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Abstract— **While uncommon, combining multiple forms of backlogs and scaled agile development is a challenge undertaken by some companies. This paper reports a study on communication with agile practices in a global software development organization distributed between three countries. The data was collected via interviews and observations in the department under investigation, and was analyzed qualitatively in order to describe how the use of backlogs affected communication among agile teams. The inconsistencies and transparency issues regarding the information between backlogs led to effects on communication.**

Index Terms— **Scaled Agile, Scrum, Global Software Development, Backlog, Communication**

INTRODUCTION

Communication in global companies is a key factor in successful software development. The use of agile methods, such as scrum, aids in improvements to the communication within development teams when used properly. For instance, the daily scrum is a way to improve communication among developers by incorporating face-to-face conversation into the daily routine. Effective communication helps the developers work more efficiently [4]. The developers can also communicate through and with the history in the product backlog which is a common Scrum technique [2]. However the communication within and between agile teams could be greatly affected by how the backlogs are used, specifically with having a break in media regarding different forms of backlogs. This particular break in media refers to the change from using an electronic backlog tool on a computer to using a physical tool such as a whiteboard with Sticky Notes, and vice versa.

In recent years, agile development has become more popular within the software industry in which 67% of companies use it and 24% of companies use some agile principles in software development projects [14]. According to Rajlich [17] the new process brings several new issues to attention in software engineering research. With a limited amount of studies done in this area and to the best of our knowledge, there have been no similar studies regarding either the comparisons between the communication while simultaneously using a physical and electronic backlog in

global organizations, or breaks in media affecting global communication.

The foundation used in this thesis is a scaled agile framework incorporated into several global software development teams reaching three different countries. The structure of the organization will be further discussed in the later sections. The software development effort we will be examining is within the Control Systems department at Volvo Group Trucks Technology in Gothenburg, Sweden. The department's use of the backlog is currently an electronic product backlog shared globally which is then divided into differing expertise areas. Cross-functional teams from each location then create a physical sprint backlog from the electronic board. We are aware that there is a break in the backlog technology within the company and we will investigate how this affects communication between different teams and between teams in different locations.

The purpose of this study was to investigate the communication between agile teams using different forms of backlogs for Volvo Group Trucks at Gothenburg, Sweden. The main research question was:

How do different forms of backlogs affect communication in a scaled agile global software engineering approach?

With the following sub-research questions:

- *How does the break in media affect the communication between agile teams in different countries?*
- *Is the physical backlog used as a communication aid within each team?*
- *Are physical backlogs used to facilitate communication between teams?*

COMMUNICATION WITH AGILE ORGANIZATIONS

Due to the limited amount of studies regarding communication and backlog management in agile organizations, the related literature section will begin with Agile and scrum methodology in general, then the scope will be narrowed down to communication and scrum in global

software development, and then finally to backlog management in global software development.

A. AGILE AND SCRUM

The term "agile methodology" was introduced in the year 2001 by 17 well-known software engineers [19]. These developers collaborated and developed a Manifesto for Agile Software Development. The Agile Manifesto is directed towards "Individuals and interactions over processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation and responding to change over following a plan" [20].

The most important advantage of the agile model is its ability to respond to the client's further changes during the development stage of the project [37]. This suggests that the agile model is flexible. The development team, project leader and the customer have an open communication towards each other. The client is involved in the entire process as the communication is continuous and not limited [19]. In agile software development, Scrum is the most commonly used method [21]. The focus of Scrum is to introduce the developers to a quick and flexible approach on delivering the product to the client [2].

Furthermore, Scrum can be used in large organizations [36] by applying the Scaled Agile Framework (SAFe) [33] [34]. According to Laanti [35] and Brown, Ambler and Royce [38], SAFe was presented at the Agile 2013 conference in August of 2013 with wide audiences. It is common that when agile methods are introduced into other organizational disciplines, other agile compatible practices are relied on. However SAFe contains practices to cover all three operational levels (Portfolio level responsible for investments, Program level responsible for plan execution and Team level) so that the use of additional practices are not needed. This also allows for Scrum methods, Kanban methods or a mixture of these to be applied in the team level [35].

Scrum practices include a product backlog, sprints, daily scrum, sprint planning, retrospectives and sprint reviews. [2] A product backlog is a prioritized list of features, containing short descriptions of all desired functionality for a product that is controlled by the product owner [28]. Tasks in the product backlog are chosen for each sprint based on priority and are then placed onto the sprint backlog. The sprint is a specified period of time, conducted in iterations, in which certain tasks should be completed. Each sprint is planned beforehand and concludes with a sprint review where the features are then demonstrated. During the sprint the team members conduct the daily scrum, which is a meeting lasting 15 minutes each day [26]. Three questions are addressed during the daily scrum which are: "What did I do yesterday?", "What will I do today?" and "What impediments are in my way?" [22].

