Agile Project Management Challenges

Analyzing and Exploring Agile Project Management Challenges from a Practitioner Perspective: A Case study on HMS

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ABSTRACT

Problem: Agile project management methodologies have been used widely to handle and cope up with the changing business environment. Hence lot of organizations are making the transition from the traditional project management methods to agile. The contrasting characteristics of traditional and agile method creates lots of challenges for the practitioners during the transition and adoption process. The transition process affects all aspects of organization. Most of the studies have addressed agile adoption challenges in software industry, but there exists lack of understanding on how agile can be adopted to other domains.

Purpose: The purpose of this thesis is to explore and analyze the challenges that occur during the transition and adoption of agile project management methodologies especially in product-based SME’s. This thesis aims to explore practitioner challenges at organization/management level, team level and individual level and maps the identified challenges to respective dimension from which the challenges occur. This thesis also presents how agile methods have been implemented in a product-based company, compared to text-book scrum practices and also provides implications for future research.

Research design/Methodology: To fulfill the aims and objectives of this study a critical literature review was performed to collect and summarize what is known in the literature about the project management methodologies and the challenges are encountered during the transition and adoption process. Next an -in depth case study was conducted in HMS, which is a SME that develops both hardware, software and firmware for IoT communication. The case company uses scrum for software and firmware development. To explore challenges a semi-structured interview as well as observations were carried out within the case company. The interview data along with the field notes from observation were triangulated to cross-check the findings from the interviewees. Moreover, the thesis adopts an abductive approach that goes back-and-forth between the theory and the empirical findings in order to develop a research model.

Results: The findings reveal that practitioner challenges are complex, diverse and multifaceted. The identified challenges were grouped based on themes within each level. It is also found that most of the challenges arise from the people and process dimension. Some challenges specific to the firmware development and most of the challenges general to software development are identified within this thesis. It was found that scrum has been practiced differently compared to text book scrum, and hence it creates new challenges for the practitioners. Moreover, there exists difference in opinion when looking at same challenges from different levels within the organization.

Conclusions: This thesis has aimed to fill the knowledge gap by providing an understanding of how scrum is adopted in a different domain beyond software. Most of the challenges occur as a result of lack of knowledge and understanding about agile values and principles. Scrum is a people-centered methodology and the success of it is very much depending on both the people using it and the people surrounding the Scrum team. Another reason is that Scrum does not specify how the work should be done, for example in the areas of architectural design or testing or organizing the team. It is up to the team to decide such things, and thus, it can be challenging for each team to find what works for it. It is found that agile adoption in a product-oriented firm is a slow process, but
surely has benefits from adopting agile methods. This leads to a conclusion that agile has a growing trend to be adopted to other firms, moving beyond the software industry

**Keywords:** Agile project management, challenges, barriers, transition, adoption, firmware development, software development, scrum, SME.

**LIST OF ABBREVIATIONS**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>SME</td>
<td>Small-Medium sized Enterprise</td>
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<tr>
<td>XP</td>
<td>eXtreme Programming</td>
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<td>SDLC</td>
<td>Software Development Life Cycle</td>
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<td>PLC</td>
<td>Programmable Logic Controller</td>
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<tr>
<td>DSDM</td>
<td>Dynamic Software Development Methods</td>
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<tr>
<td>OOPSLA</td>
<td>Object-Oriented Programming Systems, Languages and Applications</td>
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<td>ROI</td>
<td>Return-On-Investment</td>
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<td>NFR</td>
<td>Non-Functional Requirements</td>
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<td>HMS</td>
<td>Hardware Meets Software</td>
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<td>IoT</td>
<td>Internet of Things</td>
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<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
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<td>WiP</td>
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1. INTRODUCTION

Due to technological advancements, the industries are facing rising competition from the business environment and forces them to adapt to environmental changes and keep track of it to sustain the competition in the market. As a result, the organizations are using project related activities to handle large and complex projects. This saves a lot of time and helps to effectively manage resources and adapt to fast changing business world. Thus, having a project management model that complies with these advances is becoming increasingly important for organizations (Comella-dorda, Lohiya, & Speksnijder, 2016). One project management approach that has been adopted following technology’s increasing influence is agile project management. Agile methods are used to increase operational swiftness and efficiency and reduce costs (Ika, 2009).

Besides Agile project management there exists a project management technique termed as “traditional project management”. In software development settings agile project management is useful since it enables software development teams to continuously respond to requirement changes and to obtain feedback with every iteration (Dingsøyr & Lassenius, 2016), which differs from traditional project management where requirements are submitted prior to the project launch. Unlike conventional methodologies, agile methodologies don’t have a pretension to know all the requirements beforehand but focus on small functionalities that are integrated continuously and released to customers for getting feedback. The paradigm breaks in the way the software is developed, allowing the absorption of new requirements and even possible changes in the requirements already developed (Wysocki, 2014). In traditional projects the requirements have to be clear before the initiation of project and the whole product is delivered only at the end of the project and fails to adapt to frequent changes (Wysocki, 2014).

These contrasting characteristics of traditional project management and agile project management set-up for a number of potential challenges when organizations undergo transition towards agile project management. Considering the challenges as a barrier to adoption of agile, this thesis aims to explore and analyze the challenges faced during the transition and adoption of agile methodologies. To date, agile methodologies are widely used in software development firms. But recently, agile methods have witnessed its adoption in different industries like construction, travel, healthcare, product-based firms. Most of the existing studies address challenges explicit to software development firms but this thesis aims to explore the challenges related to product-based firm which is less studied in the literatures. This has led the author to the inspiration for this thesis, which aims to provide broader understanding of how agile has been practiced in real-time environment compared to text book scrum practices and the different challenges encountered by agile practitioners at different levels within the firm.

1.1 Background and Significance

Today organizations are increasingly using project-based activities, to deal with complicated, uncertain, time-consuming assignments, as well as achieve their strategic and operational goals (Tseng & Lin, 2011). Scholars and managers have devoted great deal of attention to understand how organizations deal with these unstable business conditions. Since it becomes harder to predict the future, firms are now trying to put new methodologies in place to become more adaptive rather than being predictive (Fowler, 2000). Two extensive project management methodologies exist, and
they are traditional project management and the introduction of agile practices within organizations was used to answer the complexity of the firm environment – internally and externally (Goldman, Nagel, & Preiss, 1995). Traditional project management entails extensive planning process in the initial stage of the project, where the scope is defined clearly, project task duration is estimated and positioned on a timeline, and the budget is carefully considered (Nicholls, Lewis, & Eschenbach, 2015). This method advocates a strict, controlled and sequential process to obtain high quality successful outcome (Svetlana Cicmil & Hodgson, 2006; Engwall, 2003; Hass, 2007). On the contrary, agile project management has focus on processes, collaboration, and self-organization (Pope-Ruark, 2015). Originally, agile project management methods were developed in-order to overcome managerial difficulties when using traditional project management approaches in software development industry (Highsmith, 2001). Due to dynamic environment we live in, project teams should work hard to maximize customer satisfaction, whilst working within limitations such as scope, quality and schedule while reducing risks (O. Lee & Baby, 2013). Due to this reason more and more project management practices are agile, which leads to quicker reaction times, and more effective project work (O. Lee & Baby, 2013).

In present times, agility is considered as an essential ingredient for not only gaining a competitive advantage but also for survival (Ganguly, Nilchiani, & Farr, 2009; Morris, Ma, & Wu, 2014). Although agile approaches promise to reduce time and cost, moving from traditional approach to agile approach is not an easy process (Boehm and Turner, 2009) and has its own obstacles and challenges. Several challenges have been discussed in the field of agile project management. (Serrador & Pinto, 2015) conducted a largescale quantitative study to test if using agile methods has an effect on project success. They found indications that the use of agile methods correlated to a higher reported success rate. This was shown for three categories of success; overall project success, efficiency and stakeholder success (Serrador & Pinto, 2015).

1.2 Problem Statement
According to Serrador and Pinto (2015) projects are being invested in trillions but unfortunately some projects end up in failure, which means that time and valuable resources is lost. However, they find that agile project management has a positive impact on project success. Therefore, it is necessary to have prior knowledge regarding the challenges that may arise while converting to and applying agile project management since it will improve project success rates.

The current studies that exist in the literature focus on two aspects. The first aspect shows studies that adopt quantitative and qualitative studies to address challenges and obstacles that companies face during their migration from traditional method to agile. The second aspect deals with studies that share experiences of companies that has faced the transition. Some studies explore in greater depth the dimension of company organization and management practices (Barry Boehm & Turner, 2005) and some studies focus on people related issues since the transition and adoption is a people-oriented process (Javdani Gandomani & Ziaei Nafchi, 2016). Lack of the knowledge about these challenges makes agile transformation too hard, even in small and medium companies.

Most of the previously discussed agile transition and adoption challenges are explicit to software industry. But now we can see an increase in the trend of agile adoption from software firms to other industries like healthcare, construction, travel and technology. And in this thesis the author intends
to look more in depth of how agile is adopted in product-based firms that develop software, firmware and hardware as a whole embedded product rather than a pure software endeavor. Hence it becomes important to understand how agile methods have been adopted in a different firm (eg. Product oriented firm) and what kinds of challenges are encountered at different levels (top management, team and individual) during the transition and adoption process.

1.3 Purpose
The main purpose of this thesis is to investigate challenges that occur during the transition and adoption of agile methods within product-based SME’s and to triangulate the identified challenges with that of the previously identified challenges in the literature.

By exploring the most frequently mentioned challenges of agile project management across different levels of organization- the levels being: top management, team and individual- this thesis aims to contribute with additional information regarding challenges of agile project management within product development firms. In doing so, the empirical findings from this study will reduce the gap in existing literature which is focused more towards pure software endeavors.

1.4 Research Question
The above problematization leads to the research question of this paper-

**How the scrum implementation looks like in a product-based firm and what practitioner challenges are observed during the transition and adoption of scrum?**

Addressing this question can be valuable for:

- Practitioners making or planning to make transition from traditional project management to agile project management method.
- Theorists and researchers conducting research in this field.
- Practitioners currently working in agile methodologies like scrum.

1.5 Thesis contribution
This thesis contributes to the field of Agile project management. It attempts to provide deeper knowledge about the adoption of Agile methods and the challenges faced by the practitioners during the adoption process in product-based SME’s which is least studied in the literature. The analysis of primary data summarizes and provides insight into real-world experiences of Agile adoptions in product-based firms that are less studied in the literature. The findings of this study also contribute to the area of project management in the sense that it provides further understanding about challenges within agile project management. This study provides an overview of all challenges of agile practitioners at top management, team, individual level and those challenges are mapped to respective dimensions such as Organization /Management, People, Process, Technology and Tools. The previous studies explored the challenges during the transition and adoption of agile in an asymmetric way focusing only on one dimension. But this study will provide an overview of the challenges which are essential for successful agile adoption in a product-oriented firm compared to software firm. This thesis also contributes extra knowledge regarding the adoption of scrum in a multi-project environment which is poorly addressed in the existing
literature. This study also has found certain challenges that are explicit to firmware development, challenges general to software development and challenges specific to the firm.

1.6 Thesis Outline
The further parts of this thesis have the following sequence and content:

In theoretical framework section the theories related to traditional as well as agile project management methods are described. Since the main focus of this thesis is on agile project management, detailed description of different agile methods is given. The challenges pertaining to agile transition and adoption are discussed along with the success factors for agile adoption.

Methodology section provides an outline of research methods that were followed in this study. It provides information on the participants and the criteria for their inclusion in the study. This section also describes the research design that was chosen for the purpose of this study and the reasons for this choice. The method that was used for data collection is also described and the procedures that were followed to carry out this study are included. The author also discusses the methods used to analyze the data. Lastly, the reliability, validity and ethical issues that were followed in the process are also discussed.

In the case description section, the case company is described providing detailed information about its products, services and organization.

In the findings section, the empirical data is presented in the form which is already aligned with the analytical framework developed in theoretical framework section. The data is also complemented by the observations.

Analysis section focuses on revision of results and its triangulation with the literature. The results from primary data and observation are compared with the existing literature and analyzed based on the analytical framework developed from the literature review.

In the discussion section, more general reflections and interpretation are drawn. Possible suggestions are recommended to the case company.

Conclusion section summarizes the main results from the previous sections as well as limitations, delimitations, implications and proposals for future results.
2. THEORETICAL FRAMEWORK

The objective of literature review is to examine the relevant literature to form a solid base in-order to identify the relevant characteristics that is connected with this research. In the first part the concept of project management will be defined along with a brief description of different project management methodologies used for software development. This will serve as a snippet to traditional and agile project management methods and their application in the field of software development. An attempt is also made to differentiate the traditional project management method from agile method with the description of key characteristics and driving forces that has enabled its adoption within the software industry. The first part of the literature review provides an overview of different project management methodologies and how they differ from one another.

In the second part of the review the author discusses and presents various articles that cover the challenges during the transition and adoption of agile project management methodologies. At the end of the Theoretical Frame of Reference a Research Framework will be presented. This framework will incorporate all models presented and assist the rest of the research.

2.1 Project management

According to Project Management Book Of Knowledge (2000, p. 6) a project is defined as “a temporary activity within a group, which results in a unique product or service”. Further, project management is defined as “the application of skills, knowledge, tools, and techniques to the activities of a project to meet the requirements set” (Project Management Institute Inc, 2000, p. 6).

Due to globalization and internationalization, the companies are facing pressures to be competitive in the market. The companies started to engage in project-based activities to solve this problem by reducing the uncertainty and to deliver product on time to the market (Raymond & Bergeron, 2008). Projects related to fields like information technology, pharmaceutical, construction have one thing in common. They have to be managed, planned, staffed, organized, monitored, controlled, and evaluated market (Raymond & Bergeron, 2008). Projects are characterized to be unique, innovative, complex, uncertain, ambiguous and is exposed to changing requirements. Hence the companies have to constantly evolve in order to meet the changing requirements (Nerur, Mahapatra, & Mangalaraj, 2005). The 2015 Standish Group Chaos Report, which summarizes data from the outcomes of more than 10,000 projects between 2011 and 2015, highlights that, in general, for projects of all sizes, Agile projects are more successful than waterfall projects.
From the diagram we can learn that the likelihood of agile project success is 3 times higher than the traditional waterfall method but is becoming increasingly challenged by the creeping bureaucracy of traditional Project management practices. The challenged projects are those that were completed but failed in one of the three dimensions of iron triangle (cost, schedule, scope). The report concludes that 'over the last 20 years the project management field has experienced increasing layers of project management processes, tools, governance, compliance, and oversight. Yet these activities and products have done nothing to improve project success.

The Project Management Body of Knowledge (2008) is used as a baseline to better understand project management. The project is divided into 5 different processes from the perspective of project life cycle i.e. initiating, planning, executing, controlling and closing. The number of actual phases vary from project to project. In the traditional method the processes are done in a continuous and linear manner whereas, in Agile method these processes are done in a repetitive iterative and adaptive way (Wysocki, 2014).

2.2 Project management methodologies
Historically, the tools and techniques developed to execute Project Management practices were only used in a limited number of industries such as aerospace, defense and construction (S. Cicmil, 2000). Today, the use of Project Management practices has spread across fields (Perminova, Gustafsson, & Wikström, 2008) and Project Management has become a subject discipline on its own (Atkinson, 1999). This illustrates how Project Management practices have become more established in businesses today. Within the discipline there are two methodologies that are used, those being traditional project management methodologies and agile project management methodologies.

2.2.1 Traditional project management
Traditional project management is used for projects that needed more control over them (Hall, 2012). The managers in Traditional project management create schedules for projects with defined
scopes and times to finish each task with estimated resource availability (Nicholls et al., 2015). The main assumption of traditional project management is that better planning results in better project outcomes (Nicholls et al., 2015). In traditional method a lot of initial planning and effort is put to decide the project’s scope without making changes as much as possible and carry out tasks against timeline decided upon, thus following the plan vigorously (Nicholls et al., 2015). This is also called plan-driven approach and this method is effectively used when the requirements and goals are easily and clearly defined prior to initialization of project (Wysocki, 2014). Wysocki (2014) also points out that a lot of initial planning is done to reduce uncertainty and risk of the project and also contributes to common understanding among stakeholders and improves efficiency. However early planning is one of the greatest weaknesses of this methods since they are not adaptive to external changing requirements that may affect the project (Wysocki, 2014).

