was perceived as less significant than the actual improvement was as the respondent, in line with the critical developer referred to above, emphasized that the case organization was still quite inexperienced with the new estimation process and therefore still in a learning process in which they gradually, from sprint to sprint, adjusted the way they used Scrum in general and the estimation process in particular.

## 5.5 Customer involvement

This indicator differed from the others in that almost all respondents indicated no change and answered 0 for both dimensions. This was not unexpected as the pilot interviews had pointed to that there had been little development in this area. As customer involvement is however a cornerstone of Scrum, it merits a closer investigation and the fact that the situation was nearly unchanged is in itself interesting. Despite the fact that almost all respondents answered 0 on both dimensions, there was a certain direction expressed in their opinions:

"(...) I can just say that it is my impression that there might be more [customer involvement]. But I do not think that it has something to do with Scrum, I think it is becoming more a general practice."

"I have no great insight into that area, but we have more focus on it today, but it has nothing to do with Scrum, that's what my immediate thought is (...)."

Thus, even if respondents agreed that there had been no change to be reported, they noted an increased focus on customer involvement as the organization apparently had recognized the importance of customer involvement and had started to provide the resources to do so. That the two above quoted respondents stressed, that this was not due to Scrum, about due to a general progression to more direct customer involvement, is still noteworthy.

Another remarkable facet of this indicator in this context was that the respondent representing the service department, the only department with direct customer contact was the only one who did not reply 0 on both dimensions. Instead, the indicator is rated positive with a 2 on both dimensions; however on the grounds that customer involvement, which was still very limited and only indirect in the case unit, was expected to rise. This is the only reason why the mean values on both dimensions were not 0.

## 6. Discussion

The investigation of Scrum's impact on process transparency in ISD was part of a larger study which both developed and applied a comprehensive framework consisting of six related concepts. Although a presentation of the overall result would give a more comprehensive

portrait of the method's impact, we focus here on process transparency as one of the key concepts. This still provides some valuable insights which we will relate to the findings concerning the other concepts that we have presented and discussed in more detail elsewhere [5-7]. As a starting point for our discussion we summarize the results of our analysis of Scrum's impact on process transparency in the case unit:

We found that there had been an overall positive change in the respondents' perception of all indicators. However the members of the case unit were not in agreement concerning task status and overview over the functions and features which individuals, small teams and the entire development team were working on. Some thought that more transparency and a better overview was provided through the physical visualization Scrum provided through Product backlogs and Scrum boards, while others sensed that the decomposition of tasks in smaller chunks contributed to a loss of feeling a wholeness and having an overview over the entire project and product. Regarding internal team collaboration there was a broad consensus that there was a significant positive development. Most respondents provided as a reason for this the new way the employees were physically placed closely to each other in the unit. As they were sitting together in their team, they had become able to complement each other across their disciplines, which created transparency and a new and better understanding of areas outside of their own and usual responsibilities. The majority of the respondents held the opinion that the credibility of the estimates as a basis for planning and carrying out the work had improved significantly. They reasoned that this was a result of organizing the tasks in manageable sizes and shorter time periods as well as of the fact that estimation now did not involve just management, but those who actually were to carry out the work. This argument was also provided for a perceived enhancement of the estimation process as such. The estimation process was felt simpler and more appropriate, but the respondents also saw room for further improvement to come with their growing experience with the process. Regarding the involvement of customers the respondents largely agreed that no change had occurred. Just the representative of the service department who was the only respondent with contact to customers had a strong positive perception of this indicator which however was solely based on expectations for the future.

Our study is built upon subjective perceptions; 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. However, the fact that the respondents reported no or only minimal impact on some of the indicators gives confidence that the reported efforts were genuine rather than showing a general positive bias. On this background, we 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 process transparency, these are: Customer and user involvement, Product backlog, Burn down charts, Scrum team, sprints, as well as meeting practices such as daily Scrum meetings, retrospectives meetings, sprint review meetings, and Scrum of scrums meetings.