B. COMMUNICATION AND SCRUM IN GLOBAL SOFTWARE DEVELOPMENT

Scrum methods have been used widely in global software development (GSD). This allows multiple teams from different time zones to contribute to the same software development project [29]. Some factors (such as physical separation of development teams, number of teams, number of distributions, team size, culture distance and the collaboration modes) must be considered in order to use scrum in GSD [32]. Some issues within scrum processes, such as access to the sprint boards, issue trackers and lack of effective collaborative tools, could also occur when using a global software engineering approach. Using a tool supports collaboration, project management, globally accessible backlogs, communication, issue tracking, and bug tracking could help to reduce these issues [22].

The scrum method is useful for improving the communication within software development organizations [7]. However, face-to-face communication could not be done in GSD as easily [24] due to having developers in several locations [23]. The communication within the agile GSD methods can be facilitated by email, teleconference [25], Skype [8], or a Web conference [26] [27]. The developers can also discuss the tasks and issues that occur in the project through the electronic product backlog [8].

C. BACKLOG MANAGEMENT IN GLOBAL SOFTWARE DEVELOPMENT

Many software development organizations use some kind of software tool for management and communication within the product backlog such as Jira or a Wiki. The product backlog can be accessed by all team members, no matter the locations [30] which supplies a means of communication among them. Traditional physical backlog tracking tools, such as index cards on a wall, are also beneficial within a local agile team because the developers tend to have discussions while at the board [8]. However, the traditional tool is not logical for backlog communication in distributed locations. In this case, electronic backlog tools are deemed more appropriate [28]. Using a variety of tools help GSD organizations increase project transparency and visibility which, in turn, supports the backlog management [22].

Though when combining the use of an electronic backlog with a physical backlog, some challenges may be uncovered due to the distributed environment [8]. This will be explored in the following sections in regards to the effects on communication among agile teams.

RESEARCH METHODOLOGY

The methodology used was designed and tailored for answering the aforementioned research questions. The data was collected primarily via interviews and non-participant observations at Volvo. The data was then analyzed qualitatively.

The techniques used for collecting data included interviews, non-participant observation, direct contact, literature reviews and documents supplied by Volvo Trucks.

Primary Data

The primary data is the most crucial data that was collected for this research. This includes the interview and non-participant observation data gathered from our time in Volvo.

a)Interviews

We conducted four individual interviews and one paired interview, which was done to conserve resources, with members of the different groups. The various roles interviewed included two group managers, one project leader, one product owner, one scrum master, and one developer. The purpose of these interviews was to gain information from a different perspectives regarding the quality of communication between teams, especially in regards to their use of the backlogs. The interviews were prepared and performed with the following steps:

Step 1 — Question Forming: The questions were written in a way that was aimed towards getting data that would be useful for answering our research questions while avoiding bias or leading terms. This was done according to Uwe Flick's four criteria used to design an interview guide. These criteria were: non-direction, specificity, range, and the depth and personal context shown by the interviewee [15]. After we completed our questions, we sought and utilized feedback from various people working in the software engineering industry with interview experience on a regular basis. The results of literature reviews, regarding communication among global organizations and different forms of backlogs, also helped us in forming these interview questions by finding answers to questions we hadn't previously considered.

Step 2 — Pilot Interview: An employee of Volvo was prompted to take part in a pseudo interview with the purpose of testing our interview structure and content. Our goals were to get constructive feedback of whether the questions were understandable and avoid bias. We also measured the time of this pseudo interview as our target interview time was planned for one hour per person.

The result of this pseudo interview was that our estimated time was longer than needed. The interview questions we had designed beforehand were appropriate to get the data we needed, however some minor adjustments were made to ensure the questions were clear from an outside perspective.

Step 3 — Interviews: We conducted four individual interviews and one paired interview in person at Volvo. The reason we conducted a paired interview was because of a time limitation. Of these interviews were two managers, one project leader, one product owner, one scrum master, and one developer. This allowed us to gain information from the different role perspectives. Each interview took approximately thirty minutes. Employees were interviewed individually except that one group manager and the project leader were interviewed together to conserve time for each party. One researcher conducted the interview and the other took notes and observed details. Each interview was recorded with permission from the interviewee and then later transcribed for referencing purposes in the coding and analysis.

b)Non-Participant Observation

The purpose of the observations was to gain knowledge of the normal working environment in which the team members interact with each other and with the backlogs. "Conducting observations involves a variety of activities and considerations for the researcher, which include ethics, establishing rapport, selecting key informants, the processes for conducting observations, deciding what and when to observe, keeping field notes, and writing up one's findings" [10]. While taking these things onto consideration, the goal of this non-participant observation was to carefully watch the interactions and try to understand them in depth while avoiding influencing the teams by our presence [9]. Some advantages of using this direct type of data collection were that it was the easiest way to study the behavior of those we were interested in and compare it to what we learned in the interviews, the problem of depending on respondents and interviews was decreased, and by using this a problem could be identified by making an in depth analysis of the situation. A disadvantage however was that if the subjects were aware of the reasons we were observing, they might have adjusted their behaviors to be perceived differently as usual.

