CHALMERS
UNIVERSITY OF TECHNOLOGY

Task-switching in Agile Transformation

A case study on Volvo Cars Agile hardware development teams

Master's thesis in Management and Economics of Innovation

SATHYA NARAYANAN RAMDOSS RAJA
SOFIA WAHLSTRÖM

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISON OF INNOVATION AND R&D MANAGEMENT

CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2020

www.chalmers.se
Report No. E2020:044

REPORT NO. E 2020:044

Task-switching in Agile Transformation

A case study on Volvo Cars Agile hardware development teams

SATHYA NARAYANAN RAMDOSS RAJA
SOFIA WAHLSTRÖM

Department of Technology Management and Economics
Division of Innovation and R&D Management
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2020

Task-switching in Agile Transformation
A case study on Volvo Cars Agile hardware development teams
SATHYA NARAYANAN RAMDOSS RAJA
SOFIA WAHLSTRÖM

Report no. E2020:044
Department of Technology Management and Economics
Chalmers University of Technology
SE-412 96 Göteborg
Sweden
Telephone + 46 (0)31-772 1000

Gothenburg, Sweden 2020

Task-switching in Agile Transformation
A case study on Volvo Cars Agile hardware development teams

SATHYA NARAYANAN RAMDOSS RAJA
SOFIA WAHLSTRÖM

Department of Technology Management and Economics
Chalmers University of Technology

Abstract

With the automotive industry constantly changing and being subjected to more competition than ever, the automobile manufacturers are now changing their ways of working to stay competitive. One way of doing that is to go from the traditional way of working to work more agile. When working agile, the structure of the development teams has changed from being specialized to cross-functional. The introduction of the agile way of working in the automotive industry has its challenges and frequent task-switching is one of them. While the teams work in an increased number of projects in the agile way of working, they switch tasks frequently to cater to the new structure. While most of the task-switching is necessary for the agile way of working, there is unwanted task-switching that affects the development team members.

This master's thesis has been conducted at Volvo Cars, which recently completed its agile transformation, to identify factors that influence task-switching for the agile hardware development teams. In addition to this, the effects of these identified factors were investigated. The empirical strategy was focused on a case study, consisting of an exploratory survey and semi-structured interviews. The answers from the exploratory survey were used as basis for the interviews. The interviews were conducted with the development team members and the managerial side to capture both aspects of the research topic.

Through systematic matching between the case study and literature on task-switching, the factors which influenced task-switching in agile hardware development teams were identified to be 'interruptions', 'interdependencies', 'planning', and 'collaboration'. The factors have a beneficial or detrimental effect on the hardware development teams which influenced the organization's ability to improve the agile way of working. The result showed that the types of factors did not change due to the agile transformation, but that the overall frequency seems to have increased. The study also shows that the factors have several effects on the development teams. Amongst others, it is shown to influence the amount of re-planning and quality, and increase the developer's understanding of each other's work making it easier to support each other.

Keywords: task-switching, agile transformation, automotive industry, agile hardware development, planning, interruptions, interdependencies, collaboration

Acknowledgement

First of all, we would like to thank Volvo Cars for letting us conduct our master's thesis at the company. We extend our thanks to our supervisors Magnus Lindh and Jens Schönenberg at Volvo Cars for their support and guidance provided throughout the study. We are grateful for having Maria Johansson for providing support with the administration part for conducting a master's thesis at Volvo Cars. We would also like to thank all the employees for taking their time and participating in the interviews and survey, without whom the study would not have been successful.

An extensive thanks and appreciation to our supervisor Ludvig Lindlöf at Chalmers for his continuous support, guidance and feedback. This thesis has been a great learning process and would not been possible without the constructive criticism and constant encouragement from our supervisors at Volvo Cars and Chalmers University. Also, we would like to thank Lars Trygg for being our examiner for our master's thesis.

Sathya Narayanan Ramdoss Raja & Sofia Wahlström

Gothenburg, May 2020

Table of Contents

Table of Figures

Table of Tables

1. Introduction

Traditionally, development teams have been characterized by individual work, specialized skills, managerial decision making, low customer involvement, and larger team size. In contrast, agile teams are described by collaboration, multi-disciplinary skills, pluralist decision making, high customer involvement, and small team size (Lindsjørn et. al, 2016). With the structure of the teams changing, a challenge identified by Katumba and Knauss (2014) is that with the introduction of the agile way of working, the development team members are participating in many projects and often need to switch from one task to another, also called task-switching, related to the projects. The agile way of working facilitates communication and collaboration within and among teams through synchronous communication i.e. face-to-face communication, phone calls, etc. With the team members working on many projects and an increase of synchronous communication, they must switch tasks frequently to cater to the responsibilities of the projects they are working on. At the same time, Wiesche (2018) has identified an increase in unwanted interruptions for development team members in the agile environment. These unwanted interruptions also lead the team members to switch tasks which results in a lack of time for continuous learning, loss of focus and ultimately affects the quality of work. Organizations need to reduce the negative effects of task-switching to work according to the agile principles in an efficient way.

The automotive industry is in an era of disruptive change (Hohl et. al, 2017). There is a need for automotive companies to not only improve their products but also their ways of working to develop the products (Bergqvist & Gordani, 2018). To stay competitive, automotive companies need to transform their organization to become more flexible, innovative, and efficient (Bergqvist & Gordani, 2018). The agile way of working is identified to be one of the possible ways for automotive companies to transform accordingly (Bergqvist & Gordani, 2018). The agile approach facilitates project development with continuous change while addressing the relevant risks (Böhmer et. al, 2017).

Volvo Cars has undergone a transformation from the traditional way of working with the development of vehicles to a more agile approach. The company uses its adaptation of the Scaled Agile Framework (SAFe) called Volvo Cars Agile Framework (VCAF). An agile survey conducted in 2019 by the organization management within the Excellent Exterior at Volvo Cars revealed that frequent task-switching is an occurring problem experienced by the development team members. The organization needs to deal with this for working in an efficient way according to agile principles. This was mostly expressed by the Exterior Front Agile Release Train (ART) which is also perceived to have come far in the transformation process of adapting the new way of working. It was from this context the area of this study was identified. Even though the problem of frequent task-switching was most expressed by the Exterior Front, investigating all the other ARTs within the Excellent Exterior would provide a deeper understanding of the problem and its relevant factors as each ART has undergone the transformation at different points in time and are at different stages of the continuous improvement phase.

1.1 Purpose

After the agile transformation at Volvo Cars, it was, as mentioned above, identified that task-switching is an issue within hardware development. As the structure of the development teams changed due to the agile transformation, the purpose of the study is to identify the factors that influence task-switching and the effects caused by the identified factors on hardware development team members. By identifying the factors influencing task-switching, the study aims to provide recommendations to decrease the unwanted task-switching caused by the factors resulting in a better agile way of working.

1.2 Research Questions

The following research questions form the basis of the investigation and are formulated to fulfill the purpose described above in 1.1.

RQ1: What factors influence task-switching for hardware development team members?

Factors will be identified to describe why task-switching occurs.

RQ2: How do the identified factors from RQ1 change due to an agile transformation?

Teams undergo changes in the large-scale agile transformation when it comes to the structure and how they work. Answering this question will facilitate in understanding how the factors that cause task-switching have changed due to the agile transformation and therefore also understand how the rate of task-switching has been affected.

RQ3: What are the effects caused by the identified factors on development team members?

The third research question aimed to investigate what effects task-switching influenced by the identified factors has on the performance of development team members.

2. Theoretical framework

This chapter presents the findings from the literature review. The theory is based on task-switching in agile teams. The theoretical framework consists of two sections. The first section briefly explains the Agile methodology, SAFe and Scrum, to understand the basics and the latter section presents the theories on task-switching in agile teams.

2.1 The Agile Approach

The Agile approach emerged in the software market but has expanded into the physical products as software and hardware are becoming more interrelated and the approach enables the companies to be more flexible and responsive to the customers' changing needs (Bergqvist & Gordani, 2018). In an agile approach, the demands and solutions are met by the collaborative effort of the self-organizing and cross-functional teams and their customers. The core characteristics of agile are the communication process which is described as "*frequent, good quality, feedback to facilitate the ability to change direction, as business needs change*" by Berczuk (2007). This iterative process brings the customers and developers closer to the market and thus can respond faster to changes (Berczuk, 2007). Agile teams collaborate more and has a higher frequency of feedback which reduces the documentation. This can lead to increased devotion of time and resources for the project while reducing the actual development time (Bergqvist & Gordani, 2018). The approach changes the need to rely on individuals, for knowledge to a team-based competence. The agile way of working is based on 'The Agile Manifesto' (see *figure 2.1*) which is a guide to the approach. The items to the left are to be valued higher than the items to the right. However, it does not mean that the items to the right have no significance (Highsmith, 2001).

Individuals and interactions over processes and tools
Working Software over comprehensive documentation
Customer collaboration over contract negotiation
Responding to change over following plan

Figure 2.1: The Agile Manifesto (Highsmith, 2001)

The agile management approach embraces complexity and non-linear thinking. Management in Agile settings fosters a facilitative and coordinating environment based on a 'leadership-collaboration' practice. The servant-leader approach changes the traditional management approach creating adaptive leaders and a servant leader is motivated by serving and empowering followers. Servant leaders teach, facilitate, mentor, and coach the team. They also provide transparency so that the team can make correct and efficient decisions (Bergqvist & Gordani, 2018).

2.1.1 SAFe

The Scaled Agile Framework (SAFe), was created by Dean Leffingwell and the first version was published in 2011 (Scaled Agile Framework, n.d.a). SAFe guides how teams, activities, roles, and artifacts should be designed in a large organization to fit the lean and agile principles.

There are four different configurations of SAFe; essential SAFe, large solution SAFe, portfolio SAFe, and full SAFe (Scaled Agile Framework, n.d.b). The differences between the configurations are based on which levels are included in team level, program level, large solution level, and portfolio level (see figure 2.2). The most suitable configuration of SAFe for an organization depends on the size of the organization. Essential SAFe configuration can be applied to smaller organizations (~50 employees); Full SAFe configuration can be applied to large organizations (several thousand employees) (Ljung & Udesen, 2019). The framework has a portfolio level at the top which is managing different solution trains and the solution train contains several Agile Release Trains (ARTs) and an ART contains several teams (Scaled Agile Framework, n.d.b). The responsibilities of what gets built, how it gets built, and the execution and operation of servant leadership are distributed among the team, program, and solution level. The framework also contains support functions and Community of Practice to discuss issues and share best practices (Ljung & Udesen, 2019).

Organizational hierarchies are time-tested proven practices that often slow the flow of value delivery (Agile Teams, 2019). The value streams in SAFe organize the

employees to innovate and increase their speed to provide business agility and by working in value streams agile teams overcome the shortcomings of organizational hierarchies (Agile Teams, 2019). Agile teams consist of members from across the organization who are dedicated to their teams full-time, thus eliminating the delays in pushing the value through the hierarchies. With each agile team consisting of the necessary skills to deliver increments of value, they can define, build, test, and deliver, proving the cross-functionality of agile teams (Agile Teams, 2019).

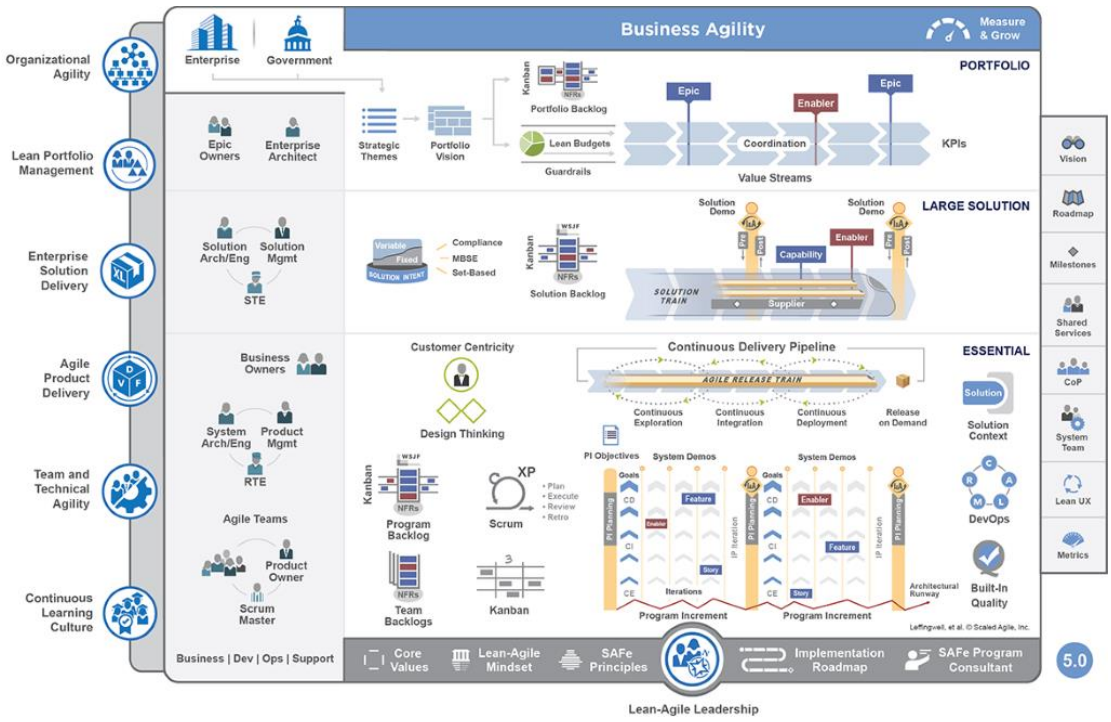

Figure 2.2: Full SAFe Framework (Scaled Agile Framework, n.d.b)

2.1.2 Scrum

Scrum is the most used method of addressing Agile methodologies (Ljung & Udesen, 2019). Schwaber and Sutherland (2017) define Scrum as a "*framework within which people can address complex adaptive problems, while productively and creatively delivering products of the highest possible value*". The concept of Scrum is based on three main pillars: transparency, inspection, and adaptation (Schwaber & Sutherland, 2017).