The stakeholder involvement is very limited in this process and these models do not present any results to the customers until the end of the project. The whole product is delivered to the customer at the end of the phase. So if the product does not satisfy customer requirements it will result in additional costs (Wysocki, 2014).

Due to dynamic business environment today, organizations tend to move away from traditional method since they are no longer flexible to changing requirements and demands from the customer (Fernandez & Fernandez, 2008).

Another disadvantage of TPM noted by Aguanno (2004) is that any design changes adopted during the testing and development phases of a project have the potential to cause chaos because of the waterfall model’s requirement to complete the preceding tasks first. This may lead to project failure on the basis of time delay and quality. According to Eden et al (2005) as well as Cui and Olsson (2009) late project changes in TPM are more expensive and have minimal beneficial effect on the resulting project delivery. This demerit of relying on TPM and the changes associated with it is clearly illustrated by the graphical representation suggested by Boehm (1981) and cited by Aguanno (2004), reproduced in Figure 3 below. This led to increased use of Agile project management (Highsmith, 2001).
2.2.2 The waterfall method

One of the most commonly used traditional project management approach is the waterfall method described by Royce (1970) is presented below in figure 3. The waterfall model shows logical progression of steps taken throughout a software development life cycle (SDLC). In this model each phase will be activated when the preceding phase has been completed.

The six stages of waterfall method are as follows:

- **Requirements**: during this initial stage, the potential requirements for the application are noted down in a specification document that describes what the application should do and serves as a basis for future development.
**Analysis:** In this stage the system is analyzed to generate models and business logic that will be used in the application.

**Design:** This stage covers the technical design requirements such as programming language, data layers. A design specification will be created outlining how the business logic will be implemented.

**Implementation:** The actual source code is written in this stage, implementing all models, business logic specified in the previous stage.

**Testing:** In this stage the testers discover and report issues within the application that needs to be resolved.

**Maintenance:** Now the final application is ready for deployment. After sales support is given to the customer through product enhancements and maintenance to keep it functional and up-to-date.

### 2.3 Characteristics of traditional project management

According to Sutherland and Ahmad (2011) traditional project management methods are Noniterative, sequential, phased, and plan-driven. But author Spundak (2014) assumes that it is hierarchical in structure in-addition to these characteristics. Furthermore, traditional project management theorists believe that it is a standardized process since a lot of planning is involved which makes it predictable (Barry Boehm, 2002; Joslin & Müller, 2015; Robert K. Wysocki, 2006). This method follows a clearly defined time frame, budget, scope which represents three dimensions of the iron triangle (de Carvalho, Patah, & de Souza Bido, 2015). The merits that are put forward for the waterfall model include its simplicity and ease of scheduling in laying out steps for development (Hass, 2007).

### 2.4 Limitations

Even though widely used, this method has some limitations: the requirements must be clear before the project initiation, heavy documentation is needed throughout the process, and high costs incurred (Khalifa & Verner, 2000) are the reasons why traditional methods face problems while dealing with changing customer requirements and evolving software products (Boehm, 1988). In this method the software is developed through repeatable and predictable process, but scientists proved that many of them were unpredictable and unrepeatable (Cohen, Lindvall, & Costa, 2004). The traditional methods focus on lot of planning and predictability which prevent them from responding to change (Cohen et al., 2004). Understanding customer requirement is more important in software development process, customers want much more features in the final products even though they are not able to provide their requirements and needs beforehand (Cohen et al., 2004). This becomes a burden to the traditional methods. Heavy documentation is needed at the end of each stage which is not suitable for all projects (Khalifa & Verner, 2000). Since the requirement keeps on changing, the developers have to be open to change otherwise it leads to project failure. Therefore, traditional methods are facing more challenges in terms of projects where the requirements of customer and end users cannot be specified during the initial stage of project execution.
2.5 Agile project management
The term agility refers to creating change and responding to change (Cockburn & Highsmith, 2001) and that’s why it is referred as change-driven process. Several authors have defined Agile project management but in this thesis the definition by Moran (2015) is chosen since it gives a general overview of Agile project management. According to Moran (2015) Agile project management is defines as “discipline that copes adaptively with rapid change through feedback learning loops that iteratively create and incrementally deliver value”. Agile project management is a process in which projects are managed and implemented in small chunks of work called iterations or sprints. Agile seems to be an effective method when the business environment is frequently changing or when the business wants to receive benefits earlier. Agile is frequently used to manage IT projects but can also be used to manage non-IT projects.

![Figure 5 The agile project life cycle](image)

From the above figure 4. We can notice that all stages expect initiation and closure undergo N number of iterations and continuous feedback is received at the end of each iteration for product improvement. The start of the agile is seen as a response to the disadvantages of traditional method such as inflexibility, failure to address new changes and the changing requirements of customer. In 2001, Agile manifesto and its supporting 12 principles was created by 17 software professionals at Snowbird, Utah. The manifesto states that the agile development should focus on its 4 core principles and it will be used as the base for characteristics identification (Highsmith, 2001): “We are uncovering better ways of developing software by doing it and helping others does it. Through this work we have come to value:

- **Individuals and interactions** over processes and tools
- **Working software** over comprehensive documentation
- **Customer collaboration** over contract negotiation
- **Responding to change** over following a plan

2.6 Agile project management methods
Some examples of agile development methods are Scrum, eXtreme Programming, Crystal methodologies, Dynamic software development method (DSDM), Feature-driven development, and Lean software development (Dybå & Dingsøyr, 2008). In this section, the author presents the concepts and method that were commonly implemented by the companies in this thesis’ empirical
study namely Scrum and the Kanban board concept and also extreme programming which is also a widely used method.

2.6.1 Scrum Background
The first Scrum was implemented at Easel Corporation in 1993 by Scrum creator Jeff Sutherland and co-creator Ken Schwaber. Together they formalized the Scrum development processes at the OOPSLA (Object-Oriented Programming Systems, Languages and Applications) conference in 1995. The main reasons for adopting Scrum in software development at Easel were amongst others the uncertainty in the development processes, unclear and changing requirements as well as the continuous evolution in technologies and tools. "Scrum is a framework within which people can address complex adaptive problems, while productively and creatively delivering products of the highest possible value" (Schwaber & Sutherland, 2013).

![Figure 6 Organization in Scrum (Wordpress.com, 2014)](image)

Even though Scrum was originally proposed for managing product development projects, it has been used largely for software project management counted as an Agile software development approach. By using Scrum, team can deliver software to the customer faster. More energy, focus and transparency will be added to the project planning and implementation. The following things can be achieved by Scrum implementation (Sutherland & Schwaber, 2007):

- Individual objectives aligned with corporate objectives
- A culture driven by performance
- Shareholder value creation
- Stable and consistent communication of performance

The Scrum framework contains three roles, three artifacts and five events. It is designed to deliver functional software in Sprints (Sutherland & Schwaber, 2007).
The management responsibilities of Scrum are divided among these 3 roles (Schwaber, 2004; Sutherland & Schwaber, 2007):

Scrum roles

Product Owner
The product owner is responsible for exemplifying the interests of all stakeholders in the project by defining the product features documented as the product requirements. He or she is responsible for the profitability of the product (ROI) as well as creating release plan. The list of requirements is called as Product Backlog, in which the Product Owner will use to ensure that the functionality is produced as prioritized according to the market value. However, the Product Owner can change features and its priority each sprint and he or she is the one who accepts or rejects work outcome.

Scrum Master
The Scrum master is a facilitator for Scrum project. He or she is responsible for the project success by ensuring that the team is fully functional, productive and Scrum process is followed correctly. Scrum Master also helps the Product Owner selects the most valuable Product Backlog and helps the team to turn the backlog into functionality. Besides, he or she supports close collaboration across all roles and functions as well as protects them from external interference.

Scrum Team
The Scrum team is a self-organizing and cross functional team which contains seven plus/minus two members. They are responsible for developing the functionality of each iteration and each project as a whole. They select the Sprint goal, specify work results and have the right to do everything within the project to reach the Sprint goal. The team manages itself and its works.

Scrum Artifacts

Below are the most commonly used Scrum artifacts throughout the process according to Sutherland and (Schwaber, 2004; Sutherland & Schwaber, 2007):

Product Backlog
It is a list of the system requirements being developed by the development teams while its content and prioritization are the responsibility of the product owner. In the project planning, the product backlog is used as an initial estimation of the requirements. It exists as long as the product exists and grows as the product grows. The Product backlog is constantly changed to identify what can make the product valuable and competitive.

### Table 1 The different components of Scrum

<table>
<thead>
<tr>
<th>3 Roles</th>
<th>5 Events</th>
<th>5 Artifacts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product Owner</strong></td>
<td>Sprint (Kick-off)</td>
<td>Product Backlog</td>
</tr>
<tr>
<td><strong>Scrum Master</strong></td>
<td>Sprint planning meeting</td>
<td>Sprint Backlog</td>
</tr>
<tr>
<td><strong>Scrum Team</strong></td>
<td>Daily Scrum (Stand Up)</td>
<td>Burn Down Chart</td>
</tr>
<tr>
<td></td>
<td>Sprint Review (Demo)</td>
<td>User Stories</td>
</tr>
<tr>
<td></td>
<td>Sprint Retrospective</td>
<td>Product Increment</td>
</tr>
</tbody>
</table>

The management responsibilities of Scrum are divided among these 3 roles (Schwaber, 2004; Sutherland & Schwaber, 2007):
**Sprint Backlog**

Sprint backlog describes the work that a team selects from the product backlog to be implemented in the Sprint. It is a real-time picture of the work that the team plans to accomplish during the sprint. In general, the work is divided into individual tasks that will take roughly four to sixteen hours to finish. The Sprint backlog can be changed only by Product Owner.

**Burn Down Chart**

Burn down chart is used as a tool to help the development team to successfully complete a Sprint on time by delivering working and shippable software product. It shows the remaining tasks to be done in the Sprint backlog.

**User Stories**

A common way in Scrum, and the Agile methodology, to express requirements is to use user stories. User stories are short, simple descriptions of features told from the perspective of the user.

**Product Increment**

The final artifact of scrum is the actual product increment as it exists at the end of a sprint, with all of the stories in that sprint which met the definition of done incorporated. At the end of each sprint, the completed features that were worked on should be added to the product for the sprint demo. At that point, the product itself is an artifact of the scrum process.

**Scrum Events**

The scrum events are designed to ensure “transparency and inspection”. The events are “timeboxed” which means that each event has a designated time frame. The core event is Scrum which has a constant duration during the development process. A sprint is time-boxed to a maximum of 4 weeks to one month. The following events are executed during the scrum: sprint planning meeting, daily scrum, sprint review, sprint retrospective (Schwaber & Sutherland, 2013).

**Sprint planning meeting**

The sprint planning is mandatory for all the team members since the scrum team defines the deliverable at the end of the sprint. The sprint planning is divided into sprint planning 1 and sprint planning 2.

In the first meeting the product owner and the team go through the prioritized items in the backlog. This is to understand the what the product owner requires. In meeting 2, the scrum team performs a detailed planning of the items they will deliver at the end of the sprint. The items are processes according to the priority order in the backlog. The items are then broken into individual tasks for which time and effort is estimated. The sprint planning meeting lasts for about 8 hours for a 4-week sprint. The output of this event is the sprint backlog with the selected items from the product backlog that the team commits to deliver at the end of the sprint and the time estimates for each item (Sutherland, 2012).

**The daily Scrum**

The daily scrum is a 15 minute stand up meeting wherein each team member answers the following 3 questions.
“What did I do yesterday that help the Development team meet the sprint goal? What will I do today to help the Development team meet the sprint goal? Do I see any impediment that would prevent me or the Development team from meeting the sprint goal?” (Sutherland & Schwaber, 2013)

Figure 7 Scrum Artifacts (Sutherland, 2012)

**Sprint review**

The participants in the sprint review are the scrum team and other stakeholders who are invited by the product owner. During the review, the product owner presents the items that has been done during the sprint and discusses the impact on the current product backlog. The stakeholders and the team review the product backlog and the result will be a revised product backlog that better meets the needs of stakeholders (Schwaber & Sutherland, 2013). After the review sprint retrospective takes place.

**Sprint retrospective**

The Scrum Master facilitates the sprint retrospective. The objective of the sprint retrospective is to inspect the different aspects of the last sprint. The team is encouraged to reflect on what went well and what can be improved in the next sprint. The Scrum master encourages the team to identify areas of improvement and what the team can do about it in the next sprint (Schwaber & Sutherland, 2013).

**2.6.2 Kanban**

The Kanban system was developed by Taichi Ohno (Former Executive Vice-President of Toyota Manufacturing Corporation) during 1950’s (“Toyota Global Site,” 2018). This was introduction to pull the products and services into the production system by responding to customer’s demand (Anderson, 2010). Kanban in the context of software development can mean a visual process
management system that tells what to produce, when to produce it, and how much to produce. Kanban is a Japanese word that means billboard or signboard.

Kanban is a Japanese word which means ‘billboard’, ‘signboard’, ‘visual card’. The Kanban board visualized workflow through a set of columns which represent the status of work done. The simplest Kanban board has 3 columns and each column represents status: To do, In progress, Done. Others have 7 columns representing: Backlog, To do, Development (with 2 columns for Ongoing and Done), Testing (with 2 columns for Ongoing and Done), Documentation (with 2 columns for Ongoing and Done), Deployment, Done. The Kanban board used Kanban cards as a visual management tool to communicate order details. Each column is associated with a ‘work in progress limit’ which denotes maximum number of items that is being worked on. Each item resides in one of the columns and flows from left to right as it is being worked on. If too many items are clustered in a single column, it is the responsibility of the whole team to solve the problems and make the flow work again.

Anderson (2010) identifies five elements found in successful implementations of Kanban:

1. **Visualize Workflow** - Which is done through a Kanban board which shows each piece of work and how it progresses through the production stages.
2. **Limit Work-in-Progress (WiP)** - Which is managed by putting a maximum count on each column on the Kanban board. If a column contains more tasks than the set upper limit, it is the responsibility of the whole team to fix this so that the flow can continue.
3. **Mange flow** - A Kanban team adds value to an organization in a steady flow. This means that different types of work, which has different workloads, must be tracked in such a way that the flow can be kept over time regardless which work is being done.
4. **Make process policies explicit** - Everybody on the team must have a high-level understanding of the entire work process. This is the only way team members can effectively suggest improvements.
5. **Improve collaboratively** - Kanban teams should, thorough measurement and experimentation, reflect and improve on the process continuously.
2.7 Characteristics of agile project management

Lee and Xia (2010, p. 90) state that “agility is at the heart of agile development principles and practices”. Following the statement, the authors state the characteristics of agile project management as: “short, iterative, time-boxed development cycles, self-organizing teams, active participation of stakeholders, and continuous delivery of working software”. Agile organizations advocated decentralized decision-making process to increase responsiveness to uncertain environments (Yusuf, Sarhadi, & Gunasekaran, 1999).