The observations were conducted in three different groups for half of a day each in the Control Systems department at Volvo Trucks. Each group consisted of multiple cross functional teams located within the same office area, so each researcher observed the teams individually from opposite sides of the room. This was done in order to cover the entire area, to gain different perspectives of the interactions, and to later be able to compare the findings for any significant occurrences. The following steps define the process we used for collecting data via observation:

Step 1 — We created an observation template/schematic for field notes to structure the research and ensure all observers are looking for the same things. The AEIOU framework [11] was a practical foundation for our schematic because it included the Environment, Users, Activities, Objects, and Interactions. We modified the framework to include other valuable aspects as well. The schematic contained:
- Date/time the observation was held
- Person who observed
- Group number observed
- Observation item number
- Observation item time
- Observation environment
- Users involved
- Activity observed

- Object of the activity
- Interactions between users and objects in observation
- Extra notes to add addition information about the observation

Step 2 — Upon meeting the team members for the first time, we were sure to inform them of the purpose for being there, sharing sufficient information with them about the research topic. We also, as an ethical concern, preserved the anonymity of the participants in field notes to prevent their identification, and instead numbered their desks and used their job title where necessary.

Step 3 — We became familiar with the setting before beginning to collect data. This entailed learning where everything was and where the persons and objects of interest were located throughout the day.

Step 4 — We recorded every observation under the appropriate headings of the schematic we created in the previous steps. Every time something happened or an interaction was made, it was recorded.

Step 5 — We reviewed and clustered our observations into the themes mentioned in the interview section to identify patterns for analysis purposes.

Secondary Data

The secondary data that we collected in this study was some documentation provided by Volvo regarding the Scaled Agile Framework, photos taken for our own understandings, and notes regarding the electronic product backlog and sprint boards. The secondary data was used to help support the interview and observation data and to get a better understanding of tools used by the organization. This data also helped us form the organizational setting for this research.

Direct Contact

The use of direct contact allowed the transfer of data to be quite efficient when there was a simple question that needed a response. This type of contact was usually conducted via email, Skype, phone calls and also face-to-face. We used this informal method of contact when there was not enough information required to hold an interview or when we needed the information in a short amount of time. Also we used this direct contact when scheduling interviews and obtaining documents.

One discussion was held at Volvo with a group manager in which we discussed the aspects of SAFe used and about the backlog tools. This form of data was transcribed for later use in the analysis process. The names of people that we have had direct contact with were replaced with pseudonyms in order to be referenced while remaining anonymous.

Literature Review Methods

The purpose of the literature review was to explore, summarize and compare existing evidence concerning backlogs and also the break in media and its effect on communication within global organizations. Also it identified research gaps in which further investigation has been suggested, provided background to support our research questions, and aided in forming interview questions.

The literature review was conducted in the following manner:

2) Search Strategy for Literature

In searching for the literature, phrases from the research questions and topic were used to identify the primary keywords. The terms agile, scrum, backlog, global software development, global scrum, and communication were the keywords used in finding related literature. The words and combinations of them were used to find case studies, journals, articles etc. The databases used in finding the papers were Google Scholar, Chalmers Library and Springer.

3) Selection of Relevant Literature

In order to reduce the results to only those papers that were relevant, an overview was created. For each paper reviewed the following categories were recorded and organized in an Excel sheet:
- Paper ID number
- Literature Title (linked to the paper)
- Author/s
- Reviewed by (researcher name)
- Is it relevant? Y/N
- Keywords
- Description of Theories/Study
- Method/Statistics
- How is it relevant to our study?
- Keywords
- Link to summary (if relevant)
- Which research question it supports

A paper was considered relevant and selected if it passed one or more the following study selection criteria:

a) Inclusion Criteria
- Literature that describes Scrum processes (the most similar of the agile processes to what Volvo is using)
- Literature discusses the use of backlogs
- Literature discusses global communication
- Literature discusses communication between agile teams in different locations
- Literature provides advantages or disadvantages of having electronic or physical backlogs (not a mandatory criteria)

b) Exclusion Criteria
- Literature is a duplicate
- The title or abstract are not related to our topic of investigation

- The full document is not available
- The literature does not pass the quality assessment
- Literature that is not written in English

No documents were excluded based on date of publication.