Scrum is performed by self-organizing and cross-functional 'Scrum Teams' which consists of three roles: one Product Owner (PO), one Scrum Master (ScM), and the development team (Schwaber & Sutherland, 2017). The PO is responsible for product-related functions such as "*maximizing the value of the product*" and "*managing the Product Backlog*" (Schwaber & Sutherland, 2017). The ScM manages the process related functions and the main task of an ScM is to make sure that everyone in the team understands the process of Scrum and follows its rules and processes (Schwaber & Sutherland, 2017). The development team consists of developers who create the product to deliver value. Apart from the roles, Scrum also contains events and artifacts which create regularity and seek to minimize the need for meetings (Ljung & Udesen, 2019). 'Sprint' is the heart of Scrum which usually lasts for 2-6 weeks that contain all the other events (Schwaber & Sutherland, 2017). The work to be done in a sprint is planned at the 'Sprint Planning'. The Development team performs a daily standup meeting called 'Daily Scrum' which is usually 10-15 min to plan for the day. At the end of the sprint is a 'Sprint Review' which is used to inspect and adapt the product backlog (Schwaber & Sutherland, 2017). A 'Sprint Retrospective' is performed by the development teams to conduct a self-analysis for improvement. The 'Product Backlog' is a prioritized list of the things that need to be done for the product and an 'Increment' is the result of the current sprint and the sprints before (Ljung & Udesen, 2019).

2.2 Task-switching

The term 'task' is to be understood as work or activity and a project can be described as a collection of tasks (Innolution, n.d). The activity of task-switching is switching from one task to another task. This can indicate switching between any task related to a project. For example, switching from answering a phone call to designing a component can be described as task-switching. In a paper by Leroy (2009), the situation of switching between multiple activities during a workday is investigated regarding how it affects the workers' performance. The result of the study indicated that the performance is suffering when people task-switch from a task that is not finished or finished but under low time pressure since the previous task is still attracting attention. To be able to execute the new task with high performance, the previous task needs to be finished under time pressure to shift focus completely which means that it is not

enough to only have finished the previous task to be able to fully focus on the next (Leroy, 2009). The study by Murugesan (2016) revealed that when team members switch between tasks, it takes a lot of time which in the end affects the performance of the team members. A related challenge identified by Katumba & Knauss (2014) is that when people are participating in multiple projects at the same time, they often need to switch between tasks, and the tasks might be in a completely different context. This can result in a lack of continuous learning for the development team members.

2.2.1 Interruptions

With the introduction of the agile way of working, teams become cross-functional and work on an increased number of projects when compared to the previous way of working (Agile Teams, 2019; Stettina & Smit, 2016). Šāblis and Šmite (2016) explain that when the number of projects for a team increases, the team has to deal with a large number of tasks and task-switching. This results in increased daily communication which increases the frequency of interruption (Šāblis & Šmite, 2016). Šāblis and Šmite (2016) also explain that the teams with a lesser number of projects would need to interact less with others and therefore are subjected to less interruption during work. Working on a greater number of projects increases the contacts the teams must deal with and the network size (Šāblis & Šmite, 2016). This affects the frequency of receiving information and is supported by Murugesan (2016) who says that when team members are working on multiple projects, they are subjected to prolonged task-switching and interruptions. In a study by Makoto Su and Mark (2008) on information workers, they also relate the number of projects to the size of the individual's network and people they need to communicate with. They also relate this to the number of communication actions that the individuals coherently do, and to multitasking which is described as *"[...] a combination of switching among different tasks and also switching between solitary work and communication with others"* (Makoto Su & Mark, 2008) which in this study is referred to as task-switching.

As described above, when team members are working on multiple projects, they are subjected to a greater number of interruptions and with the dynamically changing industry, the team members keep receiving tasks with different priorities (Šāblis &

Šmite, 2016; Stettina & Smit, 2016). Team members need to recognize the priorities of the tasks that arise (Stettina & Smit, 2016). As agile promotes more synchronous communication, the team members receive these unplanned tasks in the form of direct requests via face to face communication or through a phone call or email (Laanti, 2016; Stettina & Smit, 2016). When the priorities of the tasks are unclear, the team members face a difficult situation in handling them. Stettina & Smit (2016) identifies that limiting these interruptions through a PO would result in an efficient way of working.

Another aspect of interruptions is if the context in which they take place affects the effects on workers. In a study by Mark, Gonzalez, and Harris (2005) studying 24 information workers it was shown that depending on if the interruption was within the same working sphere the interruption was, in general, beneficial but when outside the scope it was detrimental. Another study by Mark, Gudith, and Klocke (2008) found that the context of interruptions doesn't make a difference regarding change of work pattern but instead that any interruption changed it. Another finding from the same study was that after the interruption, the interrupted work was done faster. In contrast to the result of the study by Mark, Gudith, and Klocke (2008), a study executed by Gillie and Broadbent (1989) indicated that the nature of interruption and the interruption's complexity are factors that determine if an interruption leads to disruption of the performance when returning to the interrupted task. Furthermore, their results also indicated that the length and if the person can decide when the interruption occurs are not determining factors.

2.2.2 Interdependencies

Interdependencies can be described as the dependency between teams to perform their individual work tasks (Van de Ven et. al, 1976). A dependency according to Scheerer et. al. (2015) can be described as "*a situation wherein an activity cannot proceed until another activity is complete*". In this study the term dependency and interdependency are used interchangeably and refer to a unilateral relationship, i.e. Team A is dependent on Team B but not the other way around and bilateral relationship, i.e. Team A and Team B are dependent on each other. As the interdependency can be

conceived as two distinct dependencies, the two terms can be treated as equivalent in the organizational studies (Strode & Huff, 2012).

Scheerer et. al. (2015) cite that *"Prioritization means to assign a relative value/importance to one particular activity"*. Prioritization is carried out by the PO and is responsible for ordering the backlog according to priority (Scheerer et. al, 2015). In large scale agile development, the degree of freedom in prioritizing the backlogs is restricted by the involvement of various interdependent teams (Scheerer et. al, 2015). When it comes to large scale agile teams, creating user stories that can be developed in a single sprint is a challenge identified by Sekitoleko et. al (2014) as the interdependencies in agile development increase and the increase in interdependencies comes with its challenges. There is a considerable amount of unpredictability where the teams find it difficult to anticipate the changes beforehand (Sekitoleko et. al, 2014). Followed by which is a conflict of priorities among the interdependencies as the priority of a task varies in the backlogs of the depending teams (Sekitoleko et. al, 2014).

2.2.3 Planning

Teams experience difficulty in planning the sprint as there is a constant change in priority (Sekitoleko et. al, 2014). The agile way of working requires transformational leadership which requires the empowerment of the teams and applying Scrum practices demands the involvement of the development teams in the planning and decision-making process (Moe et. al, 2009). Highsmith and Cockburn (2001) also promote the involvement of the teams in the planning process could improve the process by making it resilient when it is susceptible to dynamic prioritization. Murugesan (2016) also identified that when all the team members are involved in the planning process, it helps to understand the workflow better, and even in the absence of a team member, the team can move forward with fewer difficulties. A study conducted by Golfarelli, Rizzi, and Turricchia (2013) on a 50-story synthetic project in a Scrum setting, the development teams were able to complete only 67% of the planned stories. The study stresses the importance of allowing room for changes that may arise during the sprint and re-planning when necessary. According to Highsmith and Cockburn (2001), a strict time plan reduces the agility of the teams and the planning should allow changes

according to changing needs and priorities. While Highsmith and Cockburn (2001) and Sekitoleko et. al (2014) were considering a software development context, the same frameworks that are used in the software are being implemented within hardware development.

2.2.4 Collaboration

According to Williams (2012), the teams in an agile setting must collaborate and work together throughout the project. The most efficient, effective method of conveying information to and within a development team is through synchronous communication. Synchronous communication happens in real-time and requires a face to face conversation or a phone call. The increase in synchronous communications is supported by Laanti (2016) which says the synchronous touchpoints can provide benefits within agile hardware developments. The increase in synchronous touchpoints by Laanti (2016) indicates that the agile way of working involves more meetings and increased communication.

The responsibilities of the development team members increase with the agile way of working as they are involved in planning and work on multiple projects. The team members need to switch tasks frequently to cater to the responsibilities (Lister & DeMarco, 1987; Katumba & Knauss, 2014). This frequent task-switching leads to a loss of focus of the development team members and can ultimately affect the quality of the work (Katumba & Knauss, 2014; Lister & DeMarco, 1987). When many projects are running at the same time, the team members work on projects with varied deadlines. The team members tend to focus on the projects which are close to the deadline instead of working on projects that are in the early stages (Katumba & Knauss, 2014). The agile way of working promotes teamwork where team members collaborate more towards the successful completion of the project (Highsmith & Cockburn, 2001; Williams, 2012). When there is a lack of competence and knowledge, the team members struggle to get help from experienced people who are overloaded and are working according to their deadlines (Katumba & Knauss, 2014). With an increased workload, Stettina & Smit (2016) explain that the team members lack time to reflect on their work which is crucial for agile hardware development (Williams, 2012). Heavy workload is a

challenge also identified by Katumba & Knauss (2014) and is faced by Volvo Cars Corporation in the agile way of working.

2.2.5 Discussion of Literature about Task-Switching

The literature presented in the theoretical framework indicates that there is an increase in the amount and frequency of task-switching for development teams due to the agile transformation. The literature indicates that when working Agile, the number of projects increases for the teams as well as the collaboration among teams which leads to an increase in interaction among teams. This increase in interaction contributes to an increase in task-switching for the team members.

Even if the frequency of task-switching is expected to increase when working Agile, according to the literature, the tasks unrelated to the product backlog causing task-switching are described to be prevented and therefore decrease by having a PO as a gatekeeper. The PO is supposed to protect the team from unwanted interruptions or task-switching so that the teams can focus on the tasks in the backlog.

3. Case description

Volvo Cars produced its first car in 1927 and has since then been an innovative company with innovations such as the three-point safety belt, the lambda sond, and the side impact protection system (Volvo Car Group, n.d.). However, it is not only new product innovations that make Volvo Cars stand out. To meet the changes in the automotive industry and increase the quality, Volvo Cars went through an Agile transformation to implement more modern management methods. The result was an adaptation of the SAFe model called Volvo Cars Agile Framework (VCAF) to better fit the automotive industry. The basic Agile transformation at Volvo Cars began in early 2017 and ended in December 2019 and they are now in the phase of continuous improvement (Denning, 2020). Since they recently went through a big-scale transformation of the way of working, Volvo Cars is an interesting company to investigate how task-switching has changed due to the transformation.

3.1 Matrix management-based structure

Before the agile transformation into SAFe, Volvo Cars had a hierarchical matrix organization structure. The structure of the organization consisted of line and project structures with the project managers present on the first line level. The organization was divided into different designing units which are Vehicle Engineering, Software and Electronics, and Propulsion within the R&D division. The director of the functional department exercised line authority through a vertical chain of command. The product management has product managers who have authority through the horizontal chain of command over the staff from the functional departments. The organization was based on the format of program organization with different programs consisting of teams on different levels. The teams in the line management-based structure were led by Technical Program Leader which was supervised by the top-level management. The Technical Program Leader supervised over the program managers on different levels of the units such as the Unit Program Leader and Section Program Leader. The programs distributed the competences based on the requirements and availability. A team handled multiple projects (car 1, car 2, and so on) only when they shared some technical backgrounds and reuse resources, but additional competencies were added

when necessary. This created complexity in adding and handling variants. Hence, most of the developers worked on a limited number of projects, in many cases only one. The cycle plan which consisted of the projects (car 1, car 2, and so on) stated the market requirements and feasibilities and thus the teams were organized according to the necessary changes, variants, and new developments. The organizational structure of the matrix-based organization is represented in figure 3.1 below.