2.8 Agile vs traditional project management characteristics

Below is a summary of the characteristics that define agile and traditional project management method based on the analysis of above literatures:

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Agile project management</th>
<th>Traditional project management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standardization</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Structure</td>
<td>De-centralized</td>
<td>Hierarchical</td>
</tr>
<tr>
<td>Adaptability</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Documentation</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Predictability</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Planning</td>
<td>Continuous</td>
<td>Predefined</td>
</tr>
<tr>
<td>Process</td>
<td>Iterative</td>
<td>Non-iterative</td>
</tr>
<tr>
<td>Leadership culture</td>
<td>Self-organizing teams</td>
<td>Command-driven teams</td>
</tr>
<tr>
<td>Customer collaboration</td>
<td>Continuous</td>
<td>Initial stage</td>
</tr>
<tr>
<td>Project size</td>
<td>Small-medium</td>
<td>All types, especially large</td>
</tr>
<tr>
<td>Environment stability</td>
<td>Frequent changes, uncertain</td>
<td>Stable, predictable, less change</td>
</tr>
<tr>
<td>Knowledge</td>
<td>Tacit, highly skilled team members</td>
<td>Explicit, documented knowledge</td>
</tr>
</tbody>
</table>

Table 2 Comparison between Traditional and Agile project management

2.9 Limitations

It is known that each method has its own limitations and disadvantages if they are not used under certain circumstances. In the same way agile is suitable for non-safety critical projects with volatile requirements, built by small and skilled collocated teams (Williams and Cockburn, 2003). Adoption of agile methods leads to structural, cultural and management changes. Hence to reduce the change impact, partial adoption can be a solution (Cohen et al., 2004). The assumption of author Turk et al. (2002, p. 2) is that “customers are co-located with the development team and are readily available when needed by developers”. But in real situation face-to-face communication is not possible always and this goes in line with issue identified by Boehm (2002) that the customers operating with developing team bust be committed, collaborative, knowledgeable, representative and empowered otherwise the project development will be a failure. In the agile process there is less stress on documentation and this leads to dependence on tacit knowledge. Thus, there are larger chances of architectural flaws which cannot be easily detected by reviewers due to lack of documentation (Barry Boehm, 2002). Another issue is that agile process is suitable for only small medium sized projects (B. Boehm & Turner, 2003). For larger projects, large teams are necessary.
which makes it difficult to maintain effective face-to-face communication and big teams are effective only in less agile projects.

2.10 Challenges in the transition and Adoption of Agile Project Management methodologies.

In the literature several studies have been done regarding the challenges and difficulties during the transition and adoption of agile project management practices. To find the articles that discuss about these challenges, search was done in different databases like Google Scholar, Science direct, IEEE Xplore and ABI/Inform, Semantic scholar, Agile conference proceedings using the keywords ‘Agile project management challenges’, ‘Agile project management barriers’, ‘challenges’ AND ‘Transition and adoption of agile’, ‘challenges’ AND ‘adoption of agile’ were used along with different synonyms of the same word. The identified articles are discussed below in detail.

Some of the challenges during the transition from traditional project management methodology (waterfall method) to agile methodology (scrum) has been discussed by Bannink (2014). He identifies that absence of command and control structure, empowerment of self-organizing teams, facilitating the manager role as some of the main challenges associated with the transition. Chen, Ravichandar & Procter (2015) also conduct research, narrowing their scope to the transition from traditional to agile product development methodologies. Their study finds two broad challenges; developing new management practices that suit the method and helping business and engineering units adopt the method. Although there exists some research on challenges related to the transition (Bannink, 2014) and . Chen, Ravichandar & Procter (2015) emphasize that further scientific research needs to be conducted on this subject.

Furthermore, various findings show that project experience is a key factor related to overall success rates within agile project management. Hence, experience leads to an increased understanding for what challenges appear within agile project management and how to overcome them (Conforto, Amaral, da Silva, Di Felippo, & Kamikawachi, 2016; Hoda & Murugesan, 2016; Joslin & Müller, 2015; Stettina & Hörz, 2015). Additionally, (Stettina & Hörz, 2015) find that agile project management experience alone is not enough to sufficiently implement agile project management. Challenges lie in silo thinking, resource allocation, and the adaption of agile project management requires structure, time, and well thought out routines to enforce the cultural shift. The study made by Lindvall et al. (2004) illustrates the benefits and challenges of adopting agile development especially large organizations. The study made by Ganesh & Thangasamy (2012) concludes that the team should respond to the changing needs or requirements, thereby satisfy the customer needs rather than following a specific set of practices which was considered as a main challenge during the agile implementation process.

The study of Boehm and Turner (2005) emphasize how organizational constraints will affect the implementation process of agile project management. Most of the organizations tend to enter into the domain of agile without proper training and commitment. And hence these organizations face constraints that affect the development process, business process and people management. These constraints arise due to differences in perception between the traditional and agile project management methods. Hence the organizational constraints can be avoided by understanding the differences between the two project management methods and by learning the fundamental
principles and objectives of agile. The contrasting characteristics of the two project management methods create challenges during the transition and adoption of agile (Spundak, 2014).

Customer collaboration in traditional software development is limited to only providing requirements in the beginning and getting feedback from them at the end. This results in lack of interactions between the customers and the development team (Nerur et al., 2005). In contrast, customer collaboration is an important success factor in agile software development (Chow & Cao, 2008). Lack of customer involvement leads to problems such as difficulty in gathering and collecting requirements, pressure to over-commit, problems in prioritizing the requirements, and failure to get customer feedback, loss of productivity, and in extreme cases it leads to business loss (Hoda, Noble, & Marshall, 2010). Customer have to be present on site to deliver constructive feedback and to deliver clear requirements to the team. The end product quality also declines due to insufficient face-to-face communication with the customers (Hoda, Noble & Marshall, 2010).

According to the study of (Gandomani, Zulzalil, Ghani, Sultan, & Nafchi, 2013) the challenges during the transition to agile software development methods are grouped under 4 dimensions: 1. Organization and management; 2. People; 3. Process and 4. Tools. The study of Gregory et al. (2015) identified 7 themes of challenges: Organization, Sustainability, Culture, Teams, Scale, Value, Claims and Limitations. Hamid et al. (2015) explores factors that limit the implementation of agile practices in the software industry. The identified factors are high dependency on people/personnel, organizational dependency, and high impact on organizational structure and culture. Authors Shah and Patel (2014) perform a review of requirement engineering issues and challenges in various software development methods. Within agile software requirements, the following challenges were identified: 1. Inadequate identification of formal requirements; 2. Missing requirements, which are only discovered in next iteration; 3. Conflicting and ambiguous requirements; 4. Poor emphasis on non-functional requirements (NFR) modeling; and 5. Inadequate requirement change management. The study made by (Ganesh & Thangasamy, 2012) concludes that the main challenges when implementing an agile software development is to respond to the changing needs or requirements, thereby satisfying the customer needs rather than following a specific set of practices. User involvement is another challenge that was evidenced in Extreme Programming projects (Mohammadi, Nikkhahan, & Sohrabi, 2009).

While the above studies list out the challenges during the transition and adoption of agile methodologies, there are also existing theories that are based on prerequisites and key decisions. According to Gandomani et al. (2013), there are several critical prerequisites for an agile transformation as follows: business goals setup, addressing training needs, team set up, pilot project selection, and method selection. Each organization will undergo a different adoption process since each organization has unique culture, management practices, organizational structure, values, norms and policies. Hence this agile adoption can be considered as an iterative process due to the reason that it is based on interactions between company employees trying to agree on their development methodologies (Khalil & Khalil, 2016). An organization should also have a specific reason for its agile transformation in terms of its business goals. Organization cannot be motivated to follow the agile principles and value without a clear focus on business objectives (Gandomani et al., 2013). Gandomani et al. (2013) points out that training is important since inadequate training
Knowledge transfer has been also identified as a possible challenge in an agile set-up. Agile practices promote minimizing required project documentation, and this might make it difficult to conduct a proper knowledge transfer in a situation when one or several individuals leave the team (Asnawi, Gravell, & Wills, 2011). This was one of the main concerns of project managers. On the other hand, agile practices suggest ensuring that projects have high-quality and well-commented source code to make it easier for new programmers to take over. Another identified issue related to personnel management was that companies have not developed agile-specific recruitment policies or agile-compliant performance evaluation methods to support individual- and team-level abilities (Conboy, Coyle, Wang, & Pikkarainen, 2011). This makes it difficult to evaluate and educate individuals and agile teams.

As the issues listed above demonstrate, researchers have found that people-related factors and social factors such as customer collaboration, lack of motivation, knowledge sharing are more important than the technical factors in the successful adoption of agile practices (Asnawi et al., 2011; Barry Boehm & Turner, 2005) except the fact that proper communication tools are necessary when the teams are not co-located.

There are also studies that look to the challenges of adoption agile approaches in specific fields of activity. The adoption of agile methods has been slow in the public sector, due to the following reasons: 1. Documentation, 2. Personnel education, experience and commitment; 3. Stakeholder communication and involvement; 4. Roles in an agile set-up; 5. Location of agile teams; 6. Legislation; and 7. Complexity of SW architecture and system integration (Nuottila, Aaltonen, & Kujala, 2016). Further the adoption of agile methods in financial institutions was discussed by authors (Joseph Cody, Divakar Goswami, 2015). The banking sector is also slightly adopting agile and the challenges faced by banking institutions are: 1. Cross team dependencies; 2. Reporting and tracking of projects; 3. Assure end-to-end quality.

There are also studies that have adopted case study to learn about the agile transformation process and the challenges associated during the transition process. In this case study (Bannink, 2014), research was done concerning the identification of challenges at Portbase during the transition to Scrum process. The main challenges in this transition are the facilitating role of managers, the absence of a command and control structure, empowerment of the self-steering team, providing value to customer needs, understanding Scrum values, resistance to change and quality of the product. The research adopted by (Hajdiab & Taleb, 2016) present their experience of performing a case study for adopting Scrum agile practices in a government entity in the United Arab Emirates.
The authors identified 8 different challenges and compared it with other reported challenges. The identified challenges from this study are as follows: 1. Missing the agile master role; 2. The overzealous team; 3. The absence of a pilot project; 4. Scrum implementation; 5. Current work pressure; 6. Upper management concerns; 7. Governmental bureaucratic system; 8. Documentation requirements. (Chen et al., 2015) also conduct research, narrowing their scope to the transition from traditional to agile product development methodologies at Cisco systems. Their study finds two broad challenges; developing new management practices that suit the method and helping business and engineering units adopt the method. Another study by (Sureshchandra & Shrinivasavadhani, 2008) have summarized agile adoption of one project at Wipro technologies and the experiences of agile coaches in transitioning the mindset of the team from a waterfall to agile pattern. The dimension of people in organizations is considered a key challenge in agile development (Conboy, Coyle, & Wang, 2010).

Distributed teams, experiencing large physical distance between the actors, cultural and time zone differences, face various challenges and difficulties. Some categories that are presented in research are (i) strategic issues (e.g. decision making), (ii) cultural issues (e.g. ethics, team culture), (iii) inadequate communication (iv) knowledge management, (v) project and process management issues, (vi) technical issues, and (vii) risk management issues (e.g. risk identification, coordination) (Shrivastava, S.V. & Date, H., 2010). Agile is suitable only for smaller projects with co-located teams (Barry Boehm, 2002), but when organization try to scale agile for larger projects with distributed teams, several challenges arise which are discussed in literatures (Lindvall et al., 2004; Paasivaara & Lassenius, 2011).

The study by Landim, Albuquerque, and Macedo (2010) addressed lack of knowledge about agile values and principles as a challenge faced by companies during the transition process. The low perception of the agile practitioner towards agile methodologies may prevent them from taking responsibilities. This challenge acts as a barrier for the transition due to the fact that the user lacks knowledge about the process and hence the study emphasized the importance of training for the team members to increase their knowledge about the process which will act as a success key for the transition (Conboy et al., 2011).

The article by Bill Greene describes the experience of applying Agile approaches to the development of firmware. Embedded development (i.e. firmware) projects are quite different from object-oriented and pure software endeavors, yet they face many of the same challenges that Agile software development practices address. Several unique challenges are described, including team members’ specialized domain knowledge, technical backgrounds and attitudes toward change, and the impact hardware plays in firmware design. The authors also noted that XP and Scrum are the two most used agile methods in the field of embedded software and see that the characteristics of embedded software development bring new challenges into applying these methods (Greene, n.d.).

(Savolainen, Kuusela, & Vilavaara, 2010) describe challenges of large organizations in embedded systems when transitioning into using agile process models. The challenges include the varying size of user requirements, the role of system requirements, and architecturally significant requirements. The author also concludes that it is difficult for large organizations to be agile.
2.11 Critical success factors for agile adoption.

There are two mainstream researches on software projects: 1. Research theories on success factors; 2. Research theories on failure factors. With the focus on agile software projects authors Dr. DacBuu Cao and Dr. Tsun Chow in the year 2008 conducted a study that identified factors that are critical for the success of the projects. They introduced a concept called Critical Success Factors (CSF) in this area. The study combined literature review and a quantitative research. The success of a project was assessed in terms of 1. Quality of the end product, 2. Scope related to fulfilling the achieved objectives, 3. Delivering on time, 4. Completing the product within estimated cost. At the end of the research 12 critical success factors were identified and divided into 5 categories as follows: organizational, people, process, technical and project factors (Chow & Cao, 2008).

Based on the factors, hypothesis was developed and validated through quantitative study. At the end of the study, 3 main critical success factors were identified: 1. Accurate agile delivery strategy, 2. Uncompromising practice of agile software engineering techniques and 3. Agile team with high capability. This shows that technical and people factors are more predominant. In other words, as long as these 3 factors were fulfilled there will be little or no effect on project success.

<table>
<thead>
<tr>
<th>Organizational factors</th>
<th>People factors</th>
<th>Process factors</th>
<th>Technical factors</th>
<th>Project factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Team environment</td>
<td></td>
<td></td>
<td></td>
<td>12. Project schedule</td>
</tr>
</tbody>
</table>

![Project success parameters]

*Table 3 Potential critical success factors (Chow & Cao, 2008)*

Lindvall et al. (2002) conducted an online workshop with eighteen agile experts around the world with a goal to identify agile success factors. The authors identified three important success factors: 1. People, 2. Culture, 3. Communication.

Misra et al. (2009) did a large-scale empirical study to identify agile success factors. Through the study the authors identified nine success factors that were shown to be statistically significant. The identified success factors are as follows: 1. Customer satisfaction, 2. Customer collaboration, 3. Customer commitment, 4. Decision-time, 5. Corporate culture, 6. Control, 7. Personal characteristics, 8. Societal culture, 9. Training and learning. These articles have identified a lot of success factors that may overlap.
2.12 Analytical Framework

While a lot of previous research can prove the benefits of APM, Hoda & Murugesan (2016) find 8 main challenges in APM connected to 4 different levels within the organization: project, team, individual and task level. The project level includes activities involving the self-organizing team, Scrum Master (or project manager), and the Product Owner (or customer representative). Team level activities include involving the self-organizing team and their Scrum Master. Individual level includes activities such as self-assignment of tasks, which involve individual members of the team. The task level includes activities pertaining to technical tasks.

Moe, Dingsøyr & Dybå (2009) on the other hand, categorize challenges on team and organizational level with the argument that organizational level challenges reflects on team performances. Since the challenges presented in literature comply well with the sectioning made by Hoda & Murugesan (2016) and Moe, Dingsøyr & Dybå (2009) a merged model is adapted and acts as an analytical framework containing: Top management level, team level, and individual level challenges. The double headed arrows in the framework indicates that the challenges at one level might have an impact on the other levels. For eg. The top management level challenges might have an impact
towards the team level and individual level and vice versa (Hoda & Murugesan, 2016). The divide indicates where the challenges are expected to occur.

The top management level indicates the challenges faced by project managers who work outside the scrum team but has insight to organizational and management activities of different scrum teams and other parts of organization. The team level indicates the challenges faced by employees like product owners, group managers and scrum masters who have insight to team level activities. The individual level consists of challenges faced by developers, testers who perform individual activities.

The identified challenges within each level are finally mapped to the 4 different dimensions like organization/management, people, process, technology/tools to which they belong. The organization/management dimension represents challenges related to culture and change resistance and other factors related to organization and management of activities. The people dimension has been the subject of considerable prominence and focuses on challenges related to training, location, personnel education, group dynamics, skills etc. The process dimension indicates challenges related to the scrum events and artifacts like sprint management, prioritization of backlog, risk management, flexible scope etc. The tools/technology dimension focuses on challenges related to agile project management tools like burn down chart, Jira, Rally and technical issues such as continuous integration, tracking of bugs etc.