4) Data Extraction

The data extraction pulled the information needed from the accepted studies to answer and support the research questions. For each accepted paper from the Excel sheet at I.C.3) there was an explanation of how and why it was relevant to our study. The relevance was directed towards which research questions or section of the report that the literature could support.

5) Quality Assessment

The purpose of the quality assessment was to decide the appropriateness of each study's design to our research objective, consider the risks of bias, and to determine the quality of reporting. An example of good quality research would be where the analysis methodology is appropriate for the type of data collection in order to answer the research questions. We considered these things when reviewing literature in order to prevent flaws in our own design resulting in bias. If, after we assessed the quality of the literature, it did not suit our research it was then deemed excluded.

6) Data Synthesis

Research synthesis was used to combine and summarize evidence from primary studies on a research question as well as document and assess the quality of its findings. [12] Referring again to the Excel sheet (mentioned at I.C.3), each relevant literature must also have had a written summary containing the important information that supported our research. The information could have been things such as the setting, year of study, study design, analysis methods, and primary outcome. [13, slide 39]

Qualitative Data Analysis

Our qualitative interview and observation data was analyzed with the following steps:

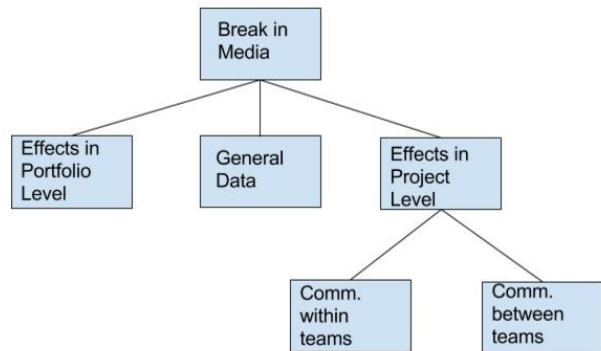### 7) Interview Analysis

Step 1 — Interview Transcription:

Each transcript included the interviewee's unique code, the date of the interview, the interviewer's name and the location the interview took place. The content of the transcript was structured by using, for each statement made, the respondent's code, the timestamp in which the statement began, the actual statement itself and any kind of gestures or reactions that happened in order to better understand the context of the conversation.

Step 2 — Interview Coding:

A spreadsheet was created to organize the interview content. Interviewees were categorized using pseudonyms such as Interviewee Role & Group Number. Responses were categorized first by theme, followed by response tone, then

timestamps and relevant quotes. The Grounded Theory Approach stated that interview results should be coded into different themes by identifying useful concepts where key concepts are marked and named [16].

Some preliminary themes had been defined for the data analysis with the expectation of emergent themes being identified later on. The preliminary themes were "break in media, communication within teams, and communication between teams" which were expected because of our research questions. The emergent themes were created because the preliminary theme was too broad for the information we received. These emergent themes were "Break in media in portfolio level, Break in media in project level, and General Data". Margin notes were used to gain insight into each theme, and to summarize the quotes. Once everything was coded, we ended up with two preliminary themes and three emergent themes. We then mapped our themes in order to help frame our research results. *Figure 1* depicts the concept map of themes from our data.

Figure 1: This concept map describes the correlation between themes in our research

Step 3 — Analysis:

The coded and themed interview data was analyzed by reading each data point and extracting useful information to answer each research question. This was done to determine a trend in behavior and communication. The responses and assumptions we drew were supported by the relevant literature in order to strengthen our argument. No further emergent themes were created at this stage.

8) Observation Analysis

Step 1 — Observation Coding:

A pre-defined spreadsheet, mentioned at I.C.b), was used to record and organize the observation content. Observation items were labeled and categorized by themes. There were two preliminary themes, communication within teams and communication between teams, and no emergent themes appeared for the observation data.

Step 2 — Observation Analysis:

The observations were analyzed using the aforementioned spreadsheet, which had been coded with observation themes. This data was analyzed by reading each data point and

extracting useful information in order to support each research question and to determine a trend in behavior and communication. The responses and assumptions we drew were supported by the relevant literature and compared with the interview data in order to strengthen our arguments.

RESULTS

This section presents the findings from the data collection. The results are discussed in the following structure: The software process in a scaled agile organization, Communication within agile teams, Communication between agile teams, Effects of break in backlog media, Break in media among agile teams, and Break in media with scaled agile development.