Although we did not have access to customers we collected, to the extent possible, data about this indicator. The case unit had not utilized customer involvement as intended by the method. This was an area where there was room for improvement both with regard to involving customers in reviews, which could contribute to raising quality of deliveries, but even more so on an ongoing basis in all vital development activities. The lack of change in this area could be explained with the fact that the product was a standard solution offered for multiple municipalities with significantly different needs. Another explanation for not involving customers to a larger extent could however be that the case organization was concerned that individual incoming requests would be too diverse to be fully integrated in the standard information system under development. Another reason could simply be a lack of experience with customer involvement, a deficiency the organization intends to resolve in the future to make the most of Scrum. In any case many of the advantages customer involvement might have, were only to a limited extent and not as much as described in the literature [10] perceived by the case organization. Due to our limited data we will not pursue any customer related issues



further when discussing the relationship of process transparency to the other concepts which make up the full framework.

The positive effect of breaking down tasks into Product backlog items had not been perceived by all members of the case unit. The overview that a Product backlog creates [11] had not been conveyed well to and recognized properly by the individual developers. Instead, the smaller product backlog items had led to a decreased centre of attention on the entirety of the task and project, since the developers now put more focus on their own tasks. It was therefore not surprising that some respondents felt that the expected overview over the status of the tasks as well as features and functions which they as sub teams or as the whole development team were working on, had not achieved the desired improvement that a Product backlog could bring. The lack of the perceived adequate structure and management of the Product backlog was astonishing, as the product owners in the case organization used the possibilities to organize Product backlog items consistent with releases in their Product backlogs, which according to the literature should create process transparency. In contrast, the introduction of Burn down charts [10] unanimously had a positive effect on the task status and overview of the features which the teams and their members were busy with. Combined with the Scrum board it provided the developers with the opportunity to see what everyone was working on in the individual sprints, and how within and beyond a sprint work progressed. The case unit had followed the guidelines from the literature and benefitted from them which probably also compensated for the perceived problems with the Product backlog.

Furthermore the case unit followed the literature as intended regarding the composition and specifications for the expected benefits of Scrum teams [11]. The size and co-location of the teams as well as their multi-disciplinary composition created the desired dynamics and self-organization. As a result of this largely successful change the case unit enjoyed the benefits of the employees' newly acquired and enhanced mutual understanding and insight into their colleagues' work and the cooperation and team collaboration between them. The newly gained process transparency in the Scrum teams contributed to a large extent to employee satisfaction as well as to quality, in particular with regard to a significant reduction of defects per KLOCs (Kilo Lines of Code) as testing was now jointly performed by dedicated testers and developers who had roles as analysts and programmers [6]. Process transparency is also related to team leadership as a well-functioning Scrum team is the result of the Scrum master's leadership too. Such leadership allows for self-organization where everyone has insights into the other team members' tasks, while at the same time the Scrum master has a clearly defined role [11]. 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 to a large extent been achieved in the case unit [7].

In case unit the improvements with regard to the estimation process and the credibility of the estimates, were ascribed to the defined length of the sprints which based on shorter time periods and manageable tasks ended with executable functions, and not as in the literature [10,11] attributed to the utilization of the Product backlog. Estimation had become easier than in the past where the estimates had to cover a time period of many months. The case unit had chosen to bring down the length of sprints to 14 days, something which Schwaber [10] actually discourages new and inexperienced Scrum teams to do. For the case unit this however turned out to have been a good decision. Despite the fact that case organization was still in a learning process and only slowly matured its use of Scrum, it had successfully managed to make a significant positive change with the introduction of sprints. Although not mentioned explicitly by the respondents with regard to the indicators investigating process transparency daily Scrum meetings, retrospectives and Scrum of scrums meetings have among others the objective to create transparency. Daily Scrum meetings support that everyone in a team gains insight into what the others are working on and at the same time makes it difficult to conceal modest work efforts, as employees publically have to communicate and document their results [6]. The latter had a substantial impact on employee performance in the case unit. It affected productivity positively as openly explaining why a task took longer than expected had the psychological