3. RESEARCH METHODOLOGY

In this section the methodological framework of the current research is discussed. The methodological choices were made based on the ‘research onion’ model as shown in figure. The research design method explains the flow of research and unifies all the methodological choices.
3.1 Literature review

To create a deeper understanding about current agile related challenges and how they might affect individuals, teams, and organizations, a critical literature review is conducted to ensure that chosen methods are suitable to address the thesis purpose. The purpose of critical review is that it provides foundation on which the research is built. The challenges that are discovered in the literature review are used to create an analytical framework. By doing a critical literature review the researcher can develop a good understanding and insight into relevant previous research and the trends that have emerged (Saunders et al., 2009). In the review part articles that address traditional and agile project management methods and the challenges during the transition and adoption of agile project managements are included. The identified articles are presented in a logically argued way by drawing out key points.

3.2 Abductive approach

For this research, inductive approach with elements of deduction was chosen. The mix of both the inductive and deductive research is termed as ‘abductive research’ which is characterized by going back-and forth between theories and empirical findings (Saunders et al., 2009). The biggest advantage of using this research approach is that it is flexible and adaptive as it helps the researcher to change the direction of research as a result of new data that appears and new insights that occur during the research (Saunders et al., 2009). Through the inductive approach the author understands the practitioner’s perspective towards working agile and the challenges faced by them at various levels within the organization. This will help the author to connect all the themes obtained from interviews and thereby build a new theory from it (Saunders, Lewis, & Thornhill, 2009). By means of inductive approach, interviews are done with ‘experts’ in the subject and through the deductive approach the analytical framework was developed on the basis of existing theories. As a part of deductive approach, the data from interviews and observations are triangulated with the literature findings. The analytical framework acts as the basis for later discussions and conclusions in the thesis. Furthermore, the framework offers a basis for what methods are best suited to collect the data in demand.

3.3 Case study method

To comply with the thesis purpose - to explore and analyze the challenges in the transition and adoption of agile project management methodologies, and to understand how agile methods are implemented in real time, a case study is performed. The research question posed in this study is exploratory in nature and case study is useful to find out “what is happening; to seek new insights; to ask questions and to assess phenomena in a new light” (Robson 2002, p. 59). Data is collected from industry experts working in agile process to provide deeper insights to the research question (Yin, 2007). Considering the characteristics of the case study research (e.g. time constraint, resource availability), the interview process in the case firm shall be flexible and tailored from one interviewee to another due to the different background and experience each interviewee. Due to the above reasons, a semi-structured interview (Saunders et al., 2007) was more relevant for this case study research. Therefore, this method is considered as relevant and appropriate for this research, keeping in mind that this is an exploratory research where the author tries not only to understand how the company managed to adopt an agile project management method in its particular conditions but also to understand the kind of challenges they are facing.
Due to time constraints a single case study was chosen as a research strategy as it “focuses on understanding the dynamics present within single settings” (Eisenhardt, 1989, p. 534) and “can employ an embedded design, that is, multiple levels of analysis within a single study” (Eisenhardt, 1989, p. 534). Analyzing the challenges of practitioners at three different levels within the organization will enable the researcher to answer the research question and to fulfil the purpose of the study. By opting case study as a research strategy, the author can investigate a current phenomenon within its context (Yin, 2014).

**Motivation behind choosing HMS as a case company**

The reason for choosing HMS, and more specifically their R&D-department as the thesis’ case study is threefold. First of all, HMS decided to make the transition in 2014 and finally made the transition to agile in early 2015. The objective behind adoption of agile is to improve the team morale and efficiency. The transition time was quite short because they felt that the preparation was taking more time and made a sudden transition without proper training. Hence HMS is still experiencing challenges in their adoption process. This means the case setting matches the thesis purpose and will enable the study to capture challenges related to the transition as well as adoption.

Secondly, HMS uses both traditional as well as agile methodologies depending upon the product that is developed. This means that there are good grounds for establishing an understanding for both methodologies and identifying similarities and differences that arise with product development process.

Finally, HMS is a Small-Medium sized Enterprise (SME) with an employee size of 250-500. According to literature findings, scrum suits well to smaller projects with smaller teams that are co-located (Barry Boehm, 2002; Barry Boehm & Turner, 2005). Scaling agile to bigger projects and larger team size becomes more challenging. Thus, a lot of research has been done to address challenges related to software development using agile in large scale organizations (Lindvall et al., 2004; Paasivaara & Lassenius, 2011). Even though HMS is a small-scale industry with co-located teams, they still experience challenges in their agile adoption process. Agile originated in the software industry, but there are many other industries like healthcare, travel, construction trying to adopt agile. But the case company is basically a product-oriented firm that develops embedded products i.e. both hardware, firmware and software. Hence the author felt that it would be interesting to study the change process within such industry, since the knowledge related to challenges with the adoption of agile methods in product-based firms is still very limited.

Taking into account the purpose of the current research, a mixed-method research was chosen as it is characterized by a combination of qualitative and quantitative data collection techniques and data analysis procedures (Saunders et al., 2009). The reason for using mixed method is to triangulate two or more independent sources of data to corroborate research findings within a study (Bryman, 2006).
3.4 Primary data

Primary data is the collection of new data that is gathered through semi-structured face-to-face interview as it provides the author with in-depth answer and also insight into the research problem studied. The semi-structured face-to-face interviews are done to receive extemporary and uncensored answers from the industry experts on their perspective on agile project management challenges. In order to generate valid and reliable data, the interviews are carefully planned, guided and recorded (Saunders et al., 2007). A brief introduction of research topic is given to interviewees beforehand so that they could well prepare for the interview. Questions are designed as open-ended as well as close-ended and following an interview guide. The majority of questions are similar but slightly adjusted due to different background of individual interviewee in order to cover the same research area. Interview begins with a brief introduction of both sides and the research purpose, followed by interview questions and discussions. The conversations are conducted in a comfortable and flexible atmosphere in order not to limit respondents’ ideas, opinions or suggestions. Observations are also performed within the case company to triangulate with the findings from the interview. Therefore, this thesis mainly uses semi-structured interviews and observations as a main source for collecting primary data.

Semi-structured expert interviews

Interviews can be conducted in a structured, semi-structured and unstructured way (Saunders et al., 2009). For this thesis, the author considers semi-structured interviews as the most appropriate data collection method since it enables the researcher to interact and have a dialogue with the research participants which enables an understanding of the social phenomena from the perspective of the participant (Wahyuni, 2010). Semi-structured interviews have been described by Wahyuni (2010) as a hybrid interview since they position between the structured and in-depth interviews. Semi structured interviews are non-standardized and may vary in terms of the number of questions asked as well as their respective order (Saunders et al., 2012). The author also uses follow-up questions in case clarifications need to made in regards to certain topics (Wahyuni, 2010). Drawing from the discussions above semi-structured interviews appeared to be more apt for this study as it aimed to understand the challenges faced by the people during the transition and adoption of agile project management methods at different levels within the organization.
Observations and variations of interviews are recurrently mentioned as the most credible and popular choices of data collection when conducting qualitative research (Yin, 2014; Saunders, 2009; Creswell, 2013). Considering observation as a method of data collection helps the author to discover what people do by watching them closely for interpreting people’s behavior (Saunders et al., 2003). When discussing observations (Saunders et al., 2007) name two different types, structured observation and participant observation. As Saunders, Lewis and Thornhill (2003, p. 222) mention, participant observation “has been extensively used … to attempt to get to the root of “what is going on” in a wide range of social settings”.

### Initiation of contacts from HMS

<table>
<thead>
<tr>
<th>Representation of Interviewees</th>
<th>Job Role</th>
<th>Level within scrum</th>
<th>Interview duration</th>
<th>Interview date</th>
<th>Years of experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>(AG, 2018) EWON</td>
<td>Present: Developer and rotating scrum master</td>
<td>Individual level</td>
<td>54 min</td>
<td>23.02.2018</td>
<td>2.5 years</td>
</tr>
<tr>
<td>(ML, 2018) EWON</td>
<td>Present: Product owner and Group manager</td>
<td>Team level</td>
<td>27 min</td>
<td>20.02.2018</td>
<td>6 years</td>
</tr>
<tr>
<td>(BO, 2018) ANYBUS</td>
<td>Present: Group manager</td>
<td>Team level</td>
<td>1 hr 12min</td>
<td>07.03.2018</td>
<td>10 years</td>
</tr>
<tr>
<td>(BS, 2018) ANYBUS</td>
<td>Present: Chief Product owner</td>
<td>Team level</td>
<td>55 min 32s</td>
<td>15.03.2018</td>
<td>7 years</td>
</tr>
<tr>
<td>(BE, 2018) EWON</td>
<td>Present: Group manager</td>
<td>Team level</td>
<td>52 min</td>
<td>22.03.2018</td>
<td>7 years</td>
</tr>
<tr>
<td>(MN, 2018) ANYBUS</td>
<td>Present: Scrum master and senior engineer</td>
<td>Team level</td>
<td>59 min</td>
<td>17.04.2018</td>
<td>5 years</td>
</tr>
</tbody>
</table>
Moreover, Bryman and Bell (2007, p. 503) point out that participant observations let “observe behavior rather than just rely on what is said”. Additionally, “participant observation has a potential to come closer to a naturalistic emphasis” and “confront members of a social setting in their natural environments” (Bryman & Bell, 2007, p. 504). According to Yin (2009) observations are good sources for additional information helping the study of the topic and it can be used as sources of evidence in most case studies. Observation can be a formal or casual data collection activity. Taking Photographs can also be useful to convey some characteristics of the case to the target audience. The author has decided to do observation since agile process like scrum are people driven and it targets many communication problems and it would help the author to take into account the atmosphere of the scrum meetings and the quality of communication during the meetings. By doing observations, practical issues within the agile method that the respondents referred to during the interviews can be clarified. This type of observations is categorized by Denscombe (2010) as participant observation, since the participant i.e. the author takes the role as a student carrying out master thesis and acts as an observer, known to most of the employees who work under agile process at the company. While gathering data through observation, the active participation by the observer is held to a minimum since the main focus is solely to observe. Even though the participation is held minimum during observation, all the participants were aware of the author’s presence, aim and the purpose of participating.

The observation was done only in the presence of Maria who is the product owner and team manager of Argos. The author was invited to take part in the daily stand up meetings by Maria whenever she is available for the meetings. The participant observer role is determined by a number of factors. Gill and Johnson (2002 have developed 4 categories of roles that the participant observer can adopt during the observation:

- Complete participant
- Complete observer
- Observer as participant
- Participant as observer
The first two roles are avoided by the researcher since she has to conceal her identity to the subjects that are studied. The last two roles will enable the researcher to reveal her identity and purpose to those with whom the researcher mingles in the research setting. Since the aim is to solely to observe the researcher takes the role of observer as participant. Thereby the author will be able to focus on her role as a researcher (Saunders et al., 2009).

**Sampling Method**

The sampling method used within this research is of great importance since the results of this study mainly depends on the interviewees. (Rowley, 2012). Purposive sampling was done within this research since the research is abductive. Purposive sampling refers to intentional selection of specific cases and interviewees so that the researcher will be able to fulfil the purpose of the study and answer the research question which is to find what challenges occur during the transition and adoption of agile methodologies (Saunders et al., 2012). Under purposive sampling there are different forms of sampling and for the purpose of this thesis, a heterogeneous sampling was done. To capture challenges and on what level they occur, the author interviewed project managers and senior level managers who have direct insights to the organizational and management level challenges. To capture the team level challenges, representatives managing the team level activities such as the scrum masters, team managers, product owners were interviewed. On the individual level, developers who work on individual tasks within the team were interviewed. From the analytical framework it can also be said that challenges at one level has an effect on the other levels and vice versa. Therefore, findings from the interviews can be attributed to different levels rather than a particular level.
3.5 Secondary data
The data that is collected previously for some other purpose and is also used in this research for the case description and as a basis for primary data collection (Saunders et al., 2009). The sources of secondary data were the company website as well as company brochures to gather general information about the case company and other sources of secondary data were screen shots of the scrum boards, product backlog, burn down charts from the agile tools used by the agile team members of HMS. Documentary secondary data like publicly available data or company reports were also used in order to triangulate findings with the primary data collected through observations and interviews (Saunders et al., 2012).

3.6 Quality of the report
When performing an empirical research study, it is important to determine its quality. The reliability and validity of the study must be checked to determine if the study can be trusted, if it is credible, and if the gathered data can be depended. Four tests are commonly used to achieve this; construct validity, external validity, internal validity and reliability (Yin, 1994)

3.6.1 Validity
Although the research was conducted in a good way, there is a factor that can affect the reliability and accuracy of the results. The main threats relevant to this research are the semi-structured interview and the observations. The author did her best to describe all possible validity and reliability threats for minimize its effect on the research study.

Construct validity
Construct validity ensures that correct operational measures are taken for the concepts that are studied in this research (Yin, 1994). Since this research uses case study as a strategy, the construct validity was achieved by developing constructs from the literature review, multiple sources of data such as interviews and observation data are triangulated to increase the construct validity. The author validated the interview questions with two of the academic advisors in the university and then finalized the questions after removing vague and unclear questions. Similar questions were grouped under headings to ensure more clarity. The supervisor of this thesis also reviewed these questions. The interview questions were sent to some of the interviewees to get feedback about the length and clarity of the questions before it was finally sent out to them. Moreover an interview guide was created and followed throughout the interview process to focus on the questions and to not steer too far from the planned path (Yin, 1994).

Internal validity
Internal validity aims to ensure that what we want to find out is indeed achieved. Triangulation is done to increase the internal validity by presenting data from multiple sources for topic investigated. Internal validity. Internal validity is a way to measure if the research was done right. Since a cause-effect relationship is not analyzed in this study, internal validity cannot be achieved.

The research is designed to explore as many explanations as possible. This is done by attending and observing formal meetings related to scrum process. The research is organized exploratory for the initial phase and makes a transition to an explanatory fashion when sufficient data is gathered about a phenomenon.
External validity
External validity or generalizability addresses to what extent the results of this study can be generalized to other relevant studies or cases (Yin, 2007). This is supported by the data collection techniques (purposive and heterogeneous sampling). The interviewees for the semi-structured interviews covered a broader range of different levels and positions of employees within the case company. The interviewees were chosen carefully in such a way that they had expert knowledge within their field to be able to answer the research question. The interviewees were chosen from the top management level, the team level and the individual level within the agile team for the author to understand the challenges from different perspectives and at different levels within the organization. Since the case company is a product-based firm, some of the challenges related to firmware development can be transferred to other product-based firms under similar settings, while most of the challenges faced by the company are inline with the challenges that agile software development practices address. Some of the challenges are firm specific due to tailored scrum practice within the firm and hence cannot be generalized. The generalizability is further discussed in detail in the discussion part.

3.6.2 Reliability
Reliability refers to exact replicability of the results under same conditions (Yin, 1994). In order to achieve reliability, a case study database was created, and all interviews were stored as audio files and later transcribed. The collected data can therefore be made available for other researchers. This will increase transparency and increase reliability of research. Furthermore, the author made sure to follow the interview guide throughout the interview process to make sure that the answers given by respondents were not affected. This helped the author to focus on questions and to not steer too far from the planned path. Since the context of the interview can affect the answers given by the respondents, all the respondents were interviewed only during the office hours and within the case company. The purpose of the interview and the ethical considerations were explained to the respondents before the interview began. The questions were sent to the interviewee’s one day before the interview to ensure that they were prepared beforehand. The interviewees sat in their cabin, or in a small conference room to ensure that there is no interruption throughout the interview.

During the data collection phase of the study, continuous documentation was done during interviews. Following this, the recorded data was transcribed within two days and re-read to ensure that they do not contain any mistakes. Furthermore, the author transcribed all the audio file of the interview and the written version was cross-checked with the original audio to ensure everything that is said is captured by the author clearly without any misunderstandings. If the author was not able to interpret any data, the interviewees were emailed to clarify the doubts to make sure the data is complete.

To minimize errors and biases in the study, observation-protocols were designed and used to document observation events with specific elements, such as: date, time, type of activity, length of activity, location, participants and general observation notes. By doing this, the study would arrive at approximately the same results if it were conducted by someone else. The most problematic feature regarding the research’s reliability, is that the case would be hard to do over again, as there probably is a lot of specific features within the company which may not exist in other companies.