D. THE SOFTWARE PROCESS IN A SCALED AGILE ORGANIZATION

The department that was investigated in Volvo Trucks included approximately 120 employees of which are located in several different countries. The main purpose of this department is to produce controls systems technology software. The management structure of the department is as follows:

Under the department director are 9 specialized area groups. Of these 9 groups, 5 develop software and have teams working in different sites. Each group has a manager and an assigned product owner that communicates between the teams, project leaders and backlogs. Each group contains between 3 and 5 cross-functional teams that are distributed among three countries, and each team is made up of 4 to 7 members. Each of the teams includes verification engineers, software engineers, and system engineers. The teams are responsible for organizing themselves while the manager offers support and coaching.

The Control Systems department in Volvo Trucks uses a mixture of agile practices within the scaled agile framework. The department utilize practices such as: cross-functional teams (a group of people with different functional expertise working toward a common goal), daily scrum, sprint planning, sprint review, deliverable demos and maintaining a product backlog, Kanban boards. Each team has a scrum master who communicates between the product owner and other team members, manages the work schedule and does planning for the team. A scrum master interviewee also stated:

"Its [the scrum master role] mainly administration, or like have the DTL [Daily Team Leadership- the daily scrum meeting] scheduled, the planning scheduled, the demo of the sprints and then I would speak and communicate enough with the team members so they know that they're actually doing what we agreed with the product owner. "

There are several teams in each function group which are distributed among different countries. Each group has a product owner who prioritizes incoming work together with the project leader and communicates with all stakeholders around the incoming work. Team members have the responsibility for their task during each sprint. Each sprint is intentionally not filled up to full task workload in order to dedicate space to manage emergent tasks or issues. This is supported with a statement from one developer interviewee as mentioned below.

"Sometimes we need to fill up with some less important things maybe to have enough [work] in the sprint. We are also investigating to have one of the teams each sprint as kind of a stand by team to be more flexible to emergent upcoming things that need to be done. So they would be planned with the less prioritized things but more like improvements and maybe they fill up their sprint to half [the work load] instead of as usual. Usually, we fill up maybe 70%, if they get more margin to handle upcoming things."

However, the department combines scrum methods with elements of traditional software processes. Each group contains a manager to handle things such as coaching, supporting the members, making sure that all operational aspects are going well, etc. There are also project leaders who manage things like budget, project planning, communication tools, and so on.

The product backlog is in an electronic form which contains backlog items (BLI) which are prioritized by both the product owners and project leaders. Then each BLI is assigned to a sprint. Each BLI can contain multiple tasks which the teams can pick based on the priority. Each team member has active tasks which are transferred to the team's physical board.

Though individual teams inside of each group mostly work in the same area, some groups have teams in other locations. In this case, they communicate with each other mainly through the electronic backlog and other means such as email, skype calls, phone calls, etc. The co-located teams have the convenience of meeting in person and discussing through the physical backlog as well. Each team's physical backlogs, within a group, are placed relatively close to each other. Each team holds their 15 minute long DTL (Daily Team Leadership) at their physical backlog, however each individual team has a different time for their meeting. *Figure 2* shows a diagram that depicts generally how a group of teams and their physical boards are arranged.
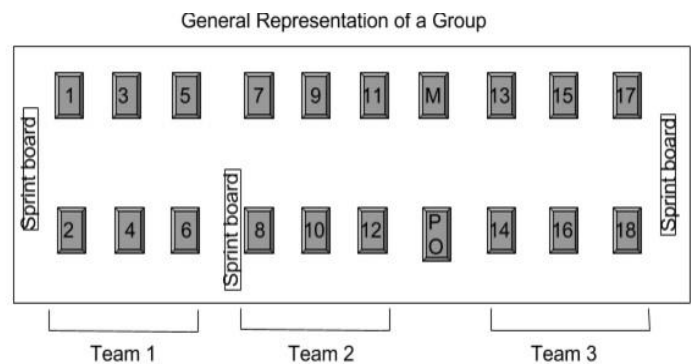
Figure 2: A general representation to depict how closely teams within a group are situated. Each team has a physical backlog

in the area. Also the group manager (M) and product owner (PO) are seated nearby.

While interviewing managers, it was made clear that they have little involvement with their team's physical backlogs. However our observations show that they do offer support and use the backlog as an aid in discussions. The physical backlog is used mainly by the cross functional team members and is solely for their day-to-day work while the electronic backlog is used to manage the entire project. All backlog items are contained in the electronic version which is managed mostly by the product owners. The project leaders can also use the electronic backlog for project planning, follow up progress, etc. The information in the physical backlog is transferred manually to the electronic backlog with an exception of the burndown chart, which exists only on the physical version. As discussed in a later section, this manual update often results in less detail of tasks and insufficient detail of what happened during the sprint.