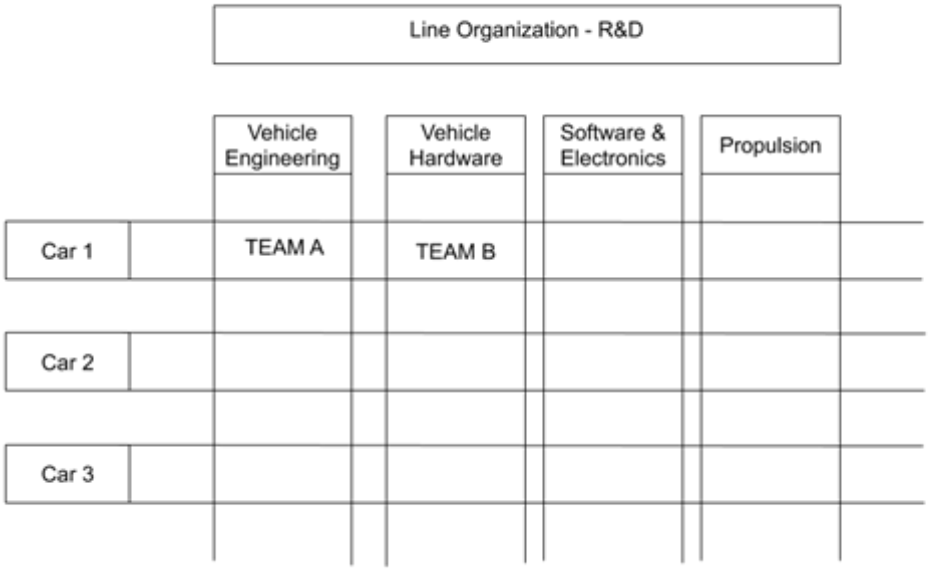

Figure 3.1: Matrix-based organizational structure

3.2 Volvo Cars Agile Framework

The transformation of the way of working resulted in the Volvo Cars Agile Framework (VCAF) which is a modified adaptation of SAFe which shows the current set-up of the organizational structure. The scaled framework uses full SAFe configuration as a basis and contains four levels: Portfolio, Solution, Agile Release Train (ART), and Team levels (Ljung & Udesen, 2019). The structure has a team at the bottom. A Scrum team consisting of a Scrum Master (ScM), a Product Owner (PO), and the Development Team which remains unchanged from the SAFe framework. On the other levels (ART, Solution, and Portfolio), Volvo Cars Corporation has introduced several specific roles to the existing SAFe structure to meet the needs of the organization. Also, the organization has introduced vehicle streams which are several merged product streams

that build a car. VCAF is being continuously updated to improve and fine-tune the organizational structure. With the help of VCAF, the organization aims to discuss and create cross-organizational learning to continuously improve and develop products for a changing society. In VCAF, the teams are responsible for all active programs from the development phase to the launch and have the responsibility of the maintenance which assures the quality over time. The teams have transformed from being specialized to being cross-functional.

3.3 Excellent Exterior

Excellent Exterior is one of the product streams within Vehicle Hardware that creates exterior solutions for the vehicles. The excellent exterior consists of five different ARTs: Accessories, Trim, Lighting, Visibility, and Front where each ART is responsible for their respective products. Each ART went from the traditional way of working to the agile way of working at different points in time with the last agile transformation occurring in 2019. This means that the ARTs are at different maturity when compared to each other regarding their agile way of working.

4. Research Methodology

In this chapter, the frameworks used to perform the study, and the research methods for data collection and analysis are presented.

4.1 Research Strategy

A case study was best chosen to be the method of investigation for this study as the research is restricted to the bounded situation of the organization in consideration. The study was performed by a qualitative research strategy as it required unstructured interviews to gain a detailed insight into the case. The qualitative research approach allowed the researchers to capture the perspectives of individuals on their situation regarding task-switching.

The study had a systematic combining approach (see figure 4.1) as data collection, empirical observation and theory generation was done in parallel.

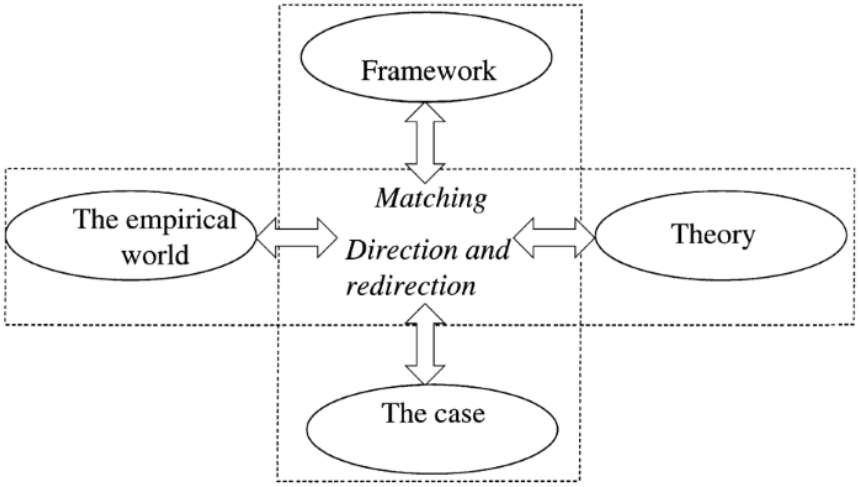

Figure 4.1: Systematic Combining (Dubois & Gadde, 2002)

The systematic combining approach has a continuous interplay between theory and empirical observation. This is represented as an abductive approach which is different from a mixture of deductive and inductive approaches. This approach is expected to be fruitful as the research objective is to discover new things — variables and relationships (Dubois & Gadde, 2002). Similar to 'grounded theory', the main

objective is to generate new concepts and development of theoretical models, rather than confirmation to the existing theory. With this approach, the study focused on determining the factors which affect the task-switching of the development team members, how the factors have changed due to the agile transformation and to realize the effects of the factors on hardware development teams.

The research process of this study is depicted in figure 4.2 below describes the different phases.

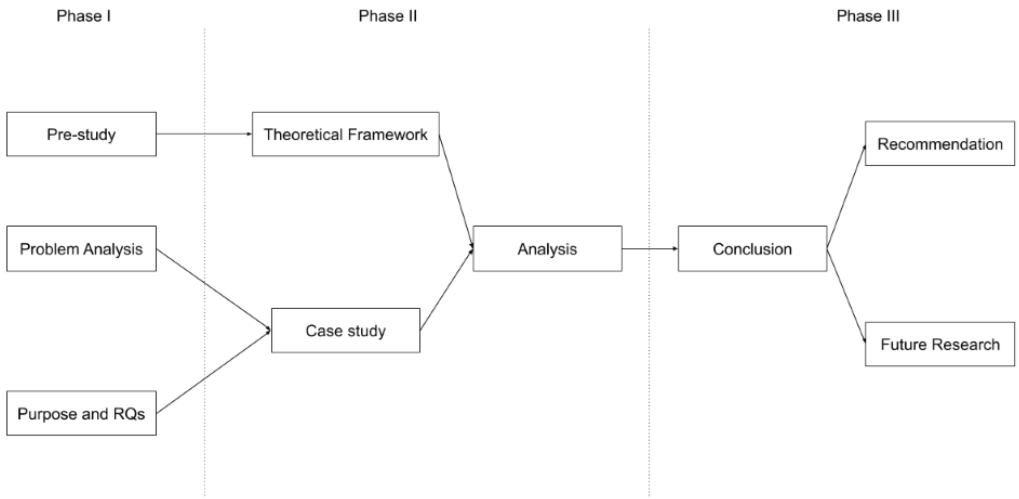

Figure 4.2: Overview of the research process

The basis of the study originated from the organization's interest in exploring the problems related to frequent task-switching and understanding the effects of it. It was perceived that teams in Vehicle Hardware have been facing challenges regarding frequent task-switching after the introduction of the Agile way of working. To better understand and identify the potential factors causing this issue, a pre-study (described in section 4.2) was conducted in the areas of traditional management style, Agile methodologies, and Scaled Agile Framework. The pre-study involved conducting interviews across Volvo Cars with people holding different roles and designation to gain different perspectives on the transformation process and how task-switching relates to the agile way of working. Additionally, the researchers attended a course on

introduction to VCAF to gain a deeper understanding of the organizational structure. After the pre-study, the insights led to the selection of data collection methods. Dubois & Gadde (2002) discuss that the findings in a case study are more convincing and accurate when it is based on multiple sources of information followed by a corroborative mode. As the study investigated the issue of task-switching experienced by development team members in the Excellent Exterior, a qualitative data on a large scale to cover the perspectives of the development team members was required and therefore an exploratory survey was selected as an appropriate choice to identify the factors which would be further investigated in detail through semi-structured interviews. In systematic combining, multiple sources can contribute to revealing aspects unknown to the researchers which are discovering new dimensions to the research problem (Dubois & Gadde, 2002). Hence to discover new aspects of the research problem, interviews also seemed as an appropriate data collection method as this would provide chances of exploring new dimensions, providing an in-depth opinion, and confirming the accuracy of the survey. The data collection methods were designed to be complementary to each other.

The method of triangulation is described by combining sources of evidence while shifting between analysis and interpretation. This offers the advantage of developing converging lines of inquiry (Dubois & Gadde, 2002). The data from the survey, combined with the interviews were triangulated to narrow the inquiry as the interviews were conducted.

4.2 Pre-study

Before the study, a pre-study was conducted which consisted of three elements: interviews, courses on organization structure, and literature study. The three elements of the pre-study were executed in parallel to one another.

4.2.1 Interviews

Eight unstructured interviews were executed to obtain a first, basic understanding and to explore what would be possible to investigate further in the study. For example, an interview was held with PIF8 to get a better understanding of what kind of data related

to the topic of the study that potentially could be used. The roles of the informants are described below in *table 4.1*.

Table 4.1: Presents the roles and ARTs of the informants participating in the interviews for the pre-study

Interview	Informants
1	Pre-study informant 1 (PIF1) - Acting Manager, Ageing Polymers
2	Pre-study informant 2 (PIF2) - Change Manager
3	Pre-study informant 3 (PIF3) - Head of Continuous Improvement & Change
4	Pre-study informant 4 (PIF4) - Head of Continuous Improvement & Change
5	Pre-study informant 5 (PIF5) - ScM at Exterior Front Pre-study informant 6 (PIF6) - ScM at Exterior Front
6	Pre-study informant 7 (PIF7) - STE at Excellent Exterior
7	Pre-study informant 8 (PIF8) - Program Manager
8	Pre-study informant 9 (PIF9) - Acting Director Exterior Front

4.2.2 Courses on Organizational Structure

The researchers took part in two courses conducted by Volvo Cars Corporation with the title “Introduction to VCAF” and “Basics in Agile, Scrum and SAFe” to develop an understanding of the organizational structure and the transformation process. The course “Introduction to VCAF” provided insights about the modified framework Volvo Cars has adapted based on SAFe to fit the organization. This helped in developing an understanding of the organizational structure and the product development process. The course on “Basics in Agile, Scrum and Safe” helped to develop a deeper understanding of the Agile principles, Scrum methodologies, and SAFe from the organizational standpoint. The knowledge and insights gained from the courses were utilized to develop a deeper understanding of the transformation process of the organization and how the organization is structured in the current way of working. This further helped in understanding the information flow, product development, and a holistic view of the functioning of the organization.

4.2.3 Literature study

A literature study was conducted in parallel to the above-mentioned components focusing on previous research conducted on task-switching, multi-tasking, and Agile transformation. This included reviewing scholarly articles, research publications, and documentation produced by Volvo Cars on the transformation process. To search for articles, Google Scholar and Chalmers Library databases were used as searching engines. Keywords used were *"Multitasking and Agile"*, *"Factors multitasking"*, *"task-switching and agile" and "task-switching effects"*. While searching for literature, it was found that when using the term *'multitasking'*, the term that was aimed for was *'task-switching'*. From that point and forward, the term 'task-switching' was used instead of multitasking.

After the pre-study, the research questions were formulated and the questions for the survey created. The background knowledge gained from the pre-study facilitated the creation of the questions even though the answers were not explicitly used in this study as part of the results.

4.2.4 Discussion of Pre-study

The literature study shows that the agile methodologies and principles facilitate the delivery of value to customers and stakeholders by orienting the teams towards value delivery. The agile specialty roles such as PO and ScM work together with the teams to support their tasks and remove impediments. From the pre-study, it was understood that Volvo Cars expects a decrease in task-switching of the development teams as the agile specific roles and framework should decrease the tasks unrelated to the product backlog causing interruptions that occur for the development teams. The agile team structure is supposed to guard the teams from unwanted interruptions to facilitate value delivery.

4.3 Relation to the previous theory

In parallel with the main study, a theoretical framework presenting was gradually formed. The theoretical framework consisted of two main parts, the agile way of working and task-switching. To find literature on these topics, the following search

engines were used: Google Scholar and Chalmers Library. Search words used at these engines were for example ‘Task-switching factors’, ‘Effects task-switching', ‘Agile transformation task-switching' for the task-switching topic and ‘SAFe’, ‘Scrum’ and ‘Agile principles’ for the agile topic. Another method used to find relevant articles was chaining which means that an article’s reference list was used as a source to find new articles.