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3.6.3 Ethics

Ethical considerations were taken into account while performing this research. All the interviewees and respondents participated in this research process voluntarily. Prior email was sent to all participants regarding the purpose of the interview and they were included in the research process only after receiving confirmation mail from them. Anonymity and confidentiality were consulted with the participants and ensured if requested. All the interviewees were asked if they agreed to being recorded. Moreover, the author refrained from referring to the statements while communicating with the management team for the sake of not interfering into the current state of relationship between the managers and the employees.

The data presented in the thesis is confidential, meaning that it is anonymized to such an extent that the persons cannot be identified by the information presented in the thesis. This lead to issues regarding being able to sufficiently describe persons with e.g. specific roles, areas of responsibility, or similar features. The anonymization process has to some extent prevented extensive description of the case.

4. CASE DESCRIPTION

4.1 Introduction

The author has chosen to do a case study on HMS (Hardware Meets Software) Industrial networks in Halmstad, Sweden. They are a leading independent supplier of products for industrial communication and the Industrial Internet of Things. It was founded in the year 1988 and has its headquarters in Halmstad, Sweden. HMS currently employs over 500 people and operated in 13 countries and with reported revenue of 119 M EUR (149 M USD, 1 183 M SEK) in 2017. The current product development process within HMS applies agile methods such as Scrum and Kanban along with the traditional waterfall method (ML, 2017). HMS stands for “Hardware Meets Software” referring to the fact that HMS products allow industrial hardware to be connected to IoT software. HMS offers a complete solution – from product development through manufacturing and support. This makes them unique and market-leading industrial communication partner (“HMS Industrial Networks,” 2018).

4.2 HMS Products

HMS manufactures and markets industrial communication products that connect industrial devices to different industrial networks and IoT systems. HMS products act as translators between robots, control systems, motors, sensors, etc. and the different industrial networks that exist on the market. HMS also offers a portfolio of wireless products as well as remote solutions for web-based control of field equipment such as electric generators, PLCs, machines, telecommunication base stations, building management systems.

HMS markets products under the following brands (“HMS Products,” 2018):

• **Anybus** - Multi-network connectivity within fieldbus and industrial Ethernet. With Anybus, you can connect any industrial device to any industrial network. Wired or wirelessly.
• **IXXAT** - Connectivity solutions for embedded control, energy and automotive testing. IXXAT products enable communication inside machines and between components in various industrial fields.

• **eWON** - Remote access and management of industrial equipment. With eWON, you can monitor and control field equipment and machinery online.

### 4.3 Services

**Customized solutions** - HMS has worked with customization projects since the company was founded. Projects range from simple brand labelling to development of completely new products. All developments are based on solid HMS technology leveraging on thousands of hours of research and development time already spent by HMS. This minimizes your costs and time to market (“Customized solutions from HMS,” 2018).

**Technical services** - Technical services from HMS help projects move forward smoothly and successfully, from idea to fully implemented and deployed solutions. The services are provided by HMS’ global team of skilled and experienced engineers who work together with customers, providing various application engineering services, technical support and training. Typical activities are project planning, setting up evaluation demos, creating and validating product configurations, providing guidance during field trials, and more (“Technical services from HMS,” 2018).

### 4.4 Organization at HMS

HMS has separate R&D teams for the Anybus, Ewon, IXAAT business units. Under R&D Anybus hardware and firmware development is done and this team is located in Halmstad. Under R&D Ewon, hardware, firmware and maintenance of cloud solutions (Argos) is done. Product development of eWON products (both hardware and firmware) handled in Nivelles, Belgium. The Argos team is located in Halmstad and sometimes cooperate with the firmware development team in Belgium. Challenges occur since the teams are not co-located and the technology used by the two teams are different. Under R&D IXAAT hardware and firmware development takes place and the Product development of IXXAT products is handled in Ravensburg, Germany. The interviewees were mainly chosen from the Ewon and Anybus business units and are currently involved in the firmware development and maintenance of cloud solutions. Hardware development is also done in an agile way but since the author didn’t get access to those employees, the interview was done with the employees involved in firmware development from Anybus unit and Argos team from Ewon unit.
5. FINDINGS

5.1 Interview results

Why HMS transitioned towards Agile project management?

when an organization makes a transition from the traditional project management method to an agile way of working, it’s not only a practical shift but also a cultural shift with the change in mindset of people towards working. Historically, HMS has been driven by a traditional sequential way of management. HMS started to adopt agile method more recently and started off in certain areas of the organization. It has been not a formal decision by the top management. It is the different teams that keeps moving over at different points of time. HMS acquired a company called Intellicom six years back which has been already practicing agile (especially Kanban) and ML was a part of the team. It was this team that had brought agile into HMS. So, they already had this agile mindset of working with flexibility and adaptability, without much documentation for requirements specification. During their transition into HMS they brought that view of how they would like to work with HMS and then they started to do it more formalized. Then they started to implement scrum all the way and the goal was to minimize administration and to be more flexible and to bring back more power to the developers (ML, 2018). One of the team managers of Anybus business unit at HMS reported that initially they had worked in waterfall method before the implementation of scrum process. And there were no testers in the team and hence development was done for a long time and then the product was given to testers for testing the new features. But now the development and testing are done simultaneously, and this was the biggest change when they started using agile (BO, 2018). In HMS the software development is done in an agile way, whereas hardware development uses a combination of Kanban and traditional waterfall method. The selection of appropriate method depends upon the type of product that is developed. This shows that HMS is somewhere between the agile and waterfall method. ML (2018) expressed that:
“HMS implemented scrum all the way and the goal was to minimize administration and to be more flexible and to bring back more power to the developers”.

From the interviews it was made clear that practically all the team members who had worked in agile method found it to have a positive effect and displayed an optimistic way of working in an agile environment. The interviewees mentioned that working in agile way contributed to better transparency and flexibility and faster delivery of value.

5.2 Themes of Challenges faced by HMS during the agile transition and adoption process

From interviewing experts like agile project managers at the top management level, scrum masters and product owners managing activities at the team level and developers working on individual tasks at individual level, several challenges were encountered. Below are some of the challenges faced by the project managers at HMS. It can also be said that the challenges at the top management level may have an effect on the team level and/or individual level and vice versa. Therefore, findings from any of the interviewees can be attributed to a different level than their own level.

5.2.1 Challenges faced by Project Managers at top Management level

A shift in decision-making: On the top management level decision making was seen as a challenge because in the agile process the self-organizing teams are given more power whereas in the traditional methodology like waterfall the decisions are taken by the top management. But in scrum all the tasks have to be managed by the team itself (ML, 2018). This statement shows how managers see the change from a centralized decision making to a de-centralized decision making power. But it is not only the managers who have to adapt to the shift but also the agile team. The shift in the decision-making process can be seen as a subtle change since the managers are used to have a command and control over the teams, therefore, the teams working underneath the managers also feel less responsible. This creates a change in mind set of the employees to be more proactive towards picking tasks.

Wrong mind-set about agile: The project managers at HMS feel that agile way of working is more suitable for software development where new features are added to the existing product but for hardware development the case is different. The hardware has to developed with close co-operation with other departments, so they feel that agile doesn’t solve everything. The project managers also feel that the agile teams must have long-term vision for the product instead of focusing on the sprints. It shows that project managers still have that traditional waterfall mindset and expect the agile teams to work in a scrum-fall approach. This creates misunderstandings between the project managers and scrum teams.

Knowledge management through documentation: In HMS the agile teams document whenever needed but it’s quite less compared to waterfall method. Most of the knowledge is within the heads of developers and the knowledge is tacit. This creates challenges for the project managers to understand what is happening within the process. So the project managers are often isolated from the scrum teams and are not involved in the scrum related meetings. This creates pressure for the
teams to document more than required but the teams also feel that the project managers should only facilitate the team rather than controlling the team.

5.2.2 Challenges faced by Scrum master, Group manager and Product owner at Team level

Taking multiple roles: Challenges are also seen in choosing different roles in the scrum like scrum master, product owner and the team manager. This is a challenge at the team level faced by different roles at the team level like the product owners, team manager and scrum master. It is possible to combine these roles in different ways. In HMS the Argos project team has tried executing different combination of roles and found that some combinations worked, and some didn’t work for them. So it was a challenge for them to find out which combination of roles work well for them. ML (2018) also added that:

“After many tries have found that the combination of product owner and team manager works quite well”.

Communication between teams: Although it is clear that the team communication is low, efforts have been put by the scrum masters every third week, where all the scrum masters meet and discuss about how different teams work and see the differences and consider it to be an open forum for taking up questions that deals with any problems and get solutions. During this meeting they also discuss about the different software tools that can assist them in their agile project management process.

Working with multiple projects: The ideal thing to work with scrum is to work on one project at a time. But within HMS they have lot of old products and some new products and they have to be maintained all the time and some products remain back without doing anything with for one or two years and when they have to suddenly make an update they have to bring in people who have the old software and add stuff and then release it. so, within one scrum team there are many products that the team has to work with at the same time. This is a main challenge for the company that was expressed by the group manager ML (2018) as follows:

“The main challenge here is to have the knowledge in one scrum team for so many different products”.

Group dynamics: The team members should work together to increase their efficiency and to achieve the final result within the estimated time. Group manager ML (2018) expressed that:

“The people have different challenges in terms of group dynamics, because they have to work on good communication within the group and have to establish an open climate within the group to get feedback from each other and that is not always easy in their case”.

Initially when they were using the traditional waterfall method the biggest problem they had in this process was that the different teams lacked continuity, since new teams were formed every time and some teams worked well while others didn’t. But the team managers failed to take advantage
of the teams that were working good together. That’s why they changed to this process to maintain the continuity and to make the teams more efficient to work on their own.

From observing some of the daily scrum meetings and also from the interviews, it is also found that the team members had different perceptions about the purpose of daily scrum meeting. Some respondents mentioned that it is a method to share the progress of their work to their scrum master and rest of the team, while others perceive it as a way to solve their problems and discuss solutions and help out each other and to learn from each other. Some respondents believe it’s a tool for continuous improvement and some just focus on how long the meeting should take place regardless of what is discussed during these meetings.

**Cross-dependencies:** HMS has different scrum teams working on different projects within different business units like IXAAT, Ewon. Anybus. Most of the scrum teams are co-located but there is not much interaction among the different scrum teams. And if the different scrum teams have to work on the same project, each team works on their respective user stories and co-operate with each other at the end. But one of the respondent’s AG (2018) reported that the teams would help out each other when in need.

"We have co-located scrum teams. If we need to work on same project, we would do our user stories and they would do their user stories. At the end we can co-operate with each other. So, we don’t work so much together. If someone is stuck with the problem we can go over and ask for help”.

One of the team managers also said that when multiple teams work together on the same project, the project managers must take the responsibility to have one lead engineer in each team and have a separate meeting with them to prioritize and divide the tasks between the groups. But is difficult to work in this situation since there is not much communication between the different teams and the teams have to depend on each other and this leads to complex issues. So, the opinion of the team manager was that the whole project has to be managed by a single team rather than multiple teams working on the same project.

**Lack of good interface with project managers:** In HMS the software development is done in an agile way and hardware development uses traditional waterfall method as well as Kanban depending upon the type of product that is developed. So, it’s the duty of project managers to have a control of different teams working on different projects. but after the adoption of agile the project managers lost their command and control over the teams and the product owner takes over the responsibilities of the project manager. One of the team managers reported that still now the scrum teams doesn’t have a proper interface with the project managers. Some of the interviewees feel that the project managers and product managers still work in a waterfall mind set and have problems in understanding what is good about agile. This situation was explained by the group manager BO (2018) as follows:

"Before adopting agile project managers were responsible for progress of the groups and more involved in software development. But after changing to agile, scrum master took over the responsibility and project managers lost their
influence and till today not found a good interface between project managers and the scrum teams”.

Managing different stakeholders: It is very challenging for the product owners especially when they have to work with multiple stakeholders within the same project because the product owner has to synchronize all the requirements from different stakeholders and should prioritize the requirements to bring best value within less time provided. The different stakeholders also have to agree to this decision. Hence, it becomes the responsibility of product owner to take care of multiple stakeholders (BE, 2018).

Multiple product owners: Sometimes when the team works with multiple projects within the same sprint, they have to work with multiple stakeholders, who prioritize in between each other. This creates lots of difficulties for the team manager as well as for the developers because the product owners have to agree with each other on prioritizing the product backlog (BO, 2018).

Lack of customer involvement: The scrum process requires close collaboration and communication with customers. But in reality, the situation is different. HMS does not sell its products directly to customers. They mostly develop internal products and release it to market. So in a scrum team, the product owner is visualized to be a customer since he or she receives feedback and requirements from the customers. In a firmware project also, a hardware team may be the customer for the software project. But in HMS, the sales team has close contacts with the customer and HMS has a separate support team to provide after sales service to the customers. But if the questions from the customers are too technical, then the support team directly contacts the development team and solves the issues. This problem was explained by some of the team managers as follows (BO; ML, 2018):

“We are not very near to our customers. we sell it to thousands of different customers and it’s the sales team that has direct communication with the customers. we don’t have lot of experience of people being our customers in this process. We have more or less seen the product owner as our customers”.

“HMS don’t sell their products directly to customers. they have distributors in between and adds a layer of complexity because they don’t get feedback directly from the end customer, also the distributor has to be trained to understand the product with multifunctionalities. Sometimes the developers meet the customers, but it is very difficult, and the developers are not interested either”.

Some of the interviewees also expressed that they communicate with the customers directly only when they develop customized products for them. But even in this case the customers are not invited to participate in any of the scrum related meetings. For eg. In customer demo the product ah_s to be shown to the customers but the situation is different in HMS where the product is only shown to internals such as product owners and product managers rather than the customers. in this case the developers feel that the product owners should be responsible for bringing in the feedback from the customers to the team.
**Choosing the right method:** Another issue is to choose the appropriate method. The contrasting characteristics of traditional and agile methods allows the managers to choose between these methods. But the method selection depends upon the type of projects. One of the project managers BE (2018) explains it as follows:

> “The method selection does not depend on the size of the project but on the type of the projects. To develop from scratch; waterfall can be used to get the big picture and the remaining parts can be worked in agile. If you have an existing product that is upgraded by adding features, then agile works best here”.

The agile method also has different practices which are suitable for different purposes. The method selection depends on many factors such as organizational constraints, abilities and business goals and it’s the duty of managers to assess such factors before the transformation. Wrong selection of appropriate agile method leads to failure and requires more effort and money.

**Rotating scrum master role:** The importance of having an experience scrum master was reported by ML (2018) as:

> “Having an experienced scrum master is important to guide the whole team and meanwhile the team has to learn from each other to be up to speed while they are growing”.

Some of the teams have a rotating scrum master in the absence of a usual scrum master. One of the developers acknowledged that it is part of the learning process on how to be an efficient self-organizing team. But it is quite challenging for the team members to take this role without proper experience. This may create problems to the team, so it is advisable for the team members to take the scrum master role only if they are certified enough to have the knowledge about scrum master roles and responsibilities.

**Sprint management:** Defining the sprint backlog is the most important part of scrum. Getting right estimates is also hard when the team keeps receiving requests from the client once the sprint starts. The customer is expecting to be able to request changes whenever this seems appropriate, and the company has to define what can be considered as minor change and integrated in the sprint or what can be considered as big change and has to be reconsidered for upcoming sprints. What can happen is that the team does not really realize the impact of this change and accept to do it without enough analysis. This will of course affect their ability to deliver on time so they will just start cutting in the testing part to be able to respect the deadline taking the risk to have to deal with bugs and rework later.

**Risk management:** Agile projects have lot of uncertainties due to constantly changing requirements from the user. Hence, it is vital to identify right user stories with risks from the product backlog and prioritize it (ML, 2018). Less research is done in this field and there is not much risk mitigation strategies identified till now. Hence, handling risks become more challenging in agile.
**Partial product owner role:** In HMS, the product owner role is split and distributed by employing a product manager and a “product owner”. The product manager takes care of the product marketing and product management aspects, owns the vision, is outward-facing, and keeps in touch with the market. The “product owner” is inward-facing, drives the sprints, and works with the team. In these cases, the so-called product owner is little more than a product backlog item writer. This approach reinforces old barriers, blurs responsibility and authority, and causes handoffs, delays, and other waste.