E. COMMUNICATION WITHIN AGILE TEAMS

In general, the environment in which the teams worked in was very positive and open for communication as noted in the observations held at Volvo. There were several instances of collaboration and discussions at the physical sprint board regarding tasks. There was a large amount of face-to-face communication between product owners and team members daily in which some discussions were held at the physical sprint boards. The scrum masters that were observed had been involved in multiple discussions inside and between teams regarding progress of the sprint and problem solving.

The cross functional teams communicate through the physical sprint boards at least once a day during the daily scrum meetings (a.k.a. Daily Team Leadership). Though these meetings occur daily, the individual team members also tend to use the boards more frequently depending on personal preference and how near the end of the sprint is. Because the teams are located in the same working space, the members can travel easily to other sprint boards to see what is being done. As mentioned by the product owner from group 1, having the physical sprint boards allow teams to work more freely and to decide how to function most efficiently among themselves. One interviewee expressed that the physical sprint board was the more preferred form of backlog to use during the DTL meeting *"...because of the physical size [of the board itself so that everyone can gather around it] and the easiness to change it [in terms of adding tasks and moving them to the different sections on the board]."*

In regards to the use of the physical sprint board and communication within the team, it is common, when a task is finished, to *"move the note [sticky note used to represent the task on the board] to verification and then ask who can verify it."* Some have stated that, if no physical sprint board was used, teams would have a harder time seeing their progress, who has which task, and if some task is not taken. However many also say that if there were no physical board, that it is easy to just communicate from desk to desk or find another way to solve problems.

F. COMMUNICATION BETWEEN AGILE TEAMS

Due to the teams, in a group, being located mostly in the same area, there have been numerous instances of cross-team communication regarding tasks, progress, and collaboration. By cross-team communication, we mean when members from different cross-functional teams communicate with each other. It was evident from the interviews that the teams find it beneficial and efficient to be located next to each other while the sprint boards are in the same area with them. This is supported by the scrum master from group 2 when saying *"there's, communication wise, a very large advantage of sitting together. It saves a huge amount of time and that is because you actually solve a lot of problems when you meet in a corridor. Or fika rooms [break rooms]. That's very efficient compared to the alternative."*

From the observations we saw that, because they were in the same area, the scrum masters and product owner could easily move from board to board to discuss tasks and sprint related things. Many occasions have been observed where the product owner has been involved in such conversations between teams. Not only was there communication between teams in person, but also phone calls were made to teams in other locations to check on progress and to ask questions.

While each cross-functional team held their DTL each day, it was not uncommon for members of other teams to drop in to listen to the meeting. This was observed in more than one team's DTL. Also as mentioned by one manager, other teams can walk through the working area and quickly look at each other's boards. *"You are crossing them [physical backlogs in the corridors] every day and you can have a look quickly at the board at least when you work and each and every team there doing the board is never far away ...if you have questions."*

The physical backlogs were used to facilitate communication between teams, especially during the sprint planning. The software engineer from group 3 have stated that:
"We try to have several common meetings where all teams participate. Either, everyone or some people from each team. When we plan the sprint, we have some common planning, have a session when we give feedback on the planning between all the teams, and then we have team-wise individual planning."

And that there are *"three cross functional teams that... do a common sprint planning and demo and so on.*"

However some people have mentioned that they rarely look at other team's backlogs. One interviewee stated that it would mostly be a waste of their time while the other wasn't sure why they didn't look at other boards.

Another important finding, however, was that for the teams to communicate between countries, the physical backlogs were not an option. They did not have the same convenience for communication around the physical boards like the co-located groups did and relied mainly on the information inside of the electronic backlog instead.

G. EFFECTS OF BREAK IN BACKLOG MEDIA

The break in backlog media allowed for inconsistencies to form while transferring information from the physical board to the electronic one. Some details in the physical board were lost in the information flow, such as the burndown chart which did not exist in the electronic version. This information was not available for teams in other locations via the electronic backlog as supported by an interviewee:

"If the physical sprint board is not updated into the electronic system, then of course you lack some information in the electronic system. And, as long as the other teams, I think the France team for example, doesn't really have that good view of what we are doing in sprint here, except for what in the electronics system "

According to the manager from group 3 we interviewed, to read the progress in the sprint the best indicator was the burndown graph. *"If you look at the burndown graph then you understand a bit where we are or if we are going to achieve or not the sprint."* On the other hand, things such as relationships between files were not represented on the physical sprint board as they were on the electronic version. In addition, the electronic backlog contained more detail about the individual backlog items than compared to the physical version - *"sometime it can be hard to understand what you mean, if you just read the note since you write down the text and it's not always easy to understand. Maybe sometime you will have to check the number and read the full details in the electronics system"*, so it would be a problem for the engineers sometimes to find out what they should do with the tasks.