4.4 Data Collection and Analysis

The first part of the data collection consisted of an exploratory survey to get a basic understanding of what factors causing developers within Excellent Exterior to task-switch and what the effects are on them and their team. How the exploratory survey was executed is described further below in 4.4.1. To understand these factors and effects deeper, interviews with respondents from the survey were executed and described further under 4.4.2.

4.4.1 Exploratory survey

To be able to get gain an understanding of how members of the different development teams within Excellent Exterior perceive task-switching during a short period, it was advantageous to use a survey since it made it possible to reach a relatively large sample size (Ejlertsson, 2005). It was also decided to perform a digital survey since it was to be sent out to 285 people in the organization and since it was digital, it was possible to reach people also working from home. Another reason why a digital survey was used was to facilitate the registration of data, the distribution of the survey was decided to be by e-mail. By using a survey, the respondents would have time to think about their answer before answering without feeling stressed (Ejlertsson, 2005) and that the presentation of the questions is the same for all respondents meaning that the ‘interviewer effect’ was not present (Ejlertsson, 2005). The option to stay anonymous was also an important part so that everybody felt that they could express their thoughts freely, so this was an option when answering.

In the introduction to the survey, the purpose of the survey, option to stay anonymous and choice to be available for further questions were explained as well as the

explanations of keywords such as task-switching, task, and transformation. It was also pointed out that their view on how it was with the previous way of working was important even if it was some time ago and also that it would be possible for them to rate how well they remembered it to increase the probability that they would make an effort and answer.

Before writing the questions, the purpose of the survey and the target group was discussed and established. The survey aimed to gain a broad understanding of how individuals in development teams within Excellent Exterior perceive the frequency, the factors causing and the effects of task-switching, and how this has changed after the transformation of the way of the working. Based on the purpose, questions were created, and different formulations of the same question were discussed to find the most suitable one.

The design of the survey was split into six sections. The first section covered the background questions which targeted acquiring subject's information such as age, they ART they belong to, their role, team size, and most importantly if they had worked at Volvo Cars before the transformation process. The next section focused on task-switching related questions in the current way of working and the previous way of working. This was followed by a section which covered interruptions related questions and the effects of task-switching. The subsequent section dealt with the changes in workload and the final section was designed to collect information on the subject's confidence level in answering the question relating to the previous way of working, an option to express any other information that they can add related to the topic. The final section also included questions to receive consent for a follow-up interview and to be accepted for the chance to win the reward, in which case the respondents had to provide their email ID.

When a first draft was finished, it was sent to our supervisors for feedback. Several feedback loops were made with changes based on the feedback. Thereafter, a testing group was chosen with members of a development team which was in the target group and the survey was tested on them. Four members of the development team and

one ScM of the development team. By testing the survey on a focus group consisting of five people who are part of the target group, it was possible to detect unclear or complicated questions, get follow up questions and understand how the respondents perceive the questions. This was done to handle the potential risk of misperception of questions that otherwise is a weakness with using a survey as a data collection method (Ejlertsson, 2005). By letting the focus group answer the questions and give feedback, it was also possible to adjust the type and number of questions to make the survey easy to answer. According to Ejlertsson (2005), the number of questions in a survey is limited since the time for answering the survey should not exceed 30 minutes and the maximum number of questions is between 40-50. From the feedback, a chance to win a reward when participating was implemented as motivation for the respondents to finish the survey and was aiming to increase the response rate.

Before sending the survey, the corresponding Release Train Engineers (RTEs) of the ARTs were contacted to get approval of sending it to the teams in the ART. The list of the target group was obtained from an internal mailing list which was not completely updated at the time of sending the survey. There could have been possibilities that some employees might not have received the survey and/or they received the survey, but it was not targeted towards them. This was a compromise that was made as there was no other consolidated list available. This also makes it unclear when calculating the response rate for the survey as the number of the intended target group is unknown. The survey was sent out on a day three of a working week to 285 employees. There were 16 automatic replies which conveyed various reasons such as sick leave, parental leave, vacation, quit Volvo Cars, and 4 cases of invalid email addresses. A reminder was sent on day one of the following week to everyone but those that left their e-mail in the comment and to those with an automatic reply. This means that some people that had already responded to the survey but wanted to be anonymous also got the reminder.

Analysis of responses

The exploratory survey aimed to explore aspects related to task-switching related to the change in the way of working. The literature study helped in understanding the transformation process from the traditional management methods to the agile way of

working and the problems that can occur due to the transformation. This served as a basis for the identification of the aspects from the survey which the researchers studied further.

The response to the question *"What are the most common factors causing you to task-switch on an average day in the current way of working?"* on the survey had responses like *"Mail", "Unplanned things", "Reprioritization", "Phone Calls", "Meetings", "Waiting for others", "Working with several projects"*. This was followed by the question "From the question above, were the factors the same in the previous way of working?" to which, out of 45 valid responses 23 respondents have responded with 'YES' and 14 respondents with 'No' while 8 respondents have reported 'some' along with responses like *"Earlier there were other persons instead of ScM and PO"*, and *"More meetings now"*. This points out that some people feel that the factors that cause them to switch between the tasks remain mostly the same, but the context could have changed with the introduction of the Agile way of working. This was identified as an interesting topic to investigate further hence the interview questions were formulated to understand how the context of task-switching has changed from the previous to the agile way of working.

To understand if task-switching is influenced by the agile ceremonies, the survey posed a question *"Do you think that current planning methods (Daily Standups, PI planning, etc.) influence the frequency of task-switching? Describe in what way"* to which out of 45 answers, 17 answered with a 'No' whereas 24 with a 'YES' (this was a multiple-response question and some responses included 'YES' and 'No' in the answer). The answers from this question indicated that the majority has perceived that the change of way of working has influenced task-switching in some way, not mentioned how, and therefore this was identified as a topic to explore further during the interviews.

Another observation was that 33 out of 45 respondents have reported an increase of workload from the previous way of working but there was no indication of the reason behind this perceived change. Therefore, it was necessary to understand if there is a relationship between workload and task-switching, and if so, then what factors

influence the perception of the respondents which relates to task-switching. Thus, the interview questions were designed to cover this topic.

When asked about continuing the work after an interruption by *"When you get interrupted during a task and the interruption leads to another task, you..."* out of 45 respondents 26 decide what to do next based on priority whereas 11 continue to the original task after the interruption. And the *"when asked about When you get interrupted during a task and the interruption does NOT lead you to another task, you..."*, out of 45 responses 28 responses indicated that they continue the original task right after the which indicated that it is necessary to determine if there is a relationship between interruption and prioritization in the context of task-switching. This was also motivated by the responses from the survey like *"Scrum/PO with unclear priorities", "Urgent emails, phone calls", "higher priority items coming in", "fires to put out", "reprioritization"* for the factor that influence task-switching. This aspect was aimed to be explored in the interviews to see how interruptions and prioritization are affecting task-switching and how has it changed with the change in the ways of working. Also, it was observed that 12 out of 45 respondents continue with the original task later during the day when interrupted and it leads to another task, and 16 out of 45 does the same even when the interruption does not lead to another task. This conveys there can be a possibility that interruptions can affect the workflow of the employees which was aimed to be investigated further.

The responses from the survey add to the context with responses like *"Working with multiple projects instead of one; the Increased amount of meetings", "working in different projects, more meetings.", "work on different parts or projects", "Working in many projects simultaneously", "working with several projects at the same time".* The responses indicate that the teams are working on a greater number of projects than before leading to increased collaboration and interaction within the teams and among teams. Working in multiple projects directly relates to a greater number of meetings which is expressed by the respondents from the survey as a factor that influences task-switching.

When asked about their perception of completion of planned tasks by *"Do you perceive that the current way of working lets you do more or less of your planned tasks during an average day compared to the previous way of working?"* 24 out of 45 respondents have reported 'Less' and when it comes to frequency of task-switching 29 out 45 respondents feel that the frequency of task-switching should be 'Decreased' in the current way of working. The responses when combined needed an investigation further through the interviews on what kind of task-switching needs to be decreased.

From the survey, when asked, *"How often do you switch tasks?"* 16/45 respondents have reported that they switch tasks every 30-60 minutes in the current way of working whereas 17/45 respondents have reported that they switch tasks every 2-4 hours. But this does not convey that if the amount of task-switching has increased or decreased. This was to be further investigated through the interviews. 32 respondents think that the effects of task-switching are dependent on the frequency of task-switching. So, this investigation was concerned about evaluating the effects of task-switching as well.

When asked about the negative effects of task-switching, 8 out of 45 respondents answered with *"stress"* and 7 out of 45 with a response that translated to that it takes time to get back to what they were doing. Also, 7 respondents mentioned that there is a reduction in efficiency as a negative effect. The interviews conducted further were designed to understand what factors related to task-switching leads to these effects and how has it changed with the change in the way of working. The survey was designed to understand the positive effects of task-switching to which 7 out of 45 responses were about dealing with issues that arise due to change in priority. This added to the investigation which was described above about prioritization. This led to understanding that the factors are dependent on the context and nature of the task-switching and are highly related to the factors that cause the switching. Therefore, the interviews were designed to develop a deeper understanding of the effects and the relation between the factors and the effects.

Analyzing the responses from the survey indicated four reoccurring themes: interruptions, interdependencies, planning, and collaboration which have a potential

relation to task-switching. Further investigation of these themes was needed to understand how they have changed due to the agile transformation and to realize the effects caused. This analysis acted as the basis for the interviews.

4.4.2 Interviews

All questions asked in the interviews were created based on the analysis of the exploratory survey responses, as described in the previous section. From the results of the exploratory survey, four themes were identified and chosen to be investigated further during the interviews.

The conducted interviews were decided to be semi-structured since it makes it possible to collect structured data as well as asking follow-up questions for clarification if needed. The interviews aimed to gain a deeper understanding of how members of the development teams perceive the change of way of working regarding task-switching and what effects the task-switching have on them as well as their thoughts about the impact on task-switching at a team level. Managers in the positions ScM, PO, and RTE were also interviewed to understand the managerial perspective on the team's task-switching.

The respondents of the exploratory survey who answered that they were open for an interview were contacted and asked to participate. In total, 13 developers were contacted and nine of those agreed to be interviewed. The selection of the managers to interview was based on how many people from which ART that had responded to the survey, meaning that the ART's with the most responses were prioritized. Another factor influencing the selection of managers to interview was to get a spread over the ARTs and the different management positions. Below is a list of the informants and their roles. Since the respondents are anonymous, they will be referred to as, for example, IF1 for informant 1.

Table 4.2: Presents the roles and ARTs of the informants participating in the interviews

Informant 1 (IF1) was a GDL at Exterior Trim
Informant 2 (IF2) was a Task Leader and Developer at Exterior Accessories
Informant 3 (IF3) was a Senior Design Engineer at Exterior Front
Informant 4 (IF4) was a Design Engineer at Exterior Trim
Informant 5 (IF5) was a Design Engineer at Exterior Front
Informant 6 (IF6) was a GDL at Exterior Visibility
Informant 7 (IF7) was a Design Lead and a Design Engineer at Exterior Front
Informant 8 (IF8) was a GDL at Exterior Front
Informant 9 (IF9) was an RTE at Exterior Accessories
Informant 10 (IF10) was a Scrum Master and developer at Exterior Trim
Informant 11 (IF11) was an RTE at Exterior Front
Informant 12 (IF12) was a GDL at Exterior Visibility
Informant 13 (IF13) was a Scrum Master at Exterior Accessories
Informant 14 (IF14) was a Scrum Master at Exterior Front
Informant 15 (IF15) was a Scrum Master at Exterior Visibility
Informant 16 (IF16) was a Product Owner at Exterior Accessories

In total, excluding the pre-study, 16 people were interviewed. The interviews were about 45 minutes long and were digital meetings in Microsoft Teams due to circumstances making people work from home. The interviews were recorded after permission was asked and no video was used since it affected the quality of the call. During the interviews, one of the researchers asked the questions and the other one took notes and asked follow-up questions in the end when needed. After one interview to another, some questions were changed or added to explore new aspects further based on insight from an earlier interview. Some questions (see Appendix II) did also relate specifically to the informant's answer from the survey to get a further explanation of that specific response. There were different sets of questions for developers and managers.

The interviews conducted were coded and analyzed using a systematic approach called thematic analysis. It involves a six phases analytic process which is (1) familiarization

with the data, (2) generating codes (3) constructing themes, (4) reviewing potential themes (5) defining and naming themes and (6) producing the report (Terry et. al, 2017). As described by Terry, Hayfield, Clarke & Braun (2017), thematic analysis is an iterative and recursive process, where the researcher often moves back and forth between the different phases. This process offers a systematic coding and analysis tool to capture experiences and reoccurring themes and interpret them beyond their description to find an underlying meaning (Terry et. al, 2017; Smith & Shinebourne, 2012). The following example in *table 4.3* shows how the thematic analysis was applied during this study.