**Too idealistic:** according to scrum, the team members have to be cross-functional and self-organized all the time. The scrum master has to remove the impediments for the team and the product owner has to provide clear requirements from the customer to be able to finish the product incrementally. But in reality, this is not valid because the team cannot be self-organized and self-empowered all the time.

**Lack of long-term vision for the product:** It was reported by some of the project managers AC that the product owner BS lacks long-term vision for the product and focuses only on the current sprint. This was even agreed by the product owners because they have to lead the visioning activities to the team which is more challenging for them. This will make the team more empowered and have common orientation towards the vision.

**5.2.3 Challenges faced by the Developers at the Individual level**

**Lack of skills:** In general, the scrum team is expected to have many different competencies and should work cross functionally to make the project a success. The developers should be specialized in their field and should know something about the remaining parts but not everything (BO, 2018).

> “Everyone needs to know a little bit about everything. We have test engineers that act as test leads and some engineers who are senior developers taking lead roles when it comes to development”

Moreover, the developers of firmware are from a more technical background rather than computer science. Hence in most of the cases, the developers lack understanding of basic software programming methods. In this fashion it is clear that firmware developers are not performing in skills that are normally learned in computer science studies.

**Getting feedback from the real end users:** HMS don’t sell their products directly to customers, they have distributors in between and adds a layer of complexity because they don’t get feedback directly from the end customer, also the distributor has to be trained to understand the product with multifunctionalities. Sometimes the developers meet the customers, but it is very difficult, and the developers are not interested either which is also a major challenge for HMS (ML, 2018). According to ML:

> “Product manager plays an important role in bringing in the feedback from customers to the team and Business development manager who is between sales and R&D department, who can also bring in knowledge about the feedback from sales team and customer. So, the managers try to meet them on a regular basis to get the feedback”.
Changing scope: In the traditional waterfall approach the scope remains fixed, whereas in an agile project the scope keeps on changing throughout the process. This creates challenges for the developers when they move from a fixed scope to a flexible, especially when it is about convincing the customer. Under such situation the product owner has to understand the flexible scope characteristic and decide which features to add or to not add to deliver the product in time. One of the developer’s AG (2018) stated that:

“The challenge is that the goal keeps changing once they start the sprint, so for the next sprint they have to change the scope and work on something else and becomes difficult to focus on one particular thing at a time”.

Lack of motivation to use agile: In HMS the transition happened very quickly since they didn’t want to spend more time planning the transition process and all other teams started using agile and they learnt about the process on the way. The scrum process itself motivates the developers to iteratively and continuously monitor the progress of their projects through interactions and discussions in the daily scrum meetings, sprint review meetings and during backlog refinement. Working in scrum also enables the developers to adapt when it’s not possible to predict he requirements. But as an individual developer they are not motivated by the top management to work agile. They developers don’t get any information or feedback directly from the customers and instead consider product owners as their customers. The challenge was expressed by one of the product owners as:

“The team itself should be responsible for the product they are developing together with product owner and should be able to bring in information from the market which features are more valuable for the product, then you get a complete team that is motivated but that is not the reality”.

The team members have to learn from each other how to work in the process and they are not given any separate training on how to adopt and use agile methods. But when a new member enters the team, it is the responsibility of the team to educate the new team member. This may discourage and demotivate the team from using agile methods. The developer explains the challenge as follows:

“Training is given sometimes but most of the times they have to learn from rest of the team members or gain knowledge through certified courses. The team has to take the responsibility to educate the new team member. They have a schedule for meetings within the team to educate the new member”.

Knowledge about agile: One of the problematic challenge of people involved in agile projects is to have knowledge about the agile values and principles. If the lack proper training, it would be difficult to understand and work with full dedication. The successful adoption of agile is only possible if the developers and the stakeholders have good knowledge about the agile value and principles.
Lack of scrum training: Group manager ML added that:

“People are more important because the group dynamics depends on the people and if the group doesn’t work, the efficiency decreases. No separate training is given, it is more about how they work with scrum”

She expressed that the team members learn and understand the process by themselves. If a new member joins an existing team, they have to learn the process from rest of the team members. If it’s an entirely new team that has not worked with scrum before then the team has to be trained first.

Lack of Customer involvement: One of characteristics of agile methods is a constant customer involvement in every aspect of the software development process. However, HMS does not invite customers to all of the scrum related meetings. This is because HMS does not sell products directly to the end customers and develop products that are internal to HMS. Instead the product owners and sometimes developers visit customers on site and interact with them to gather product requirements and to obtain feedback from them.

One of the developers at HMS reported that they have a support team through which the customers can interact and clarify their doubts. If the support team does not have enough knowledge to answer the questions, then the customer support team forwards the query to the development team. The developers are isolated from the customers. the salesmen have contact with the distributors and the distributors have contact with the customers. The developers manage to travel with some of the support team members to meet the customers to understand how their product works in real time (AG, 2018)

Too much transparency: Daily scrum was scary in the beginning but as managers they motivate them and describe the reason that it is not to show their weakness but to help them to get help from others in those fields that they are weak and to improve themselves. Still now some teams are not comfortable working this way. But most of teams think that it’s a good way to work. This increases the efficiency of the team (BO, 2018).

Concurrent designing: In the case of firmware development, the developers have to depend on the hardware for testing the software or firmware. In many cases the final hardware cannot be defined until very late in a project. This means that most of the time the software development is done on different hardware than the actual target. In HMS, there is less communication between the hardware and software development teams, hence it creates challenges for the developers to perform testing at the right time without the hardware (BO, 2018).

Unconventional customer: The software development team of Ewon provides cloud solutions to remote management. The developers in the team get their feedback from customers through their website and from the support team. But they don’t have face-to-face communication with the customers. But for firmware development, the customers are mostly internal, since the company develops internal products and lacks information about their end-users. In the case of HMS, the customers are mostly internal except for the customized products (BS; BE, 2018).
**Distributed teams:** HMS is a global organization operating over 13 countries. The product development teams of Ewon and Anybus are currently working in Halmstad but they have one cloud service team (Talk2M) in Belgium working for the Ewon business unit. However, agile is suitable only for locally distributed teams and projects. This creates challenges because the developers are distributed at different geographical locations and this creates barriers for effective communication and collaboration. One of the developer’s AG (2018) mentioned that:

> “The only team we are cooperating with is currently in Belgium. But we have come to a decision that we will not help each other on each other’s services. If we want to develop a new service we can cooperate together with them and if they say yes, we communicate with them through skype, email but not travel often to meet each other. When they have their sprint demos we try to invite each other over skype”.

**Lack of business knowledge:** The scrum team is expected to be a master of all trades. They have to possess knowledge about everything rather than specializing in a particular thing. As of now the team members possess IT and domain specific knowledge but lack business knowledge. Since agile requires constant interaction with customers, developers are expected to possess business knowledge to gain the confidence of the customer in their overall ability (Conboy et al., 2010; Hajjdiab & Taleb, 2016).

**6. ANALYSIS**

In the analysis part the findings from the interviews and observations are analyzed with the existing literature. Triangulation is done to cross-check the findings from multiple data sources with the existing literature. This increases credibility of the study.

![Figure 15 Triangulation analysis of data](image-url)
6.1 Analysis of interview results

During the analysis of raw data, several themes emerged which captures the key idea about the data in relation to the research question (Braun & Clarke, 2006). Then these themes were grouped according to their similarities for the purpose of making sense of them in relation to the analytical framework created from reviewing the literatures. This method is theoretically flexible and provides a rich interpretation of study, both inductive and deductive (Braun & Clarke, 2006). The acknowledge that both inductive and deductive approach are interactive in some way because the researcher keeps a specific interest in identifying themes influenced by the analytical framework.

### Table 5 Table representing challenges at top management level

<table>
<thead>
<tr>
<th>Job role</th>
<th>Level of analysis</th>
<th>Multi-faceted roles</th>
<th>Identified existing challenges</th>
<th>Dimension of challenges</th>
<th>Confirmation with the literature</th>
</tr>
</thead>
</table>
| Project manager | Top management level | No | 1. Shift in decision making  
2. Wrong mindset about agile (consequence of cultural shift)  
3. Knowledge management through documentation | Organization /Management dimension | All the 3 challenges confirm with the literatures; (Nerur et al., 2005); (Moe, Aurum, & Dybå, 2011; Denning, 2015)  
Boehm and Turner (2005)  
(Gandomani et al., 2013)  
(Nerur et al., 2005) |

#### 6.1.1 Top Management level challenges:

1. **Shift in decision-making:** The shift in decision-making is a consequence of the cultural shift. Before the implementation of scrum at HMS the project managers had command and control over the teams and were responsible for the progress of the teams. But after the implementation of scrum, the scrum masters took over the responsibility and project managers and they lost their influence on the teams. The scrum team was given more decision-making power and the team was empowered to work flexible and adaptive. So here the challenge lies in altering the project manager’s traditional role of a planner and controller to that of a facilitator who co-ordinates and directs the collaborative efforts of different agile teams involved in the development process (Gandomani et al., 2013; Nerur et al., 2005). Thus the shift in culture removes the decision-making power from the project managers to the scrum teams (Denning, 2015; Moe, Aurum, & Dybå, 2012). This was evident from the observations that the project managers were refrained from the daily-stand up meetings and the decisions were taken only by the scrum team.

2. **Wrong mind-set about agile:** The project managers face difficulties to ignore their previous authorities and roles, and hence they lack good interface with the scrum teams (Nerur et al., 2005; Sureshchandra & Shrinivasavadhani, 2008). Some of the project managers feel that it’s not a right way to work agile for all the projects and were not aware of the real change. They should understand the real benefits of agile and support the self-organizing teams to work agile.

3. **Knowledge management through documentation:** Knowledge management is done in traditional product development methods through extensive documentation. This serves as an
artifact for communication and tracking of bugs during the execution of sprints. Whereas, in agile less documentation is done to encourage lean thinking and to cut down on overhead. Hence the knowledge in traditional methods is explicit compared to agile where the knowledge is tacit and this forces the top management to rely on the development teams (Nerur et al., 2005). Especially the project managers face challenges to communicate with the scrum team since they don’t have much knowledge about how scrum teams work and how documentation is done within the team. Thus, a lack of interface is between the project managers and the scrum teams. Hence the teams have to decide which knowledge should be codified and what to remain tacit (Nerur et al., 2005).

6.1.2 Team level challenges:

1. Taking multiple roles: The group managers at HMS have multi-faceted job roles which makes it more challenging. The group managers also function as a product owner and vice versa. The developers have a role of rotating scrum master. So they combine their job roles in different ways. Sometimes it works and sometimes it doesn’t work well. So it is quite challenging for the teams to decide the correct combination of roles to function successfully. This challenge is new and has not been discussed in any existing literatures. But further research has to be done in this field to find out whether it’s possible to have multi-faceted role in agile and what combinations of roles work better in such situation.

2. Group dynamics: Group dynamics is important in an agile team. Group dynamics refers to how team members communicate, interact, motivate co-employees within the team. In HMS the team managers work a lot to ensure the team dynamics is maintained throughout the process. This becomes more difficult since the team members possess different types of knowledge, experience and skills. So it’s the responsibility of the team manager to properly select the team members in order to find a proper balance between different types of members within the team. The right balance can help to build a successful team. The team members have different perceptions about the purpose of scrum daily stand-up meetings. So, the team managers have to educate the scrum master and team members to understand the purpose of daily stand-up meetings. It was evident from the observation when some of the team members discussed issues other than what must be discussed during the daily stand-up meetings. This lead to longer meetings and hence someone had to break in the discussion and make sure they discuss those issues after the meeting. This challenge deviates from the literature since the concept of group dynamics is discussed widely as a challenge in distributed agile software development (Shrivastava & Date, 2010). From observing the stand-up meeting, the author interprets that the Argos team had good dynamics in terms of communication, co-operation and knowledge sharing and team effort. The team self-assigned the tasks among themselves and shared their problems with all others in the team. The team members are multi skilled and know about each other’s tasks. The team carefully listened to problems as well as the progress of their team members and provided suggestions and solutions to problems. It was evident that there was close collaboration within the team.

3. Rotating scrum master role: The role of scrum master is to lead the team, solve impediments and improve team communication and motivate the team (Schwaber & Sutherland, 2013; Sutherland & Schwaber, 2007). Hence it is important to have an experienced scrum master for this
role and in HMS most of the scrum masters are certified. But some of the teams have rotating scrum master roles in the absence of a usual scrum master. The developers have to be trained well to take up this role otherwise the team will face difficulties to execute work. The literatures explain the role of scrum master’s in general but does not provide any knowledge about the rotation of scrum master role. From the observation, the author noticed that during the stand-up meeting, the team decides among themselves who has to take the role of scrum master for the upcoming sprint, so everybody gets a chance to play the role of a scrum master.

4. **Sprint management:** Sprint duration plays an important role in scrum. It is the duty of the scrum master to wisely select the duration of sprint to maximize benefits. In HMS the sprint duration is around 3-4 weeks. but sometimes there is always changing requirements from the customer. Normally “no new requirements can be introduced during these sprints” (Vlaanderen et al., 2011: 59), but this is hard to achieve in reality. Only the important requirements that has less impact on the delivery timing are integrated into sprint. The other requirements are reconsidered for the upcoming sprint. The embedded and firmware environment places extra difficulties on software development. The firmware development can undergo only minor changes within the development process compared to software development. Adding more work than the team can do makes it difficult to meet commitments and to measure velocity and progress of the team (Akif & Majeed, 2012).

5. **Risk management:** It is found that risk management in agile projects is not studied much in the literatures and explored least by the researchers. But in HMS the risks are handled by prioritizing user stories with higher risks from the product backlog. The high-risk items are implemented in initial iterations to mitigate risks earlier in the projects. But it is not known how the different teams handle risks related to sprints, customers, continuous integration etc. Hence a formal risk management technique or framework is lacking in agile methods and remains as an impediment to agile adoption.

6. **Lack of long-term vision for the project:** According to Cohn (2010) the product owners should have long term vision for the product. He also states that the role of product owner is challenging since they have to address inward and outward facing needs all the time. One of the product owners mentioned that they have to communicate the vision of the product to everyone in the team and it is the hardest part and this goes in line with the literature (Cohn, 2010). It seems that the product owner role is diverse in practice as the literature describes it and the challenges faced by them are many. Hence the organization should help the product owners to identify their teams’ customers to give the teams a better view of what they are developing and why they are developing and to whom they are developing the products. This way the team can be more empowered and more involved in the vision of the development.

7. **Prioritizing user stories with multiple product owners:** Scrum is more suitable to work with single product at a time. But in the case company the teams work with multiple products within the same time. Therefore, they have multiple product owners who have to prioritize in between each other and that becomes more difficult for them since they have to agree with each other on prioritizing the backlog. This challenge deviates from the literature because the prioritizing the
backlog is described as the responsibility of the product owner, but no studies are available that describes challenges of multiple product owners.

8. Managing different stakeholders: In HMS the scrum team has multiple stakeholders like project managers, line managers, product managers, customers involved in the project. So it’s the duty of product owner to identify most important stakeholders for the team and its quite challenging for them. The challenge also lies in focusing user value and remembering that they have both internal customers as well as external users (Cohn, 2010).

9. Cross-dependencies: To scale larger projects the tasks are dividing between different teams (Joseph Cody, Divakar Goswami, 2015). In the case company there is less communication between different scrum teams. They work separately on each other’s user stories but cooperate at the end. Such cross-team dependencies create the need for additional coordination when planning upcoming iterations (Joseph Cody, Divakar Goswami, 2015).

10. Working with multiple projects: The case company runs several projects within the same sprint. But scrum is suitable only for running single project at a time. The team lacks focus on a specific project due to pressure on working with multiple projects and have to switch between them frequently. Moreover, the company works with new products as well as maintains old products. Hence it becomes difficult to have the knowledge in one scrum team for so many different products. This challenge is more specific to firm and can cause delay in delivery due to split focus.