Due to requiring manual updates for the transfer of backlog item details between both forms of the backlog, physical and electronic, this leads to the loss of some information if not done correctly. The manager from group 3 also expressed that *"because you lose some,... some miss-documentation due to the fact that we wrote many things as it happened on the board and so on, so at the end, people are lazy often to write and I mean you have some information lost."*

However, in the case that the information is not transparent enough, other methods such as a telephone call, email, skype call, face-to-face discussions, etc. are used for communication.

H. BREAK IN MEDIA AMONG AGILE TEAMS

While the teams in a project often work from different locations, they communicate mainly through the electronic backlog which is managed by the product owners. The interviews revealed that the communication through the electronic backlog is usually between the product owners and scrum masters. The inconsistency of information between backlogs is brought into light by a software engineer from group 3 stating:

"Maybe if someone add a task or backlog item, they didn't write all information clear enough or not at all. And then of course if someone else start working on that, it's hard to know what has to be done. Maybe you did spend half of the day just looking around for people try to find out what's going to be done."

According to the scrum master from group 2, they generally use the electronic backlog for the communication to the other teams instead of the physical board. Every task they have to document why they did something and then everything is stored in the electronic backlog. The physical ones are for the teams, themselves, to gather around and show the clear priority while the remote teams rely mainly on the electronic backlog to have all necessary information.

Though teams rely on the electronic backlog for information from other teams, it is more complicated for them to use. As a software engineer in group 3 stated in an interview:

"It's hard to find the information in the electronics system because you don't have connection always between different things [connection between tasks], it could be hard to find the information sometimes. It's a bit complicated to use from time to time".

It is not easy for a software engineer to find the tasks they have in the electronic backlog and requires much more effort to use as compared to the physical backlog. People can look at the physical board and get overview of the sprint easily.

The physical backlogs are more there for the team's daily use and the information is then translated into the electronic version with less detail regarding specific decisions or problems discovered during the sprints. However most of the interviewees expressed that the break in media does not create an issue in project communication for them, and that the information provided in the electronic backlog was transparent enough. The project leader and manager from group 4 stated:

"I mean a disadvantage would of course be if there is an information on the physical board which is not transferred to the electronic one if that's needed. But I don't see it as a problem actually. "

I. BREAK IN MEDIA WITH SCALED AGILE DEVELOPMENT

A project leader we interviewed mentioned that they have little, to no, part in using the physical backlogs of each team

and that they mainly use the electronic one. They also stated that because each team member chooses their tasks during a sprint and the ownership is only visible on the physical backlog, it is hard for them to directly contact someone responsible for a task without first going to the corresponding product owner. The project owner said during an interview:

"One negative thing is that the rest of organization is handling projects, and nobody's assigned to projects here [in the control systems department]. They're assigned to teams that are not assigned to projects [can have multiple projects] and they have different BLI's, or tasks to do. And that can be annoying for the project leader, they like to see who is doing that work for me [product owner], and I like to talk directly to him. The project leader would like to have people in project teams [people in a team working on one project], we are not divided in that way. And the rest of organization, a lot of them are divided in that way but not we, not control systems."

However many interviewees, including managers and project leaders, have stated that the missing ownership in the electronic backlog is not a big concern in the communication. They have mentioned that even though the information is only on the physical backlog, it is not really so important for them to see the physical board as it is for the engineers. One project leader stated during an interview that "*the easiest and the best [method of communication] is of course talking face to face.*" As the project leader expresses:

"It's for sure easier [for communication] if I have a team in Gothenburg [Sweden] than in Lyon France] so to say. But the [physical] board itself is not important. No, it's more the daily talk between the product owners. I mean [for] the developers that is a gain."

DISCUSSION

Our research explored communication with backlog management in scaled agile software development from the perspective of the Control Systems Department of Volvo Trucks in Gothenburg Sweden. We interviewed and observed various members from 5 different function groups within the department. The results of our qualitative study reveal that distributed agile teams face minor communication challenges caused by having a break in backlog media, however they aren't regarded as issues in the department because they have adapted to the challenges.

As shown from our results, for cross-functional teams to be fully aware of how well the sprint is going, the burndown chart is the main indicator of if it will be completed or not. However the burndown graph is only a component of the physical backlog which means that teams in other countries cannot view this. This is only a minor challenge because other solutions have been put in place to adapt to this. If there are questions then a phone call can be made. The physical board is more beneficial to teams operating in the same location because they are the ones who can see and use them. In addition, it is also more efficient to use for the daily meetings due to the physical size, ease of moving things around, and the ability to have everyone stand around it and discuss. This validates that the physical backlog is an aid in communication within the cross functional team *(Research Question: Is the physical backlog used as a communication aid within each team?)*. Berczuk [8] also supports this when stating:

"When the team was located in one room we used traditional backlog tracking tools including index cards on a wall and a burndown chart generated using a spreadsheet approach. The team liked the visual feedback that this provided."