Table 4.3: example of thematic analysis used in the study

Quote	Simplified meaning	Sub-Theme	Theme
"We get a priority list before every planning which projects are more priority than other and then if they get something that they don't know the priority of, they discuss with the PO."	The development team members get a priority list before every PI planning and when they receive new tasks with unknown priority, they discuss that with the PO	Interruption and prioritization	Interruption

4.5 Quality of Research

Credibility is about how believable the findings of the study are (Bell et. al, 2011) meaning how well they can be considered to reflect reality. In our case, the credibility was assured by using several methods such as an exploratory survey and semi-structured interviews during the data collection to make sure that the findings were valid. If the interviews would have been executed right away, there would have been a risk of missing out on some aspects. At the same time, a limitation of the study that affects the credibility was that it was not possible to investigate the previous way of

working in detail. This was covered by inquiring the informants about their perception about the previous way of working, irrespective of their response to how well they remembered the situation before the transformation in the exploratory survey.

Transferability refers to how well the findings of the study apply to other contexts (Bell et. al, 2011), in this case, to other than Volvo Cars. It is difficult to generalize results based on one case since the context is very specific to the case and influences the results. However, for this study, the setting is described in the case description to make the reader aware of the specific context in which this study was performed.

Another aspect of the quality of the research is regarding how likely the findings are to apply at other times, also called dependability (Bell et. al, 2011). To increase the dependability, the methodology has been described in detail and added to the methodology chapter continuously during the progress of the study. How the analysis of the exploratory survey and the interviews has also been presented in detail and the questions for both the survey and the interviews are presented in the appendices.

Confirmability considers how objective the study is, or in other words, to what degree the researchers have allowed their own values to affect the study (Bell et. al, 2011). To make a qualitative study completely objective is difficult since the study is conducted based on the researcher's perception of the context. The confirmability of the study was supported by the choice of methods. A pre-study was used to first gain knowledge and understanding of the organization before formulating the research questions making them more accurate. Thereafter, the results of an exploratory survey were used to identify themes to investigate further. This means empirical data instead of theory or the personal interest of the researchers was used to decide how the study proceeded further.

4.6 Ethical Considerations

Ethical codes increasingly emphasize the importance of openness and honesty in communicating information about the research to all interested parties (Bell et. al, 2011). The ethical principles cited by Bell et. al. (2011) should avoid harm to

participants, lack of informed consent, invasion of privacy, and deception. To ensure that these principles are fulfilled, all the identities of the informants were protected, and the information was collected only after receiving consent. The informants were communicated about the purpose of the study to avoid deception and all the topics discussed were limited to the scope of the study and not any matters of privacy. The interviews were also recorded after receiving consent from the informants to document the findings.

Four ethical and legal considerations discussed in. Bell et. al. (2011) were taken into account while performing this research study, which are data management, copyright, reciprocity and trust, and affiliations and conflicts of interest. Data management focuses on the issue of who owns the data and its legal rights and under what circumstances other people are entitled to use it. Copyright relates to the intellectual property right that protects the owner of the copyright from unauthorized copying and usage. GDPR does not allow the storage of any personal data that can be traced back to the individuals. Options were given to reveal the identities in the survey for follow-up interviews and to secure the chance of collecting the reward. But the identities are modified to protect anonymity when publishing. In this research study, Volvo Cars Corporation owns the data and thus, is responsible for its availability and usage. In the data collection process, the rights of the data subjects have been taken into consideration so that their rights are not violated. Though the data is owned by Volvo Cars Corporation, the research and its related information are published by the Chalmers University of Technology. The contents of the publication are published after Volvo Cars Corporation's approval to ensure its secrecy. Regular meetings with the supervisor from the Chalmers University of Technology were conducted to avoid the outcome being influenced by Volvo Cars which would affect the affiliation and conflict of interest.

5. Results

From the exploratory survey, indications of potential factors were found and chosen to be further explored through interviews. Except for identifying the factors, its contexts were also investigated to understand how the factors affect task-switching as well as the effects of the task-switching. The findings from the interviews are presented in this section.

5.1 Results from the interviews

The overall result shows that there has been no change in the type of factors influencing task-switching due to the agile transformation. This is described by IF8 as "*The characteristics were the same, since the development cycle is the same. We change the entire methodology that we do things and who is responsible. Before we had identical teams doing the same things. Now we have one team that does it all, so we have more projects*". The citation clearly shows that there has been a large change of the way of working due to the transformation, but the characteristics, or factors as they are called here, remained the same. This perception is shared with IF2, IF3, and IF4 as well. The factors identified are interruptions, interdependencies, planning, and collaboration. These factors and their contexts are described further below.

5.1.1 Interruptions

Interruptions are a factor that interviewees perceive as making them task-switch and are described to be meetings, e-mails, phone calls, and running into people since it interrupts the developers in their ongoing work and make them switch to what the interruption is about. IF1 states that "*The interruption in working comes from dependency*" and it is supported by the statement from IF4 that says, "*Sometimes tasks involve several dependencies which leads to more interruptions*". IF6 also believes that interruptions might be influenced by the interdependencies. Interruptions are described by the informants to influence them through different channels, such as e-mails and phone calls, which are the same as before according to IF15.

The issue of interruption is also related to tasks reaching the developers from the side by the above-mentioned channels. IF2 describes that the interruptions should go through the PO in theory for the current way of working, but even if a little is going through the PO for the moment, there is no larger change from before. Interruptions are still reaching the team members directly. This perception is shared by IF7, IF13, and IF14 as well. Of the seven informants having a management position, five of them pointed out that if the task that comes from the side is larger and changes priority or takes a lot of time, the PO should be contacted by the developer that received the task or the task should go through the PO to the developer. This is exemplified by IF11 "*If they [the team] need to change the priority if it is not clear, they should go to the PO*". IF11 and IF14 experience that different people and teams deal with unplanned tasks in different ways. IF14 says "*In some teams, they are better at lifting it to the PO to get it prioritized. Some teams handle more under the radar like they try to fit it in another story or do it anyway. Many are just taking it on, not going the official prioritization*". IF14 also points out that it would be a great difference if the unplanned tasks come directly from the PO while IF7 is not sure that it would help since the PO would need to go to the team member anyway to understand the priority. However, the prioritization is expressed to be clear by the respondents, but that the challenge is to follow it due to interruptions and tasks coming in from the side. For example, IF8 describes that s/he does the tasks that cannot wait first, and when a request for another task comes s/he will change. IF11 and IF6 describe that it is up to the team members as well to learn to say no to tasks, for example, meetings with a lower priority which shows that it is also the developers' responsibility to be able to judge if a task-switch should be prioritized or not. This indicates that the individuals carry more responsibilities over task-switching i.e. deciding if they should switch tasks, compared to the previous way of working.

Responses from interviews with developers indicated that they, especially CAD engineers, need uninterrupted focused work time. They experience that some components of the Agile way of working take that away since it makes them stop what they are doing to join an agile meeting that is not directly related to the task they are working on. This was brought up by F15 who says "*Design engineers complain over not having time to do the CAD work due to e-mails and are disturbed more than the*

GDLs of the agile ceremonies" and by IF4 who describes the personal experience "*When developing a part, the most efficient way to get really focused and deep into the task requires no interruption at a period, preferably two hours.*" The effects of an interruption experienced by some team members are that the flow is lost and difficult to get back "*in the zone*". IF6 describes it as "*You need to start again, and it takes some time to catch up with what I was doing. So, sometimes you need to prioritize if the interruption is necessary to attend or not*". However, there seems to be a difference between if interruptions in the form of communication come from within or outside the team. This is expressed by IF15 as "*E-mails from the outside is more disturbing than the communication within the team, they appreciate that [the communication within the team]*".

5.1.2 Interdependencies

Another factor that influences task-switching for developers is the interdependencies. Interdependencies represent other teams that the development teams are interdependent on for performing their tasks. IF6 describes that "*We have our priorities set during the PI but things can change the priority [...] at the end of the day, I'd say that personally, it's not that I say that I need to finish this task by today because probably I'm dependent on someone else or something else comes in*". From the informant's statement, there are indications that the interdependencies affect the prioritization order in which the developers can do their tasks. IF7 expresses that "*[...] it's not always so easy to do the one with the highest priority when you lack time, because you are expected to deliver both*" which illustrates the difficulty to always follow the set prioritization. The same informant also describes that it is sometimes difficult to prioritize a task before another one when it comes to answering questions or smaller tasks. The expressed reason is that in the end, the informant is dependent on the person that asks the question in at a later stage which results in the perception that it is the best to just do it. This is another aspect of how interdependencies affect prioritization of tasks the developers are doing and therefore leads to task-switching to do the most important first.

During the interview, planning which is related to interdependencies was a reoccurring topic that has changed with the transformation and is also perceived as a context in

which task-switching occurs. IF3 describes the change as "*Before the transformation when it comes to planning, you needed to take care of some projects, there might be a few key people doing the planning and that's the planning for the group. Now, everybody is in the planning, so the planning is like a project*". IF3 also points out that re-planning occurs which is a perception shared by IF7 and IF15 as well. IF7 describes it as "*[…] we also depend on others design and they make changes that can make us re-plan in the middle of a sprint*" showing that re-planning can be caused by interdependencies which IF15 also mentions during the interview. Working with interdependencies as described by the informants requires flexibility and thus the planning should allow room for flexibility. IF12 describes the unpredictability and importance of planning while working with interdependencies as "*Normally you do the planning together with your dependencies but sometimes you have unforeseen dependencies or minor things […] So the flexibility is crucial in this work. With development, you need to do something that does not exist. you can just build it but in some of our work we create the building blocks, like Lego, so you need flexibility*". From the managerial perspective, IF15 adds to this by "*One reason is that they couldn't foresee it. Another is that... I think it's hard to... you have so many dependencies and it's complicated to do a car so it's hard to think of everything, so things always come up during a sprint*".

Another aspect of interdependencies that is related to planning and causes task-switching is to be aligned with teams that are not working agile, for example with suppliers or other departments. IF6 describes the interdependency of a supplier that doesn't work agile as "*[…] but it's also hard to try to make our suppliers understand that [the presence of planning weeks during which they don't work] as well because not all in the automotive industry are working in this way [agile way of working]*". Interdependencies with other departments that don't work agile were discussed by for example IF15 during a conversation about if it was easier to align with interdependencies when planning together "*In some areas this planning helps us. It depends on how agile these departments are. Some don't do so much planning so that's the same*". This indicates that there is a difference when an interdependent team also works agile since that involves more planning together which facilitates the alignment.

IF6 also expresses the difficulty of having interdependent teams that are not agile by saying "*[…] sometimes we have dependencies in these departments, for example, design who is not working agile and then it's a bit tricky. Different departments also have different prioritization so it's also a bit harder trying to get aligned in that sense*". The informant is also pointing out the importance of highlighting the interdependencies during the PI planning to be able to get management's help to facilitate it. The issue of not being aligned with interdependent teams is related to task-switching since the developers need to change tasks when waiting for feedback or input before proceeding. This is described by several informants, IF15, IF8, IF12, and IF9. IF14 says that "we are waiting and can't proceed because we wait for feedback". According to IF4 this could be avoided by "*[…] if we are better to tell our dependencies between each other and that we require it at a specific time*". IF9 comments that the interdependencies have always led to waiting times to get input to tasks and it hasn't changed from before the transformation. IF12 also adds that task-switching, in this case, can be good since s/he doesn't need to just wait but can do another task during the waiting time.

5.1.3 Planning

Planning is another factor that influences task-switching since it helps the developers to structure their work. Four of the developers brought up that there is less time to work due to that more time is dedicated to planning. This is exemplified by IF7 who says, "*We have less time to work due to planning*". Another view of the change of planning is what IF3 says "*Now, everybody is in the planning, so the planning is like a project*". The developers' perception of that more time goes to planning is confirmed by the managers who all agree that they have fewer hours to dedicate to the work tasks since the new way of working has introduced different agile ceremonies for planning. Even so, they do not think that it is too much. In contrast, IF11 expresses that "*I don't think that they can plan enough, I don't think that they have planned enough […] they haven't really thought of the issue that if they have planned enough, they won't feel things are coming in from the side*". From this citation, it is clear that when the planning is not enough, it will affect the teams further into the sprint in the form of re-planning when tasks that come from the side as interruptions need to be added into the priority list. Therefore, planning does indirectly affect task-switching. IF10 describes the

interrelation between planning and priorities as "*they [unplanned tasks] for sure disturb the team's priority list, they can also come from the PO after the PI planning has been done – new things such as quality issues, request from supplier...*" conveying the task assignments from PO's due to priority changes.