11. Lack of good interface with project managers: It is found that some of the group managers at HMS lack good interface with project managers because of their lack of willingness to change their management style. Sometimes the project managers fall into old habits and try to control the teams and their decisions. This creates challenges for the team level employees which shows parallels to the literatures (Denning, 2015; Moe et al., 2012).

12. Choosing appropriate method: The top management has to choose the right method for the execution of projects. Suitable project management method either waterfall or agile has to be adopted for the type of product that is going to be developed. And the challenge also lies in choosing the appropriate agile methods because there are several different practices that are based on the same agile values. In the case company scrum is widely used since they develop firmware and maintain cloud solutions for their internal products. The hardware development uses Kanban method. But wrong selection of method may cause more effort and cost and sometimes failure (Gandomani et al., 2013).

13. Working with distributed teams: Agile is more apt for co-located teams but if the teams are distributed there arises issues in communication since the teams are located at a distance and at different time zones and cultural differences might also have an effect on the teams (Shrivastava & Date, 2010). This was also evident in the case company since they co-operate with one team at Belgium and the communication is done through skype. In the distributed agile development communication tools play a vital role since face-to-face communication is not possible (Gandomani et al., 2013). The team faces challenges due to difference in technologies used by the distributed team, hence they restrict themselves from working with distributed teams.
14. **Partial product owner role:** From observing the firm, it could be said that the responsibilities of product owner is distributed to the product manager. The role is split in such a way that the product manager takes care of the product marketing and management activities which is more outward-facing, whereas, the product owner role is more inward facing, working within the team and driving sprint. This approach blurs the responsibility and authority. Instead of splitting the product owner role the company should face the challenge of applying the role properly. One person should be in charge of the strategic and the tactical product management aspects. This may well require organizational changes, including adapting job roles and career paths and developing individuals to take on a rich set of responsibilities.

15. **Not realistic:** According to scrum the team should self-assign and self-organize the tasks by themselves, but this is not the case in HMS. Because the team members are not trained enough to use the scrum process and lack knowledge about agile values and principles which cannot make them empowered all the time. This creates challenges for the scrum team to transition towards agile and to adopt it successfully.

16. **Lack of Communication between teams:** According to Lindvall et al. (2004) agile method should facilitate communication with the customer as well as between teams and within the team. The communication within the team is good but there is lack of communication between different scrum teams. All the scrum teams are collocated but they don’t communicate often since they work on different projects. But the initiative is taken by the scrum masters to meet and discuss about the progress of the team and issues faced by the team and find solutions for those problems.

17. **Lack of customer involvement:** In HMS, the customers are both internal and external to the firm. Most of the customers are internal eg. Product manager, hardware team, project manager, product owner. But for customized products the customers are external. But in either case there is lack of face-to-face communication with the customers. There is not much collaboration with them. The customers are sometimes invited to sprint review meetings to see the product and give feedback on it. This applies for firmware development, but in the case of Ewon team, they are very far from the customers. the product owner acts as a customer and provides feedback to the team. Thus lack of customer involvement leads to decreased product quality and becomes a challenge (Chow & Cao, 2016)
### Job roles

<table>
<thead>
<tr>
<th>Job role</th>
<th>Level of analysis</th>
<th>Multi-faceted roles</th>
<th>Identified existing challenges</th>
<th>Dimension of challenges</th>
<th>Confirmation with the literature</th>
<th>New challenges</th>
</tr>
</thead>
</table>
| Scrum master     | Team level        | Yes (Ewon) Developer      | 1. Taking multiple roles  
2. Rotating scrum master  
3. Sprint management  
4. Risk management  
5. Not realistic | Covered under Organization/ Management, People, Process dimension | Challenges 3 is line with the literature (Akif & Majeed, 2012), (Vlaanderen, Jansen, Brinkkemper, & Jaspers, 2011) | Challenge 1 deviates from literature because it is firm specific because scrum altered from the textbook scrum.  
Challenge 2 deviates from the literature because only the scrum master roles have been discussed and lacks knowledge about job rotation.  
Challenge 4 deviates from literature because risk management is discussed only in distributed agile projects but not in localized projects. |
|                  |                   |                           |                                                                                               |                                                                                          | Challenge 5 is discussed in literature (Akif & Majeed, 2012).                                |                                                                                                                                               |
| Product manager  | Team level        | Yes (Ewon) Group manager  | 1. Having long term vision for the product                                                            2. Organizing and prioritizing user stories with multiple product owners  
3. Managing different stakeholders  
4. Partial product owner role | Covered under People, Process dimension                                                              | Challenges 1 and 3 goes in line with the literature Cohn (2010)                                     | Challenge 2 not discussed in any literatures since it is specific to firm.  
Challenge 4 is specific to firm.                                                                                                                                                                           |
|                  |                   |                           |                                                                                               |                                                                                          |                                                                                           |                                                                                                                                               |
| Group manager    | Team level        | Yes (Ewon) product owner  | 1. Lack of good interface with project managers (consequence of cultural shift)  
2. Choosing appropriate method  
3. Prioritizing user stories with multiple product owners  
4. Cross-dependencies  
5. Group dynamic  
6. Lack of communication between teams  
7. Working with multiple projects  
8. Lack of customer involvement | Covered under People, Process, Organization/ Management dimension | Challenge 1 goes in line with the literatures (Moe, Aurum, & Dybå, 2011; Denning, 2015)               | Challenge 3 deviates from the literature because it is firm specific and occurs due to altering of scrum practice.  
Challenge 7 is specific to firm.                                                                                                                                                                           |

**Table 6**: Table representing challenges at team level

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- **Level of analysis**: The level at which the job roles operate—team level, product owner, group manager.
- **Multi-faceted roles**: The roles that employees take on within their job.
- **Identified existing challenges**: The specific challenges faced by employees in their respective roles.
- **Dimension of challenges**: The categories under which the challenges are classified—organization, management, people, process.
- **Confirmation with the literature**: References to literature that confirm the challenges.
- **New challenges**: Any challenges that do not align with existing literature.
6.1.3 Individual level challenges

1. **Lack of customer collaboration:** In HMS most of the development is done for internal products and hence the team doesn’t have much communication with the customers. But only for customized products the team has direct communication with customers. This creates problems for developers in terms of getting clear requirements from the customers and also their feedback on the product. This affects the final quality of the product due to lack of face-to-face communication (Hoda et al., 2010). The Ewon team provides cloud solutions to remote management. They receive feedbacks from the customer through their websites and from the support team. This shows that there is lack of collaboration between software team and customer (Chow & Cao, 2016).

2. **Changing scope characteristics:** The main objective behind using agile methods is to increase flexibility and adaptability. Since the team has to adapt to changing requirements, the scope is not fixed and changes throughout the process. This flexible nature of scope poses challenges for the developers to work with different scopes in each sprint, and frequent changes become difficult to handle. This challenge is not discussed as a challenge in any literatures and hence does not confirm with any literature.

3. **Lack of training:** From the interviews at the team level, it is confirmed that developers are not given any separate training to work agile. The team member has to learn from others in the team. If a new member enters the team, it’s the duty of other developers to educate the new team member. So lack of training demotivates the employees to work agile since they lack knowledge about agile practices (Conboy et al., 2010).

4. **Lack of knowledge about agile:** Formal training is given only to teach agile practices but that is not enough for the developers. They have to understand the agile values and principles continuous training has to be given (Conboy et al., 2010). Along with training, coaching also has to be given to assist the team along the journey of agile transition and adoption (Conboy et al., 2010). Through proper formal training the team can understand more about the process and creates awareness about their team rights (Akif & Majeed, 2012).

5. **Lack of motivation to use agile:** The top management support towards the agile team is very less in the case of HMS. The team members are not motivated enough to work agile. But the developers feel motivated through the process itself since they are given more decision-making power and flexibility to work in the scrum process. Lack of motivation also causes problems since the developers don’t embrace the agile values and principles due to the fact that they are familiar with only the practices (Conboy et al., 2011).

6. **Lack of communication between teams:** In HMS there are different agile teams working on different projects. communication within the team as well between different teams is vital in an agile environment. But sometimes for larger projects the tasks are divided between different teams. Thus each team must be able to communicate and co-ordinate with other teams which might be challenging for them (Lindvall et al., 2004).

7. **Getting feedback from real end users:** In HMS, customer collaboration is quite low, due to the fact that they sell their products to internal customers and lacks knowledge about the real end consumers. The feedback from real end users are received by the developers either from the support
team or from the distributors who have direct contact with them. But for HMS, getting feedback from the end users to the developers is a big challenge. This challenge is specific to the firm.

8. **Too much transparency:** It was reported by some of the group managers in the case company that the team had difficulties to adopt to agile since there is lot of transparency in the work and the weakness of the developers is also exposed to others in the team. This creates skepticism towards agile and also makes them counter-productive (Conboy et al., 2010). This challenge can be found in the initial stage of agile transformation, but the fear can be overcome by confronting the fear of change with the scrum master or group manager and getting help from them to overcome this difficulty. The team manager has to motivate the team members to increase their ability to follow agile.

9. **Distributed teams:** It is found that one agile team is Halmstad is co-operating with team at Belgium and the communication is done through digital tools like skype since face-to-face communication is not possible with distributed teams (Gandomani et al., 2013). The teams sometimes face communication and co-ordination problems due to different time zones, language barriers (Shrivastava & Date, 2010).

10. **Lack of business knowledge:** The team members were technically qualified and specialized in their fields, but they lacked knowledge about the business in which they are working. This was a concern from the project managers because they feel that the developers should possess some knowledge about the business to gain the trust of customers. since the team has to collaborate with the customers most of the time, they are expected to possess some business knowledge in order to deliver value to the customers (Conboy et al., 2010; Hajjdiab & Taleb, 2016).

11. **Unconventional customer:** The customer of a firmware project is not so clear case. There can be two types of customers for firmware project. One is the end customer and the other is an internal customer. In HMS, the end-customers are the people who actually make use of their system. In a firmware project also, a hardware team may be the customer for the software project. Hence it becomes difficult to define their customer and to collaborate with them effectively (Punkka, 2005).

12. **Concurrent design:** Designing a firmware system includes both hardware and software design (Wolf, 1994). In many cases the final hardware cannot be defined until very late in a project. This means that most of the time the software development is done on different hardware than the actual target. Testing in a firmware project is trickier than in workstation software development. The resources, memory and timing form the highest risks to a project. These should be tested on real target, but this is not usually available until very late in the project (Punkka, 2005). This becomes a challenge for the company to co-ordinate work activities between software and hardware development.

13. **Lack of skilled team members:** Firstly, almost all project managers found it difficult to find developers that displayed all of the skills necessary for agile. The agile team members should be highly skilled to fill the gap between user requirements and coding (Hamid et al., 2015). Literatures (Marchenko & Abrahamsson, 2008; Moe, 2013) says High level of specialization is not needed in scrum but the team member should be able to take over the tasks of another team member but this case study shows that this is not possible in practice. Moreover, some of the developers in firmware
development had less understanding of software programming methods, hence cross-training has to be provided for the developers to develop both software specific knowledge and domain specific knowledge.

<table>
<thead>
<tr>
<th>Job roles</th>
<th>Level of analysis</th>
<th>Multi-faceted roles</th>
<th>Identified existing challenges</th>
<th>Dimension of challenges</th>
<th>Confirmation with the literature</th>
<th>New challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firmware developer</td>
<td>Individual level</td>
<td>No (Anybus)</td>
<td>1. Unconventional customer</td>
<td>Covered under People, Process dimension</td>
<td>Challenge 1 is discussed in the literature (Punkka, 2005)</td>
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<td></td>
<td></td>
<td></td>
<td>2. Lack of training</td>
<td></td>
<td>Challenge 2, 3 and challenge 4 are in line with the literatures (Conboy et al., 2010); (Conboy et al., 2011); (Akif &amp; Majeed, 2012)</td>
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<td></td>
<td></td>
<td></td>
<td>3. Lack of knowledge about agile</td>
<td></td>
<td>Challenge 5 confirms with the literature (Lindvall et al., 2004)</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>4. Lack of motivation to work agile</td>
<td></td>
<td>Challenge 6 is inline with the literature (Conboy et al., 2010)</td>
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<td></td>
<td></td>
<td></td>
<td>5. Lack of communication between teams</td>
<td></td>
<td>Challenge 7 confirms with the literature (Conboy et al., 2010; Hajjdiab &amp; Taleb, 2016)</td>
<td>Challenge 10 and 11 are specific to the firm and do not confirm with the literatures.</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>6. Too much transparency</td>
<td></td>
<td>Challenge 8 is discussed in the literature (Punkka, 2005)</td>
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<td></td>
<td></td>
<td></td>
<td>7. Lack of business knowledge</td>
<td></td>
<td>Challenge 9 is discussed in the literature (Hamid et al., 2015; Marchenko &amp; Abrahamsson, 2008; Moe, 2013)</td>
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<td></td>
<td></td>
<td></td>
<td>8. Concurrent design</td>
<td></td>
<td>Challenge 2 is specific to the firm.</td>
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<td></td>
<td></td>
<td>9. Lack of skills</td>
<td></td>
<td>Challenge 3, 4 are in line with the literature (Akif &amp; Majeed, 2012; Conboy et al., 2010)</td>
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<td></td>
<td></td>
<td></td>
<td>10. Getting feedback from real end users</td>
<td></td>
<td>Challenge 5 is in line with (Conboy et al., 2011)</td>
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<td></td>
<td></td>
<td></td>
<td>11. Changing scope characteristic</td>
<td></td>
<td>Challenge 6 is discussed in the literatures (Hamid et al., 2015; Marchenko &amp; Abrahamsson, 2008; Moe, 2013)</td>
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<td></td>
<td>Challenge 7 is in line with (Lindvall et al., 2004)</td>
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<td></td>
<td>Challenge 8 is discussed in (Gandomani et al., 2013; Vasudeva Shrivastava &amp; Date, 2010)</td>
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<td></td>
<td>Challenge 9 is discussed in (Conboy et al., 2010; Hajjdiab &amp; Taleb, 2016)</td>
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</table>

Table 7 Table representing challenges at individual level
Relating all the results from the analysis

From the analysis of data, several themes of challenges have emerged. The challenges are mapped to respective dimension based on its nature. Most of the challenges are from the team and individual level mentioned in the framework. The top management influence is less on the scrum teams and their job roles are distributed among the scrum master, product owner and development team. Hence the project managers are not directly involved in the scrum process. The different themes emerged within this study have been mapped to people, process, organization/management dimension and the technology/ tools dimension in the framework. Each level comprises of interviewees with multi-faceted and overlapping job roles.

Since agile is often considered as a culture rather than a process, it can be said that people is at the heart of the agile process. Hence it is proved from this case study that most of the challenges arise from the people dimension (see figure 16). The main origin of these challenges is due to changes in organization structure and culture. Change can be a complex process since the values of agile are completely different from the traditional project management methods. The result is that, the transition and adoption of agile affects all aspects of the organization which is confirmed through this study.