The physical backlog is also used to facilitate communication between teams in the same location *(Research Question: Are physical backlogs used to facilitate communication between teams?)*, especially during the sprint planning. All teams in a group have a joined sprint planning where they take tasks and use the backlogs. Referring to *Figure 2*, the use of physical backlogs are beneficial for teams working in the same location because team members can easily walk across the room to view another team's backlog and have discussions about tasks. Also according to our interviews, the co-located teams prefer to use the physical backlog while working together. The reason being that, due to the large size and complexity of the electronic backlog, there are usability issues that are more easily overcome by using the physical backlog.

In the context of global software development, the physical backlogs simply aren't feasible for globally distributed teams because an average project includes development teams from multiple locations, in which an electronic backlog is required. This electronic form of backlog is what connects all of the teams to each other and the project. Because the department uses different forms of backlogs, the information within each form must be updated manually to ensure transparency in all locations. These manual updates lead to an inconsistency of information between them.

Both, the physical and electronic backlogs, serve different purposes in projects as the physical backlog aids in daily work for the teams and the electronic backlog aids in collaboration in different locations. However the insufficient manual updates between the backlogs cause transparency issues in a sprint due to the inconsistency of information in the team *level (Research Question: How does the break in media affect the communication between agile teams in different countries?)*. Marchenko and Abrahamsson [28] support that the electronic backlog tools are best suited for use in global software development. Hossain, Babar and Paik [22] further suggest that *"..globally accessible backlogs help reduce misunderstandings and improves team collaboration processes"*, while Berczuk [8] suggests physical backlogs for teams within the same location.

The inconsistent information between different forms of backlogs is also an issue in communication in the project level. Though this is an issue, most of the interviewees agreed that it can be solved by other means of communication such as skype, telephone, video conference, etc. It is supported by Paasivaara, Durasiewicz and Lassenius [23] that using different communication tools helps improve interactions and communication.

We can conclude that there are effects to communication in global software development while using different forms of backlogs however the department does not regard it as a problem. They have realized these affected areas and adjusted accordingly with the aid of other communication tools. *(Research Question: How do different forms of backlogs affect communication in a scaled agile global software engineering approach?).*

J. LIMITATIONS

Regarding global communication, we didn't have the available resources to gain the direct perspective from a globally distributed team member. However we have insight regarding communication with global teams from the managers and local team members who regularly communicate across locations. The key members of communication, however, are located in Gothenburg, Sweden (such as group managers, project leaders and product owners).

K. RECOMMENDATIONS:

In order to reduce the amount of inconsistencies between backlogs, notes could be made of important things that are said during the daily scrum and then be updated into the electronic system afterwards. The remote teams and also the project leaders could gain a more transparent view of the sprint from this since the electronic backlog is their main source of information regarding other teams. However if this is not deemed feasible to the department, it could be beneficial to explore new technologies such as a digital smart board. This tool generates a graphical user interface representing an electronic scrum board that offers the same visualization as the physical backlogs but incorporates features inspired by the use of a physical board. For example, *"the movement of the sticky notes can also cause movement of a corresponding sticky note on another [virtual] scrum board if the task is linked"* [39]. The software for these smart boards may not be advanced enough at this time, but it is progressing and could be a potential solution in the near future.

CONCLUSION

This study investigated the use of different forms of backlogs within agile teams and the effects it had on communication for Volvo Group Trucks Technology in Gothenburg, Sweden. The data was gathered by conducting interviews (employees) and observations with the teams within the Control Systems department. The data was analyzed qualitatively by first defining themes and then grouping the data accordingly. We analyzed effects of the break in media on communication in scaled agile software development. The communication within team and between teams are also taken in the account.

The results of the study show that the break in backlog media does have effects on communication in global software development however these effects are not regarded as an issue. Though there are effects, the break in media allows each form of backlog to serve a different purpose. The physical backlog is used mainly for the daily communication within and between teams that are in the same location. On the other hand, the electronic backlog is used for overall communication in the project, especially between the teams in different locations. The usability issues regarding the electronic backlog are a main factor that promotes the use of the physical backlog in communication within the teams. Insufficient updates between the backlogs lead to inconsistent information between the backlogs however, because of other communication tools used, it is not regarded as an issue within the department.

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