IF6 and IF14 share the perception that the teams might not be done with learning how to use the planning sessions in the right way. IF14 points out that it's important to write the stories so that "they are achievable in the time of the sprint". IF1 says that "For now, PI planning is good, you interact, talk and plan, but what you put up is a small part of what you do. It's hard to find how detailed you need to do the planning" which indicates that it takes time to learn how to do the planning in the best way. IF7 brings up a similar difficulty in the statement "*[…] it's difficult to estimate the points but then it comes up something during the way that adds points but we're bad at putting up points on this because we are used to it, but we don't think of it when putting points*". This indicates that there are partly difficulties in estimating the time it takes to execute a task but also to do it along the way, so in the end, they do 'tasks' that are not officially planned. To handle the uncertainty when planning and to keep the flexibility is to not plan 100% of the capacity according to IF6, IF13 and IF16, for example by the citation by IF16 "*You leave 30% free for unplanned or unexpected things. You need that from experience to handle work that could not be planned things and small assignments*". It also shows that how much to plan is something that learns by experience.

5.1.4 Collaboration

Since the transformation, the majority of the informants expressed that the collaboration in the team has increased and that it's easier to help each other due to the transparency of what they work with which comes from the agile ceremonies that they do together. This is exemplified by IF6 who says "*Now, it's easier to support when others are having issues, and they can support me if there is something small for example*". To support a colleague, a task-switch is occurring since the focus shifts from the developer's current task to the colleague's task. Collaboration also helps the team become mature from the views of managers. IF15 says "*[…] the definition of matured teams is that they are good at collaboration and have a good communication within the*

team". The informant also points out the experience plays an important role in helping the agile teams to mature by saying "*[…] they also have more work experience and are calmer in what to do in different development stages*". This points to the difference among teams in their learning process and being at different lengths in the agile transformation.

An effect from the collaboration on task-switching is related to quality and expressed by IF14 who states, "*Quality could be better because people help each other more*". IF16 mentions that "*The good thing now is that more people are involved in tasks and help each other or fill in each other's weak areas and therefore it becomes a better delivery*". These two statements show that the increased collaboration that is enabled by task-switching between team members expects the quality of the teams' deliveries to increase. This perception is however not shared with all the developers. There is a fear or perception of that the quality is reduced due to having less time to work on the development tasks and a more constant workload compared to before the transformation. The constant workload comes from that the developers in a team share the tasks in the current way of working which contributes to a perception that there is always another task to be done. How this is perceived to affect the quality is described by IF3 who says "*There is a risk that we make a less quality product because we are focused on closing the stories and going into the next sprint. It might not be maturity to close it but we need to*". IF1 shares the same view saying that "*Quality gets worse because you don't have the time to look through things. When you are finished, you move on, but before you looked at it in different perspectives […] now you don't really get that dip in your work and go directly into the next thing. People get stressed and risk of worn out*". As described here, the workload is perceived to have changed from having downtime where time to reflect came naturally to be more constant with always another task waiting. It relates to task-switching by that the constant workload makes the developers task-switch when considered done with a task instead of spending the downtime at analyzing the past work which is perceived to increase the quality of the work by the developers.

5.2 Summary of results

The results can be summarized as that the identified factors influencing task-switching have not changed due to the agile transformation but the context of the factors influencing task-switching has changed. Interruptions make the development team members task-switch and are mostly in the form of emails, phone calls, and running into a colleague. The interruptions arise mostly from interdependencies and have a priority associated with it. The effects of interruptions are focus on distraction and workflow disruption. Interdependencies can influence task-switching as the teams are dependent on one another. When there is a difference in the priority among interdependencies, the teams must plan and switch tasks to not interrupt the workflow of the interdependent teams. Misalignment with the interdependencies when they do not work agile or have a different priority list can lead to frequent re-planning and task-switching. With the introduction of the agile way of working, the development team members express that they spend less time on working as they spend more time in planning. The influence on task-switching from planning is in the form of constant re-planning which causes the development team members to task-switch when they have tasks coming from the side and when they must wait for the independencies. The results indicate an increased collaboration among teams, in turn increases the interruptions, the communication with interdependencies, and frequent re-planning causing the development team members to switch tasks frequently. An increase in collaboration can enable the development team members to offer support to their colleagues. The results identify a difference in opinion on the quality of work between the development team members and managers. Increased collaboration has led to the development of mature teams.

6. Discussion

The results presented in section five is discussed below. The discussion is carried out with an approach of providing critical reflections on the empirical data with current literature that is presented in section 2 to answer the research questions.

6.1 Interruptions

From the results of the interviews, interruptions in different forms can lead the development team members to task-switch. The different forms include phone calls, emails, running into someone, and tasks coming from the side from suppliers and other departments that need to be done immediately. The results indicate that these interruptions mainly arise from the interdependencies and the number of interdependencies directly influences the number of interruptions the team members experience. The results of the interviews show an increase in the number of projects handled by the development teams. The increase in the number of projects leads to an increase in communication as the development team members need to be in contact with a greater number of people compared to the previous way of working which is in line with what Šāblis and Šmite (2016) describe in their study.

The agile way of working, explained by Laanti (2016), promotes synchronous communication which results in an increase of face to face communication and phone calls. The face to face communication can be in the form of meetings or people directly approaching others. With the increase in synchronous communication, it is natural to see an increase in the interruptions for the development team members. The interviews do not indicate if the mentioned interruptions are related to a task in the backlog and therefore is expected, or if it's concerning something else that is unexpected for them, that is, tasks unrelated to the product backlog. The spectrum for interruption is broad and includes the unexpected interruptions that the development team members don't explicitly expect. However, teams are planning for unexpected tasks or interruptions, which is discussed further below in section 6.3.

From the results, the development team members directly receive interruptions through different channels where according to both Stettina and Smit (2016), and the informants, they are supposed to go through the PO. These interruptions arise from within the organization and from the outside world which usually refers to the suppliers. If the team members are clear about the priority of the interruptions they decide if they should switch from the current task if the priority of the incoming task is higher, or continue to what they were doing if the priority of the incoming task is lower than the task they were doing. Since the team members make this decision on their own depending on the priority list, the agile way of working could be said to increase the responsibility of the team members regarding task-switching when an interruption occurs.

Agile is about creating predictability on tasks that need to be done and the tasks should go through the PO since it's the PO that should have the conversation with the stakeholders about what needs to be done. The reality is however not completely like this and tasks still reach the team members from the side. When the priority of an incoming task is unclear the team should get it clarified by the PO which still requires them to switch from their ongoing task. It can be argued from the results that even if the incoming task was to be directed through the PO, the PO would need to approach the development team members to discuss the possibility of carrying out the incoming task if the PO is not able to decide on his/her own. The team members must switch from their current task to handle the discussion with PO and with a greater number of interruptions coming in through the PO or directly to the development team members, the amount of task-switching has increased. A possible way to handle this situation is to include the PO in the loop of interruption to create a learning curve and over time, the PO could improve the understanding of the interruptions and handle it efficiently.

As shown in the interviews, some teams are better at including the PO when new tasks reach the team members while others just do the task without writing a story or discuss with the PO. One reason for not contacting the PO that is brought up in the results is that they are used to do the task and therefore they just do it. However, this is not according to the agile way of working since the tasks should go through the PO

(Stettina & Smit, 2016) and if the PO is not contacted, there is no information that the tasks are reaching the team members through the wrong channel. Another potential problem with not including the PO is that the PO is outside of the information loop and won't be able to make decisions regarding the priority since s/he doesn't have all the information, which has been stated as an issue with letting the tasks go through the PO. That some teams think that it works well with letting tasks go to the PO or that the team members go to the PO when getting a task from the side could indicate that the teams are at different levels of agile maturity.

When discussing interruptions, it is also important to understand the nature of the interruptions that arise. The study by Mark, Gonzalez, and Harris (2005) shows that the interruption within the same working sphere is beneficial but when outside the scope it was detrimental. The results support this as the team members feel comfortable in changing tasks within a similar context. Also, the results show that the team members display a positive attitude towards interruptions from within the team when compared to outside the team. The interruptions have different effects associated with them depending on their nature as to whether it is considered as an interruption or not. This establishes a close relation of interruptions to the other factors which are interdependencies, planning, and collaboration. These are discussed in detail in the respective sections of the discussion. The common perception from the results according to the interviews is that interruptions lead to workflow disruption and loss of focus and this further results in a reduction of quality of work. This is supported by the findings of Katumba and Knauss (2014). In general, according to Murugesan (2016), it takes time to get back to the same pace when interrupted and this has an impact on the performance of the team members.

6.2 Interdependencies

The results reveal that the interdependencies are perceived to increase the frequency of task-switching. From the findings of Šāblis and Šmite (2016) and Stettina and Smit (2016), the team members receive tasks from interdependent teams with different priorities through different channels during a sprint. This is in line with the results of our interviews and the results also indicate that the team members do not always do the

task in the order of the set priorities when there is a lack of time as they are expected to deliver all the assigned tasks. When the interdependent teams have different priorities, the teams need to plan with their interdependencies in mind. They cannot focus only on the tasks which carry a high priority in their list but also need to consider other tasks that would not hinder the work of their dependent teams. Even when there is a deadline approaching or lack of time for a task, the team members spend time across different tasks instead of focusing only on the one with the highest priority and hence are subjected to task-switching more frequently. The difference in priorities caused by the interdependencies is identified as a major factor the team members to task-switch and the results show that PI planning is used to align better with the teams, they are dependent on.

By using the agile ceremonies, the teams can create a shared understanding of the priorities of different interdependencies and can plan accordingly. However, the results also indicate that this becomes difficult when the interdependent teams do not work agile. It becomes difficult to align with them and thus affects the planning process. From the results, the misalignment with the interdependent teams increases the waiting time for responses to moving ahead and moving reduces the efficiency of planning. Clear communication to the dependent teams about the requirements and timeline can reduce this thus improving the efficiency of the short feedback-loops. The misalignment with the interdependent teams caused when the teams are not working agile or carry a different priority list also results in frequent re-planning for the teams and thus subjecting the teams to frequent task-switching. This also increases the time spent in re-planning thus decreasing the actual work time. The misalignment with the interdependent teams increases the communication which as identified by Šāblis and Šmite (2016), increases the interruptions.

6.3 Planning

Highsmith and Cockburn (2001) explains the drawbacks of having a strict time plan affecting the agility of teams and the importance of allowing room for unexpected changes. The results reveal that the teams do not plan for their complete capacity and rather plan only for 70% of their capacity allowing room for unexpected changes. The

study conducted by Golfarelli, Rizzi, and Turricchia (2013) also promotes that it is optimal to plan around 70% of the work capacity to be able to accommodate the changes that can occur. The interviews portrayed the change in planning methods over the previous and the current way of working. The results indicate that the planning activity involves all the necessary people in the current way of working which makes it to better align with others and optimize the workflow. The literature by Murugesan (2016) supports the indication that better alignment and workflow optimization can be achieved when all the members are involved in the planning process.

When the time spent on planning increases, it is natural to lose time on the planned work given that the total amount of available time remains the same. The results of the interviews exert stress on this finding as it is commonly agreed by the development team members and the managers. The goal of increasing the amount of time spent on planning is to be able to decide what tasks are reasonable to execute during the increment but also to align with the interdependencies to make the workflow smoother. However, there are perceived difficulties with the planning since the planning ceremonies themselves are by some perceived as interrupting the ongoing work by the developers.

The results of the interviews show that this is crucial for development team members especially the CAD engineers who need uninterrupted time to focus on their work. The study by Katumba & Knauss (2014) shows that the interruptions during work can lead to loss of focus and affects the quality of work. This contradicts the study by Mark, Gudith, and Klocke (2008) which shows that after an interruption, the interrupted work gets done faster. The context of task-switching can be a possible explanation for this. Gillie and Broadbent (1989) explain that the nature of interruption and the interruption's complexity are the factors that lead to the disruption of performance. The results of the interviews reveal that when interrupted, the engineers are usually subjected to a complete context change and it affects their performance. The planning should allow room for an uninterrupted time but in practice, it does not do so. The interviews also show that even when planned carefully, the engineers are subjected to interruptions in other forms such as people approaching with questions or receiving

phone calls, emails with high priority and they tend to respond immediately. This shows that interruptions are not always following the set prioritization order since developers seem to handle them immediately rather than understand the priority and handle it accordingly. This was the situation before the transformation as well as meaning that interruptions still result in task-switching regardless of the priority of the interruption.

There are indications from the interviews that the process of planning involves a learning curve and that the teams are still learning how to plan more efficiently. When the planning improves, it will be easier to foresee what needs to be done and to align with interdependent teams to get the work done smoothly. More efficient planning would also affect the interruptions that emerge from interdependencies and tasks coming from the side since more of them would be handled during the planning and therefore be planned. Further, our results show that communicating the requirements clearly to the interdependent teams could reduce the waiting time, thus improving the feedback loop. From the results, the teams haven't fully learned on what level of detail that the planning should affect their perception of that tasks come from the side and that there is a lot of re-planning. If the teams still are in the learning phase of how to use planning most efficiently, it is not yet possible to see how task-switching has changed in this context. It could be that task-switching has increased during the learning phase due to that they are not fully used to plan in agile ceremonies resulting in that these ceremonies can be perceived as interruptions in the work and not as value-adding as they have the potential to be.