effect that it deprived the employees of the opportunity to hide behind a task longer than necessary [6]. The increased number of meetings had however reduced the amount of uninterrupted development hours. This was outweighed by the fact that the meetings created better visibility, oversight and knowledge, which allowed employees to tackle unforeseen challenges better, which had a positive effect on productivity as waste time was avoided [6]. Retrospectives are intended to support transparency and increase the productivity among others as a result of the project participants' learning from their own and others' mistakes, so that they are not repeated in the next sprint or iteration. Retrospectives should address the overall application of the method, its processes and practices, and the more specific experience in the daily development work and its relation to the resulting product [10]. The latter turned out to be an area the case unit did not focus on and thus did not benefit from [5,6]. It can be explained with the case unit's early stage of utilizing Scrum and their lack of experience with regular retrospectives. Scrum of scrums should be used in large, complex development projects where several Scrum teams are associated [10]. The idea is to ensure transparency and the sharing and exploitation of potential knowledge that exists in different Scrum teams. The responses we received document that the way the case unit used Scrum of scrums had affected communication between the teams in a positive direction despite the fact that no clear guidelines for this communication activity had been developed [2]. Although it remained unclear whether the case unit used Scrum of scrums, as the literature recommended it, the use of Scrum of scrums did not only contribute to improve lines of communication in general, but also had a positive influence on the ability to monitor project progress. The interaction between the Scrum teams raised the common understanding of the individual Scrum team's status, where they positioned themselves as compared to the other teams and with regard to the development process of the overall product. Our overall positive assessment of Scrum on process transparency of the ISD process 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 [16]. 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 increase of process transparency as one outcome of Scrum. CAS theory underpins agile ISD methods [17] 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, while others inhibit it [8,18]. A number of concepts are frequently used when discussing CAS. They are intertwined and mutually reinforcing and have been put forward within the area of ISD as follows [9,19]: 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 developers and testers, 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 iterative development cycles, and for poise at the edge of time and chaos, for instance with regard to compliance to deadlines and uninterrupted workflow, which thus empirically and theoretically lend support to the identified perceived positive impact of Scrum on process transparency and as indicated productivity, quality, employee satisfaction [6] as well as team leadership [7] of ISD in our case setting.

## 7. Conclusion

The normative literature on agile ISD [10] postulates the importance of process transparency for ISD projects and puts forward several ways such transparency should be achieved, but provides little empirical evidence how and with what effect transparency is accomplished in practice. We fill this gap and offer empirical evidence and theoretical backing of how process transparency is achieved and what its impact is. As such our work responds and contributes to calls for research on visual management [20] and the visual dimension of organizing [21] and supplements work on visualization related to IS on process flow charts and PowerPoint as representations and inscriptions in IT projects [22,23]. It also extends work on the role of physical artifacts in agile software development [24] which hints both at the mutually intertwined and supportive, social and material, notational nature of story cards and wall boards. This work together with research on how development, implementation, and use of digital workflow visualization boards entangled in sociomaterial practices shape the focus of attention and facilitate integration of new operational practices [25] open up for further research on ISD in general and agile ISD in particular as sociomaterial practice [26].

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 Scrum on process transparency in ISD and project management and it provides a useful operationalization of the concept through five indicators. Despite the fact that the case unit had challenges, the indicators identified the areas where the company had achieved to exploit the potential of Scrum and its practices with regard to increasing process transparency and its effects. We also discussed how and with which impact process transparency was related to the other concepts of our framework. Although several authors underline the importance of an open organizational culture for agile development [9, 27] and argue that an open and innovative organizational culture is necessary to develop software 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 artefacts and creations [28] and the cultural changes as a result of an implementation of Scrum would have an impact and become evident 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 process transparency indicators. In hindsight the relationship between culture and process transparency 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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