Management of people issues is an art more than a science, that the source of the problem can be the organization, the project, the team, or the individual and there is no technique that can solve all problems (Conboy et al., 2010). Most of the issues raised in this study confirm with the literature findings but some of the challenges are specific to the firm and cannot be generalized.
<table>
<thead>
<tr>
<th>Level of analysis</th>
<th>Identified challenges</th>
<th>Dimension of challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization/Management</td>
<td>1. Shift in decision-making</td>
<td>Organization/Management</td>
</tr>
<tr>
<td>Management level</td>
<td>2. Wrong mindset about agile</td>
<td>People dimension</td>
</tr>
<tr>
<td>Project managers</td>
<td>3. Knowledge management through documentation</td>
<td>Process dimension</td>
</tr>
<tr>
<td>Team level</td>
<td>1. Taking multiple roles- firm specific</td>
<td>Technology/Tools</td>
</tr>
<tr>
<td>Scrum master</td>
<td>2. Rotating scrum master role- firm specific</td>
<td></td>
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<tr>
<td>Product owner</td>
<td>3. Sprint management</td>
<td></td>
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<tr>
<td>Group manager</td>
<td>4. Risk management</td>
<td></td>
</tr>
<tr>
<td>Individual level</td>
<td>5. Having long term vision for the product</td>
<td></td>
</tr>
<tr>
<td>Software developer</td>
<td>6. Organizing and prioritizing user stories for multiple projects- firm specific</td>
<td></td>
</tr>
<tr>
<td>Firmware developer</td>
<td>7. Managing different stakeholders</td>
<td></td>
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<td></td>
<td>8. Lack of good interface with project managers (consequence of cultural shift)</td>
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<td></td>
<td>9. Choosing appropriate method</td>
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<td></td>
<td>10. Working with multiple product owners- firm specific</td>
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<td></td>
<td>11. Cross-dependencies</td>
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<td></td>
<td>12. Lack of skills</td>
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<td></td>
<td>13. Group dynamics</td>
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<td></td>
<td>14. Lack of communication between teams</td>
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<td></td>
<td>15. Lack of customer involvement</td>
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<td></td>
<td>16. Partial product owner role- firm specific</td>
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<td></td>
<td>17. Not realistic</td>
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<tr>
<td></td>
<td>1. Lack of Customer collaboration</td>
<td></td>
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<tr>
<td></td>
<td>2. Changing scope characteristic- firm specific</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Lack of training</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Lack of knowledge about agile</td>
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<td></td>
<td>5. Lack of motivation to work agile</td>
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<td>6. Lack of communication between teams</td>
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<td></td>
<td>7. Concurrent design</td>
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<td></td>
<td>8. Too much transparency- firm specific</td>
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<td></td>
<td>9. Lack of business knowledge</td>
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<td></td>
<td>10. Distributed teams</td>
<td></td>
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<tr>
<td></td>
<td>11. Lack of skills</td>
<td></td>
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<td></td>
<td>12. Getting feedback from the real end users</td>
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<tr>
<td></td>
<td>13. Unconventional customer</td>
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</tbody>
</table>

Figure 16 Relating all the results from the analysis
7. DISCUSSION

The framework explains the 3 different levels from which challenges arise. Some of the challenges like lack of collaboration and communication with customers, lack of skills exists at team level and individual level and there is no difference in opinion when looking at these challenges from different levels. Because these challenges persist while working as a team and as individual. But within the same individual level there was difference in opinion, because of the type of product that is developed i.e. software and firmware. For e.g. The software team did not have much problem with the scope changes, since they work on incremental changes within the same software, whereas, the firmware development team had difficulties with frequent scope changes, since they had to work with multiple projects within the same sprint. From figure 16, one can also say that the project managers at top management level face most of the challenges from organization/management dimension. The scrum masters, product owners, group managers at team level and developers at individual level face most of the challenges that arise from the people and process dimension.

From analyzing the case company results with the literature it is found that challenges occur despite the fact that agile is only suitable for smaller teams and smaller projects. This idea of small teams being optimal for agile practices was supported by earlier research (Barry Boehm & Turner, 2005; Cockburn & Highsmith, 2001). Scholars suggest two reasons for this. First, small and startup companies have more dynamic culture which is naturally better suited to flexible and agile practices (Asnawi et al., 2011). Secondly, small companies usually do not have any legacies to follow; they have not established formal and rigorous processes yet (Asnawi et al., 2011; Cockburn & Highsmith, 2001). The recommendation of limiting the size of an agile organization is often linked with the importance of direct communication. Efficient communication is important when a software development project utilizes agile practices, especially because of the goal of having less documentation compared to traditional methods. Hence it is obvious that the company culture and the lack of formal implementation process has made the company to adopt agile as well adapt the practices to their needs. But more research is needed to understand how far the agile can be adapted to ensure more flexibility. Agile allows flexibility and adaptability, but to what extent? Is not known. This can be an implication for future research.

One thing observed from the case company is that, the agile transition was quite fast, but the adoption is still a slow process. The reason is that it is a product-oriented firm that develops embedded systems (software, firmware and hardware) and differs from the pure software industry. Scrum is more suitable for software development, but now the trend is changing, agile is being adopted by different types of firms like product-based firms, construction industries, medical industries etc. since HMS is a product-based firm, it has some unique challenges which distinguishes it from the pure software endeavors. But on the other hand, the company faces many of the same challenges that agile software development practices address.

Customer relations may differ in firmware project dramatically from mainstream software project. The position of customer may be filled by end users, product manager or hardware development team in some cases. It is obvious that the relationship between software developers and these different types of customers vary a lot (Punkka, 2005). In the case of software development, it is
easy to identify their end consumers, whereas, in a product-based company it becomes to difficult
to address who their end users are. HMS manufactures connecting devices for IoT purpose and
they sell their products to manufacturing companies and system integrators. There are distributors
in between who sell the product to the customers. Thus, HMS comes very last in the value chain,
in the case of customer value.

From the analysis of case company, it is found that challenges are specific to the type of projects
that is developed. For firmware development projects challenges in terms of lack of domain
specific knowledge, unconventional customers, concurrent design occur. These challenges can be
transferred to other product development firms practicing scrum, but it’s difficult to generalize
since it is a single case study. The existing literature discusses challenges related to software
development, but less research has been done on how the agile methods can be adapted to other
forms of product development like firmware and hardware. Moreover the adoption of agile
practices has been a topic of research in the recent times and the studies have analyzed which
practices can be adopted to embedded software development (Greene, n.d.). This study has
identified scrum practice better suits firmware development. It also encounters challenges as
discussed above. Hence these findings will contribute to the existing gap in the literature regarding
agile adoption in product-based firm.

Some challenges that are specific to the case company were also found. This is because of the fact
that the case company has adapted scrum in a multi-project environment, where a single team
works on multiple projects within the same sprint. But according to the literature, scrum is suitable
only for single project environment, but the case company does not comply with the rules of scrum
and has adapted it according to the working environment. To my knowledge the adoption of scrum
process in a multi-project context is poorly addressed. The challenges that arise under these
circumstances are: prioritizing user stories with multiple product owners, managing knowledge for
all the products within the same team, changing scope characteristics, rotating scrum master role
(for job rotation). These challenges are specific to the case company.

The challenges related to general software development has been widely discussed in the literature.
The case company also employs scrum for software development process which results in
challenges that are mostly parallel with the literature findings. The resulting challenges under this
context are: shift in decision-making, wrong-mindset about agile, knowledge management through
documentation, sprint and risk management, lacking long-term vision, managing multiple
stakeholders, group dynamics, method selection, lack of good interface with project managers, lack
of (knowledge, training, motivation, communication, customer collaboration, business
knowledge), distributed teams, fear due to transparency, cross-dependencies. There challenges can
be generalized to software-based firms since they are the common challenges seen during the
adoption of scrum process in a single project environment.

Personnel education is identified as one of the key tasks for ensuring the successful adoption of
agile methods (Cockburn & Highsmith, 2001). Conboy et al., (2011) argue that formal training is
not enough; people should understand and learn agile values and principles in addition to practices
to be motivated and committed. These human-related factors reflect the fact that individuals and
organizations need to change their ways of working when they start to adopt agile practices. Moe
et al., (2012) argue that this change requires a reorientation by project personnel and management, and they add that this change takes time and resources. The findings from this study supports the claim that people-related issues comprised the largest single category of challenges. Most of the people related challenges can be managed by providing proper scrum training and by understanding and learning values and principles of Agile, not just the practices (Managerial implication).

Moreover, the case company has a modified version of scrum, with multifaceted and overlapping roles that is not described in the literature scrum. The modification of existing roles or adding new roles possibly increases the confusion between the old project management model and the agile one. In the case company, additional roles like product manager, group manager and project manager exist. Clear roles have to identified for successful agile implementation. The project manager should take the role of coach and protector (Barry Boehm & Turner, 2005). But the situation within the case company differs, the project managers role is taken by the scrum master who acts as a servant leader rather than a command-and-control focused project manager. There are similarities between the two roles (eg. Impediment removal). But the project manager in the case company takes responsibility of handling scope, budget, timeline required for the project. So obviously, a project manager will be a part of each scrum sprint. At the same time, he will be handling the other aspects of a project outside the scrum team. The product owner role is split and distributed to product manager. The product manager takes care of the product marketing and product management aspects, owns the vision, is outward-facing, and keeps in touch with the market. The “product owner” is inward-facing, drives the sprints, and works with the team. This causes barriers and blurs the responsibility. Clear mapping of roles has to be identified between traditional and agile method for successful adoption and organizational changes have to be done to develop the ability to take on rich set of responsibilities rather than splitting roles.

8. CONCLUSION

This research aims to understand how scrum is practiced in real time in a product-based firm and what challenges are faced by practitioners during the transition and adoption of agile methodologies. The introduction of agile methodologies in organizations brings benefits but also creates challenges during their transition from traditional project management methods to agile methods and also during the adoption of agile methodologies. So far, the literature has discussed about the adoption of agile in software-based firms. In order to understand how the scrum implementation looks like in a different firm other than software industry, the author did a case study on a product-based company (HMS) and has identified the practitioner challenges at three different levels within the organization through interviews and observations. The purpose of this study led to the research question:

“How scrum implementation looks like in a product-based firm and what challenges are observed during the transition and adoption of scrum”

The scrum implementation is tailored according to work environment within the case company. The main challenge in adopting Scrum is how to use Scrum. So far there is only a definition of the process and the practices around it but there is no description about how it should be applied concretely in the companies or any recognized process or standards reference for best practices.
Scrum is a people-centered methodology and the success of it is very much depending on both the people using it and the people surrounding the Scrum team. The case company is studied from a multi-project environment and with multi-faceted roles which leads to challenges like: prioritizing user stories with multiple product owners, managing knowledge for all the products within the same team, changing scope characteristics, rotating scrum master role which are specific to the firm.

The challenges identified within firmware development (Anybus unit) are: lack of domain specific knowledge, unconventional customers, concurrent design. While the Ewon business unit which develops software experienced the following challenges: shift in decision-making, wrong-mindset about agile, knowledge management through documentation, sprint and risk management, lacking long-term vision, managing multiple stakeholders, group dynamics, method selection, lack of good interface with project managers, lack of (knowledge, training, motivation, communication, customer collaboration, business knowledge), distributed teams, fear due to transparency, cross-dependencies.

From this study, it is found that agile adoption in a product-oriented firm is a slow process, but surely has benefits from adopting agile methods. This leads to a conclusion that agile has a growing trend to be adopted to other firms, moving beyond the software industry.

8.1 Limitations
The scope of this research is limited to only small and medium scaled industries that practice agile methodologies for their product development process. This study, however, couldn’t identify to what extent these challenges might have an impact on agile transition and adoption. The observation period was less, and the author participated only in two of the scrum related meetings. As only one person observed the teams in action, there is always a chance that some challenges or factors may have gone unnoticed. This was mitigated by the discipline of keeping the research diary throughout the observation period. The results obtained cannot be directly generalized to other product-based firms, since it is a single case study which is qualitative in nature. However, as the data presented by this study covers only a single adoption case only, there is room for more research in the area to derive more general adoption challenges.

8.2 Implication for future research
The technology/tools dimension is least explored since there has not been many tools for measuring the progress of agile. This dimension can be explored further to understand the challenges related to inflexible tools and technology related issues. Nowadays, practitioners are less concerned about adopting agile and more concerned about sustaining agile. The sustainability of agile has not been widely researched. Research in these areas needs to have a specific and relevant focus. Moreover, this study has identified challenges related to 4 dimensions, but it not known what impact these challenges create on each level. A quantitative study can be conducted to analyze the impact of each of these challenges on respective levels. A longitudinal study can also be performed on the case company to better understand the dynamics of the adoption process of Scrum in a wider context. Since the company does not completely comply with the rules of scrum, more research is needed to find out why scrum is not practiced exactly in real-time and what prevents the complete adoption of scrum. Further work on the same project as described in the
thesis could lead to a deeper and more exhaustive investigation of the phenomena in the case. The hardware development using agile is not explored in this study and hence could be a source of further investigation to analyze the challenges of adopting agile in hardware development which again could strengthen results. There are lots of issues with flexibility and adaptability of scrum. Further research is also possible in this area to understand the pros and cons of tailoring agile according to needs.
APPENDIX

Agile burn down chart (HMS, 2018)

Product backlog with prioritized user stories (HMS, 2018)
Release projectory chart (HMS, 2018)

Scrum board (HMS, 2018)
Agile principles
That is, while there is value in the items on the right, we value the items on the left more.”

The 12 basic principles of agile software development manifesto are as follows (Agile manifesto, 2001):

1. “Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
4. Business people and developers must work together daily throughout the project.
5. Build projects around motivated individuals. Give them the environment and support they need and trust them to get the job done.
6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
7. Working software is the primary measure of progress.
8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
9. Continuous attention to technical excellence and good design enhances agility.
10. Simplicity—the art of maximizing the amount of work not done—is essential.
11. The best architectures, requirements, and designs emerge from self-organizing teams.
12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.”

Extreme programming
This method was developed by Kent Beck in the year 1999. Extreme programming (XP) is a software-centric agile method aimed to improve software quality and responsiveness to changing user requirements. This process has frequent ‘releases’ in short development cycles to improve productivity by introducing checkpoints for adopting user requirements.

Other elements of XP include: programming in pairs or doing extensive code reviews, unit testing of all codes, avoiding programming of features until they are actually needed, a flat management structure, simplicity and clarity in codes, expecting changes in the customer’s requirements as time passes and the problem is better understood, and frequent communication with the customer and among programmers. The original XP recipe is based on four simple values, simplicity, communication, feedback and courage, and twelve supporting practices taken from Beck’s book as following (Beck, 1999):

1. Planning Game:
Planning the next releases features is performed by having developers estimate the effort needed for the customer stories implementation. Then the customers decide about the scope and release time. This emphasizes the close interaction between customers and developers.
2. Small Releases:
Release the software often to the customer with small incremental versions. New version of products is released at least monthly or can be even daily.

3. On-site customer:
Include a real customer that can work with the development team and is available full-time to help defines the system and answers questions.

4. Simple Design:
Design the simplest solution that is workable at that time and constantly evolves to add needed flexibility. Useless complexity and unessential code should be removed

5. Pair Programming:
Two programmers write all production code together at a single computer. One writes the code and, at the same time, another reviews the code for correctness and understandability.

6. 40-hour week:
Work no more than 40 hours a week as a rule. Never work overtime for two consecutive weeks.

7. Refactoring:
Restructure the system without changing its behavior by removing duplication complexity from code, improving communication, simplifying, and adding flexibility.

8. Continuous Integration:
Build and integrate the system several times a day whenever the task is completed.

9. Collective Code Ownership:
Every developer owns the code. Therefore, they can change any part code in the system at any time

10. Coding Standards:
Developers write all codes in accordance with rules.

11. Metaphor:
The metaphor is a simple story shared between customers and developers of how the system works.

12. Testing:
Test driven development is the key which means the developers write unit tests before the production code. The unit tests must run perfectly for development to continue and be kept running at all times. Customers write the functional tests to test the stories.

Ideally, XP project starts with a short development phase, followed by a long period of simultaneous improvement and maintenance, and lastly retirement when the project no longer makes sense (Beck, 1999).
Interview guide

(Note that some questions were altered according to the position of the interviewee and some follow-up questions were asked to get detailed information)

1. please introduce yourself
2. Do you have prior experience of working in traditional project management method?
3. Do you have prior experience of working in agile methods?
4. What is the major difference between these two methods?
5. Which agile methodologies are you using currently and why?
6. How did the transition happen and how long did it take?
7. Who played a major role in the transition process?
8. What kinds of challenges did you face during the transition and adoption process?
9. How do you go about choosing appropriate method?
10. How the development process has changed after the adoption of agile?
11. How the employees reacted to adopting agile?
12. How decision-making is done in agile?
13. Does the team take enough ownership? How tasks are assigned?
14. How does the management support the self-organizing team?
15. How do you see yourself in a scrum process?
16. How often do you communicate with self-organizing team?
17. How did you deal with the cultural shift?
18. What is your opinion about working in agile?
19. What are the most important success and failure factor for the adoption of agile?
20. Who are your customers and how often do you interact with them?
21. How the feedback of the customers is provided to the team?
22. Are the customers invited to take part in scrum related meetings?
23. Which agile practices do you consider important? And why?
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