6.4 Collaboration

That the teams have started to collaborate more is in line with the agile way of working according to Berczuk (2007) that describes that the team relies more on collaboration when working agile. This results in more frequent communication to make it easier to get support, which is stated in the results. Šāblis and Šmite (2016) explain that with an increase in communication the number of interruptions also increases. Task-switching in this context could be argued to be positive since it enables collaboration which has positive effects on the work. As the collaboration increases, it increases the understanding of the work of other people and even in their absence, the work can

proceed with fewer difficulties (Murugesan, 2016). From the results, the managers believe that task-switching in the context of supporting each other and completing each other's weaknesses increases the quality which logically would be the case since errors can be found early in the process when asking for help but Katumba & Knauss (2014) explains that this becomes difficult when the team members are overloaded and cannot help each other. However, our results do not communicate any findings on team members not being able to help each other. Increased collaboration creates a better understanding and facilitates the promotion of better teamwork. The results also reveal that the team members appreciate the communication within the team and do not consider it as a disturbance. This expresses a positive attitude towards task-switching when team members must switch tasks to help their teammates.

The view that the quality increases are, as presented in the results is not shared by all the informants. The results reveal that there is a fear of the quality decreases with task-switching coming from the context of having many tasks at the same time and therefore always having to task-switch when done with a task instead of using the earlier downtime to analyze the executed work. Stettina & Smit (2016) express the crucial importance of reflecting on the work for agile hardware development. The reduction in downtime to reflect on the work is most likely from the time availability as there is less time to work on tasks due to that more time is dedicated to planning and that the developers are engaged in more tasks, there is always another task to take on. However, it should be possible to plan the time for reflection in the time plan since it's according to Stettina & Smit (2016) is important to reflect on the work. That the developers perceive that there is no time for reflection which affects the quality could, therefore, be a result of that they have not yet fully learned how to plan for it.

Since the perceptions of developers and managers about the quality are contradicting, it's difficult to understand what the reality looks like. One could argue that the teams are still learning the agile way of working and have not been able to harvest the benefits resulting in a fear that the quality is getting worse compared to before the transformation. On the other hand, it's also possible to argue that the quality is getting

better because of increased collaboration. However, it’s not possible to know from the results of this study but could be a topic for investigation.

From the results, with an increase in collaboration, we could argue that the agile way of working is helping the teams to mature compared to the previous way of working. The teams participate in planning together which helps the individual team members to understand their responsibilities and the work of others. This leads to uninterrupted workflow, even in the absence of a team member. They can handle the interruptions efficiently by increased collaboration with the PO. When it comes to planning, collaborating with the interdependencies helps the teams learn about the unexpected tasks not being in the product backlog that can occur over time and thus reducing the unpredictability. The results show that the teams gain more experience over time in handling the collaboration and their learning process is crucial to function effectively in an agile way of working.

7. Conclusion

The purpose of the study was to identify factors that influence task-switching for development team members in a hardware development setting. The first research question was to identify what factors that influence task-switching for hardware development team members. The identified factors are interruptions, interdependencies, planning and collaboration. Interruptions break the workflow of the team members causing them to switch tasks and this results in the loss of focus. The interdependencies are identified to be a factor that influence task-switching for the team members when there is a misalignment among teams. The interdependencies lead to frequent re-planning and reprioritization causing the team members to switch tasks frequently. Planning is important for the development team members to handle task-switching effectively and it should allow room for unexpected changes. Collaboration has increased among the interdependent teams and within the teams in the agile way of working which has led to frequent task-switching. This can be explained by the increase in communication among teams which in turn increases the interruptions for the team members. The increased collaboration among team members enables them to learn about others work which helps maintaining a smooth workflow. The increase of collaboration facilitates the learning curve for the teams about unpredictability and thus increasing the maturity of the teams.

The second research question was how the identified factors changed due to the agile transformation. The study shows that the factors themselves have remained unchanged regarding their type, but their context has changed. With the agile way of working, the development team members work on more projects compared to the previous way of working, which also increases the number of people the team members must stay in contact with. This has led to an increase in the number and frequency of interruptions the team members face. The interdependencies have also increased with the agile way of working and now the teams cater to the needs of all the dependent teams rather than focusing only on their own delivery. Planning in the agile way involves more people and interdependencies. Agile way of working facilitates collaboration through agile ceremonies which helps the individuals to be aware of the other team members work.

With the change in context described for the identified factors, the study has identified an overall increase in the frequency of task-switching with the agile way of working compared to the previous way of working.

The last research question concerned the effects of task-switching on development teams. The study shows that the frequency of task-switching has increased, and this has several effects on the development teams. The increase of interruptions in the agile way of working results in loss of focus and workflow disruption for the development team members. The misalignment with the interdependent teams can result in frequent re-planning and re-prioritization. The misalignment also leads to increased waiting time for the development team members and increase in interruptions caused by the other teams. Planning more in the agile way of working reduces the actual work time for the development team members, which lead to a perception on reduction in quality of work by the team members. While the agile way of working has increased collaboration among teams and team members, the effect of which is realized through improved understanding of other people's work and therefore it is easier to help colleagues or maintain the workflow in the absence of a colleague. The managers view the effect of increase of collaboration as increase in quality as the issues are resolved at an earlier stage.

7.1 Future research

Throughout the research for this study, new areas related to task-switching were discovered but determined to be out of scope. These areas would however be interesting for Volvo Cars to look further into as it would contribute to the continuous improvement of the agile way of working.

To build upon this study, a recommended future research is to conduct a large-scale survey within the organization to investigate how the identified factors from this study affect the employees on a larger scale. By doing so, it would be possible to get statistical trends and data from a large target group to create a better overall understanding of the situation compared to this initial study.

Another topic of investigation concerns to determine what type of tasks, or interruptions, that are necessary to reach the developer directly and which tasks that should go through the PO. There is a need to let through some tasks that can be addressed by the developers quickly to remain a fast and responsive organization. Except to determine when a task is too large to reach the developers directly, it is also needed to investigate how the necessary interruptions can reach the developers without disturbing them.

A more specific area of task-switching that was found to be out of scope for this study is how the quality of products is influenced by task-switching. This topic is related to both the increase of collaboration due to going agile which causes increased task-switching, but also the increase on interruptions. By investigating the topic of quality, it would be possible to measure the quality and compare it to the perception of developers and managers which in this study were found to have contradicting perceptions of the change of quality.

The study shows that team maturity is a crucial factor that facilitates the teams when it comes to handling wanted and unwanted task-switching. The teams learn to handle their tasks efficiently through collaboration and experience over time which contributes to the maturity. The potential of team maturity in reducing unwanted task-switching is a suggested future research from this study.

7.2 Managerial implications

Following this study, recommendations will be presented to reduce the unwanted task-switching related to the identified factors.

There is still a need of continuous improvement of planning to make it efficient and perceived as value adding for all team members. By improving the planning, there is potential for reducing unwanted task-switching by aligning better between interdependent teams and foreseeing tasks that are now considered as coming from the side. To do so, there is a need for the teams to actively involve the PO when getting tasks from the side. This will help the PO to stay updated and s/he can as a result protect

the team better from tasks that are not in the backlog in the future resulting in less unwanted task-switching. Clear communication with interdependent teams would facilitate alignment resulting in decrease of task-switching for the team members.

To help the developers to find time to reflect upon their work instead of directly task-switch when done, it's recommended to include the reflection time as part of a task when planning. This is important since the lack of time to reflect made the developers perceive that the quality of their work decreased.

Even if the developers perceive that the quality decreased, a wanted effect from working agile is to assure the quality, which also is something observed in this study. Since the view of how the changes has affected the quality differ, it's recommended to introduce quality check measures and continuous monitoring.

References

Agile Teams. (2019). Retrieved 22 February
2020, from https://www.scaledagileframework.com/agile-teams/

Bell, E., Bryman, A., & Harley, B. (2011). *Business research methods*.
Oxford university press.

Berczuk, S. (2007, August). Back to basics: The role of agile principles in success with a distributed scrum team. In Agile 2007 (AGILE 2007) (pp. 382-388). IEEE.

Bergqvist, J., & Gordani Shahri, N. (2018). Large-scale agile transformation - A case study of Volvo Cars' transformation process. Chalmers Open Digital Repository. Retrieved from https://odr.chalmers.se/handle/20.500.12380/255549

Böhmer, A. I., Hugger, P., & Lindemann, U. (2017, June). Scrum within hardware development insights of the application of scrum for the development of a passive exoskeleton. In *2017 International Conference on Engineering, Technology and Innovation (ICE/ITMC)* (pp. 790-798). IEEE.

Denning, S. (2020, January 26). Why And How Volvo Embraces Agile At Scale. Retrieved 11 May 2020 from https://www.forbes.com/sites/stevedenning/2020/01/26/how-volvo-embraces-agile-at-scale/

Dubois, A., & Gadde, L. E. (2002). Systematic combining: an abductive approach to case research. Journal of business research, 55(7), 553-560.

Ejlertsson, G. (2005). *Enkäten i praktiken:*
en handbok i enkätmetidik. Lund: Studentlitteratur AB. Second edition.

Geisler, R. (2015). *Industrial Software Applications. A Master's Course for Engineers*. Berlin, Boston: De Gruyter Oldenbourg. Retrieved 10 Feb. 2020, from https://www.degruyter.com/view/product/431072

Golfarelli, M., Rizzi, S., & Turricchia, E. (2013). Multi-sprint planning and smooth replanning: An optimization model. *Journal of systems and software*, *86*(9), 2357-2370.

Gregoire, Marc. (2014). *Professional C++ (3rd Edition) - 24.2.2 The Spiral Model.* (pp. 785). John Wiley & Sons. Retrieved from https://app.knovel.com/hotlink/pdf/id:kt011BCW43/professional-c-3rd-edition/the-spiral-model

Gandomani, T. J., Zulzalil, H., Ghani, A. A. A., Sultan, A. B. M., & Parizi, R. M. (2015). The impact of inadequate and dysfunctional training on Agile transformation process: A Grounded Theory study. *Information and Software Technology*, *57,* 295-309.

Gillie, T. & Broadbent, D. What makes interruptions disruptive? A study of length, similarity and complexity. Psych Research, 50, (1989), 243–250.

Highsmith, J. (2001). History: The Agile Manifesto. Retrieved 22 February 2020 from https://agilemanifesto.org/history.html

Highsmith, J., & Cockburn, A. (2001). Agile software development: The business of innovation. *Computer*, *34*(9), 120-127.

Hohl, P., Münch, J., Schneider, K., & Stupperich, M. (2017, November). Real-life challenges on agile software product lines in automotive. In *International Conference on Product-Focused Software Process Improvement* (pp. 28-36). Springer, Cham.

Innolution (n.d.). Task. Retrieved 4 March 2020 from https://innolution.com/resources/glossary/task

Katumba, B., & Knauss, E. (2014, December). Agile development in automotive software development: Challenges and opportunities. In *International Conference on Product-Focused Software Process Improvement* (pp. 33-47). Springer, Cham.

Laanti, M. (2016, May). Piloting Lean-Agile Hardware Development. In *Proceedings of the Scientific Workshop Proceedings of XP2016* (pp. 1-6).

Leroy, Sophie. (2009). Why is it so Hard to do My Work? The Challenge of Attention Residue when Switching Between Work Tasks. Organizational Behavior and Human Decision Processes. 109. 168-181. 10.1016/j.obhdp.2009.04.002.

Ljung, A., & Udesen, J. (2019). *The role of the first-line manager in a Scaled Agile organization A Case Study at Volvo Cars Corporation* (Master's thesis).

Lister, T. R., & DeMarco, T. (1987). *Peopleware: Productive projects and teams*. New York: Dorset House.

Lindsjørn, Y., Sjøberg, D. I., Dingsøyr, T., Bergersen, G. R., & Dybå, T. (2016). Teamwork quality and project success in software development: A survey of agile development teams. *Journal of Systems and Software*, *122*, 274-286.

Maassen, M. (2018). Product development models in the IT sector-From Waterfall to Agile Project Management Models in the case of AVIRA SOFT S.R.L, *Proceedings of the International Conference on Business Excellence*, *12*(1), 568-578.

Makoto Su, N. & Mark, G. (2008). Communication Chains and Multitasking. CHI 2008, ACM Press (2008).

Mark, G., Gonzalez, V., & Harris, J. No task left behind? Examining the nature of fragmented work. In Proc. CHI 2005, ACM Press (2005), 321-330.

Mark, Gloria & Gudith, Daniela & Klocke, Ulrich. (2008). The cost of interrupted work: More speed and stress. Conference on Human Factors in Computing Systems - Proceedings. 107-110.

Miller, W. S., Zhuang, L., Bottema, J., Wittebrood, A., De Smet, P., Haszler, A., et al. (2000). Recent development in aluminium alloys for the automotive industry. *Materials Science and Engineering: A, 280*(1), 37-49.

Moe, N. B., Dingsyr, T., & Kvangardsnes, O. (2009, January). Understanding shared leadership in agile development: A case study. In *2009 42nd Hawaii International Conference on System Sciences* (pp. 1-10). IEEE.

Murugesan, L. K. (2016, December). Overcoming challenges in self-organizing agile software teams. In *2016 IEEE International Conference on Computational Intelligence and Computing Research (ICCIC)* (pp. 1-4). IEEE.

Šāblis, A., & Šmite, D. (2016, May). Agile Teams in Large-Scale Distributed Context: Isolated or Connected?. In *Proceedings of the Scientific Workshop Proceedings of XP2016* (pp. 1-5).

Scaled Agile Framework (n.d.a). About. Retrieved 22 February 2020 from: https://www.scaledagileframework.com/about/

Scaled Agile Framework (n.d.b). Home. Retrieved 22 February 2020 from: https://www.scaledagileframework.com

Schwaber, K., & Sutherland, J. (2017). The Scrum Guide TM. The definitive guide to scrum: The rules of the game. November 2017

Smith, J. A., & Shinebourne, P. (2012). Interpretative phenomenological analysis. American Psychological Association.

Sommerville, I. (2011). *Software engineering*. Harlow: Addison-Wesley, cop. 2011. Retrieved from http://proxy.lib.chalmers.se/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=cat06296a&AN=clc.b1426294&site=eds-live&scope=site

Stettina, C. J., & Smit, M. N. (2016, May). Team portfolio scrum: an action research on multitasking in multi-project scrum teams. In *International Conference on Agile Software Development* (pp. 79-91). Springer, Cham.

Sekitoleko, N., Evbota, F., Knauss, E., Sandberg, A., Chaudron, M., & Olsson, H. H. (2014, May). Technical dependency challenges in large-scale agile software development. In *International Conference on Agile Software Development* (pp. 46-61). Springer, Cham.

Scheerer, A., Bick, S., Hildenbrand, T., & Heinzl, A. (2015, January). The effects of team backlog dependencies on agile multiteam systems: A graph theoretical approach. In *2015 48th Hawaii International Conference on System Sciences* (pp. 5124-5132). IEEE.

Strode, D. E., & Huff, S. L. (2012, January). A taxonomy of dependencies in agile software development. In *ACIS 2012: Location, location, location: Proceedings of the 23rd Australasian Conference on Information Systems 2012* (pp. 1-10). ACIS.

Terry, G., Hayfield, N., Clarke, V., & Braun, V. (2017). Thematic analysis. The Sage handbook of qualitative research in psychology, 17-37.

Van de Ven, A. H., Delbecq, A. L., & Koenig Jr, R. (1976). Determinants of coordination modes within organizations. *American sociological review*, 322-338.

Volvo Car Group. (n.d.). Our Company at a Glance. Retrieved May 11, 2020, from https://group.volvocars.com/company

Wiesche, M. (2018). Toward a Model of Managing Interruptions in Agile IT Projects. Project Management, 10.

Williams, L. (2012). What agile teams think of agile principles. *Communications of the ACM*, *55*(4), 71-76.

Appendix

Appendix I – Questions for the exploratory survey

Background questions

1.Your age

- 20-30
- 31-40
- 41-50
- 51-60
- 61+

2.Which ART do you belong to?

- Exterior Accessories
- Exterior Front
- Exterior Lighting
- Exterior Trim
- Exterior Visibility
- Appealing Design
- Other:

3. Your current role

4. Number of people in your team (excluding ScM & PO)

5. Did you work at Volvo Cars before the transformation?

- Yes
- No

6.Your last role before the transformation (if applicable)

Task Switching

Planned Task - Any activity planned until the start of the day Unplanned Task - Any activity that you do on a working day which is not planned prior to the start of the day

7.On an average day with the current way of working, how often do you switch task?

- Less than every 10 minutes
- Every 10-30 minutes
- Every 30-60 minutes
- Every 1-2 hours
- Every 2-4 hours

- Other:

8. As you recall it, how often did you switch task with the previous way of working?

- Less than every 10 minutes
- Every 10-30 minutes
- Every 30-60 minutes
- Every 1-2 hours
- Every 2-4 hours
- Other:

9. On an average day, how much of the task switching is usually planned?
Answer in percentage

10. As you recall it, how much of the task switching was usually planned with the previous way of working?
Answer in percentage

11. How much of your planned tasks are you able to complete on an average day with the current way of working?
Answer in percentage

12. As you recall it, how much of your planned tasks were you able to complete on an average day with the previous way of working?
Answer in percentage

13. What are the most common factors causing you to task switch on an average day in the current way of working?
(Separated by comma. Example: factor1, factor2, factor3)

14. From the question above, were the factors the same in the previous way of working?

If your answer is 'No' or 'Some', mention the factors which are different in the 'Other' text box. (Separated by comma. Example: factor1, factor2, factor3)

- Yes
- No
- Some
- Other:

15. How would you rate frequent task switching? (0 = negative, 10 = positive)

0	1	2	3	4	5	6	7	8	9	10

Task Interruption

Task interruption - In this section, an interruption is defined as any activity like an ad-hoc phone call, email, running into someone, etc. which interrupts the flow your current work

16. How often does an interruption leads you to another task?

	Never	Sometimes	Mostly	Always	Can't say
Your Answer					

17. When you get interrupted during a task and the interruption leads to another task, you...

- ... Continue the original task later during the day
- ... Continue the original task right after the interruption
- ... Decide what to do next based on priority
- Other:

18. When you get interrupted during a task and the interruption does NOT lead you to another task, you...

- ... Continue the original task later during the day
- ... Continue the original task right after the interruption
- Other:

19. Do you think that current planning methods (Daily Standups, PI planning, etc.) influence the frequency of task switching? Describe in what way

20. How did the previous way of working influence task switching?

21. Do you experience that frequent task switching is problematic for....

	Can't answer	Not at all	Sometimes	Mostly	Definitely
... YOU in the current way of working?					
... your TEAM in the current way of working?					
... YOU in the previous way of working?					
... your TEAM in the previous way of working?					

22. What do you see as the positive effects of task switching on YOUR work? (Separated by comma. Example: effect1, effect2, effect3)

23. What do you see as the negative effects of task switching on YOUR work?
(Separated by comma. Example: effect1, effect2, effect3)
24. Do you think the effects of task switching depends on the FREQUENCY of task switching?
If your answer is 'Some effects', mention those effects in the 'Other' text box

- Yes
- No
- Some effects
- Other:

25. Do you think the effects on YOUR work were the same during the previous way of working? If not, describe the difference
If your answer is 'NO', describe the changes in the 'Other' text box

- Yes
- No
- Maybe
- Other:

26. What effects would you say that task switching has on your TEAM?
(Separated by comma. Example: effect1, effect2, effect3)

Task Switching

27. How has the workload changed in the current way of working compared to the previous way of working?
If possible, describe the changes in 'Other' text box

- Increased
- Decreased
- Unchanged
- Other:

28. Do you perceive that the current way of working lets you do more or less of your planned tasks during an average day compared to the previous way of working?
If possible, describe how in the 'Other' text box

- More
- Same
- Less
- Can't answer
- Other:

Current Way of working

29. Do you feel having a common system like VIRA across different departments to track backlogs/deadlines/progress will influence task switching?

If possible, describe how in the 'Other' text box

- Yes
- No
- Maybe
- Other:

30. Do you think the frequency of task switching should be _____ in the current way of working?
If possible, mention how should your answer be implemented in the 'Other' text box

- Decreased
- Increased
- Remain the same
- Other:

The last questions

31. After answering these questions, how confident are you that you remember the situation with the previous way of working on a scale from 1 to 5? (1 = Not confident, 5 = Very confident)

32. Is there anything else that you would like to add?

33. To be able to share the reward with you, we need your e-mail but note that this means that you won't stay anonymous. If that is ok with you, write your e-mail below.

34. Is it ok with you that we contact you for further questions?

- Yes
- No

Appendix II – Questions for developers

Questions for developers

1. Can you describe your role?
2. How long have you been at Volvo Cars?
3. How does your normal working day look like? (what do you do? What sort of communication occurs?)
4. If he has held multiple positions, then do you think the amount of task-switching and the factors causing it is the same for all the positions?
5. What do you see as a task? And what do you consider as an interruption?
6. You had mentioned "*[answer from survey for that specific informant]"* as the factors which cause task-switching. Can you elaborate?
    a) What kind of task-switching would you say that they are? Unplanned or planned? Is that problematic for you?
    b) Do the switches caused by "*[answer from survey for that specific informant]"* result in that you change priority of your tasks?
    c) Was it the same before the transformation (the same causes?)
7. How would you relate agile methodologies to task-switching?
    a) Are there any specific components in agile way of working that you feel influences task-switching?
    b) How is it different from before?
    c) Is Agile transformation helping in seeing a bigger picture? (how is it different from previous way of working) (based on his answer from survey)
8. In the new way of working, do you think the characteristics/factors of task-switching has changed? (The reasons for task-switching)
9. What kind of task-switching would you say are the most challenging/difficult; the planned (for example meetings) or unplanned (interruptions, ex. E-mail, questions)?
10. When you get for example a phone call or e-mail, do you change priority and do what the person ask you to do, or do you continue with your priority?

a) Does it matter if the tasks have different priority? How do you decide which one to do?
b) Are the priorities of the tasks that comes up are clear to you? Or do you think more clarity would be good?

11. Compared to before, how would you say that ad-hoc task-switching has changed?

12. Compared to before, how would you say that the planned task-switching has changed?

13. In the end of the day, would you say that you finish the things/tasks that you planned to finish? Why?

14. Many people from the survey have reported that they complete less of their planned tasks in the current way of working which is in contrast with your answer.

a) Can you describe in what way do you feel it is the "less"?
b) What do you think is different? How do you handle your tasks?
    i. Is planning helping you with that?

15. In the survey, you had mentioned that the **positive** effect of task-switching is "*[answer from survey for that specific informant]"*. Can you elaborate on this? (Give an example?)

a) Do you see any other positive effects?

16. In the survey, you had mentioned that the **negative** effect of task-switching is "*[answer from survey for that specific informant]"* Can you elaborate on this? (Give an example)

17. Are you able to collaborate more to your team in the current way of working?

18. The effects of Task-Switching that you mentioned in the survey, do you perceive that your team members perceive the same effects?

19. How are tasks being given to you? (apart from the ones planned during the sprint) How has it changed from before?

20. Regarding the dependencies, would you say it's easier to work with them in the current way of working considering the PI planning and the agile way of working?

a) Has it changed the level of interruptions related to dependencies?
b) Does it help you to not re-prioritize to handle the interruptions?
c) Is this influencing the amount of task-switching

d) How do you think can a sprint be stabilized? (planning/exploring or identifying more dependencies?)

21. Most people from the survey have reported that having a common system like VIRA might influence task-switching. What would you say about that?

a. Does it help with dependencies? To keep to the scheduled tasks

b. Do you discuss about this with your team?

22. What do you feel about the workload changes?

a. Why do you feel so?

b. Do you finish the same amount anyway?

23. Is there anything else that you would like to add?

Appendix III – Questions for managers

Questions for managers

1. Can you describe your role at Volvo Cars?
2. How long have you been at Volvo Cars?
3. What position did you have before the transformation?
4. How has your role (work profile) changed after the transformation?
5. Can you tell us about how you are connected to the team?
6. How do you think the teams are affected by the change of way of working?
7. How has the way the teams get their tasks changed from the old way of working? (after the transformation)
8. Do you think the tasks going through PO instead of directly going to the developers would help in prioritizing the work?
9. How do you think teams/individuals deal with unplanned tasks?
    a) What do you think are the major causes for them?
    b) Can they be avoided by planning?
10. How does it work with changes in the prioritization for the teams?
    a) Are the teams/individuals clear about the priorities of the tasks they are assigned?
    b) Is it influenced by the way of working?
11. How often does the prioritization of tasks change for the dev? Teams?
    a) About new tasks coming up
    b) How do teams deal with supporting other people (Before the work/ along the way)
    c) Changes in the existing set of tasks
    d) Is there a difference from before the transformation?
12. Are any specific components of Agile affecting the amount of task-switching?
13. Is dependency a major factor for frequent task-switching?
    a) Would you say it makes a difference when dealing with Task-Switching that the dependencies are “clearer” now when planning is done together (PI)? In what way?

14. There is a conception that the teams plan more compared to the previous way of working but still are subjected to frequent task-switching.

a) Why do you think this happens?
b) Is spending more time planning and less time for actual working affecting the quality of work of individuals/teams?

15. Are the teams/individuals protected in any way on tasks they do that are outside their project scope? Ex: when we mean project scope, it means anything other the projects they are working on.

16. Have there been any changes in the team in terms of people incoming/Outgoing?

a) Capacity?
b) Stability, maturity?
c) Would you say that this affects the team dynamics/their work/outcome? (How do you "see" that?)

17. What do you think about the transformation process in terms of Task-Switching for individuals/teams?

18. Is there anything else that you would like to add?

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISION OF INNOVATION AND R&D MANAGEMENT
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden
www.chalmers.se

CHALMERS
UNIVERSITY OF TECHNOLOGY