Managing inter-team collaboration effectively in large-scale agile software development

A case study

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Managing inter-team collaboration effectively in large-scale agile software development: A case study

Msc. Innovation Management

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Management summary

Introduction
Agile development emerged in the software development industry in the early 21st century (Dingsøyr & Moe, 2014). Although agile is established as the gold standard for small teams developing software, implementing agile on a larger scale is perceived as challenging (Dingsøyr & Moe, 2014). Agile was originally intended for autonomous teams, so implementing it on a large scale results in a challenge for the organization to keep inter-team collaboration effective (Dingsøyr, Bjørnson, et al., 2018). The literature identified several factors and best practices that influence the effectiveness of inter-team collaboration in large-scale agile software development (ASD). Studies propose different factors and best practices, indicating the fragmented and disjointed nature of the field. This research has captured the shortcomings of the existing literature in the following two gaps. Literature gap 1: The current literature on factors and best practices affecting effective inter-team collaboration in large-scale agile software development is incoherent. Literature gap 2: The current literature on factors affecting effective inter-team collaboration in large-scale agile software development is likely to be incomplete. The scattered, exploratory and underdeveloped state of academic knowledge leaves both academics and practitioners deprived of a coherent and evidence-based overview to guide their reasoning about effectively managing inter-team collaboration in large-scale ASD. To ensure that the findings of this research have both academic and practical value, the study was conducted in collaboration with a software company applying agile on a large scale. CM.com, the case company of this study, wanted to understand how to effectively manage their inter-team collaboration in the research and development (R&D) department. For these purposes, this research established the following research question (RQ): How to manage inter-team collaboration effectively in large-scale ASD? To guide this research question, three sub questions (SQ) are developed. SQ1: What is effective inter-team collaboration in large-scale ASD? SQ2: What factors and best practices, that affect the effectiveness of inter-team collaboration in large-scale ASD, can be identified in literature? SQ3: What affects the effectiveness of inter-team collaboration within the R&D department of CM.com?

Literature background
To establish a solid theoretical foundation, I have chosen appropriate and well-supported definitions of the core concepts of this study that contribute to their validity. The definition for the first core concept, agile software development, is defined as "*the continuous willingness to create change rapidly or inherently, embrace change proactively or reactively, and learn from it while contributing perceived customer value (economy, quality, and simplicity), through its collective components and connections to its environment*" (Conboy, 2009). The second, large-scale agile software development is defined as "*agile development initiatives involving more than two teams*" (Dingsøyr & Moe, 2014) . And the final, effective inter-team collaboration is defined as "*an evolving process in which two or more teams actively and reciprocally engage in joint tasks and depend on each other with respect to operational functioning and the pursuit of at least one overarching organizational goal, with minimal overhead for the organization to achieve and maintain their desired level*" (Bedwell et al., 2012; Bosch & Bosch-Sijtsema, 2010; Cha et al., 2015).

Research methodology
To address the stated research question with sub-questions, I used two sequential research approaches in this study. First, a systematic literature review was conducted to identify and synthesize the existing knowledge on factors and best practices affecting the effectiveness of inter-team collaboration in large-scale ASD. Second, 12 semi-structured interviews with practitioners were conducted to form a comprehensive understanding of the effectiveness of inter-team collaboration in CM.com's R&D department. This understanding is substantiated by field research and unofficial discussions with practitioners. I chose to include every role within a team and within the R&D department in the

interviews to gain insights from all possible perspectives. The factors from the systematic literature review were analyzed using a deductive data analysis method. New factors were identified using an inductive data analysis method used.

Results

I identified 9 factors totaling 11 corresponding subfactors that influence effective inter-team collaboration in large-scale ASD. These identified factors are: Inter-team dependencies, planning alignment, knowledge sharing, communication, team autonomy, personal differences, clarity of roles and responsibilities, collaborativeness of organizational structure and collaborativeness of organizational culture. In addition, 20 best practices were identified in the literature combined into overarching categories. These categories are: Activity-based best practices, tools and artifacts, and structure-based best practices. Building on the insights from 12 semi-structured interviews with practitioners from CM.com, I identified three new factors that affect to the effectiveness of inter-team collaboration in large-scale ASD. These new factors are: Clarity of organizational strategy, human resources and organizational growth. In addition, I described each of the identified factors and best practices and illustrated how a factor affects the effectiveness of inter-team collaboration within CM.com's R&D department. Furthermore, by iteratively synthesizing the above findings into an overview, based on the relations specified in the existing literature and interviews, I developed the factor-best practice overview. Finally, it is important to maintain a broad and dynamic view on effectively managing inter-team collaboration in large-scale ASD, as some factors and best practices change over time within an organization.

Discussion

The findings of this study have implications for both theory and practice. Starting with the theoretical implications. First, the results confirm previous statements about the incoherent literature as well as emphasizing the value of synthesizing the existing literature (literature gap 1). The relevant literature revealed that the effectiveness of inter-team collaboration depends on a large number of factors and best practices, but each source focused on specific components of inter-team collaboration in large-scale ASD. With the fact that effective inter-team collaboration is an evolving process and complex given the large number of factors and best practices, it is important to apply a holistic approach to manage inter-team collaboration effectively in large-scale ASD. Secondly, the results confirm previous statements about the incompleteness of the literature (literature gap 2). The identified novel factors can contribute to a more complete body of literature about factors affecting the effectiveness of inter-team collaboration in large-scale. Although the new identified factors do not represent new concepts for the effectiveness of inter-team collaborations, it does in the context of large-scale ASD. By addressing the two identified gaps in the literature, this study has identified, summarized, and expanded existing knowledge about factors and best practices that influence the effectiveness of inter-team collaboration in large-scale ASD, resulting in the most complete work to date. Finally, the development of the factor-best practice overview contributes to the existing literature by providing a coherent conceptual overview of the available knowledge on how the factors, which influence the effectiveness of inter-team collaboration in large-scale ASD, can be leveraged by best practices.

The findings of this study have implications for management, both in general and for CM.com. Starting with the general managerial implications. Managers can use the findings to generate broader understanding of the factors and best practices that influence the effectiveness of inter-team collaboration in large-scale ASD. The results indicate that a dynamic and broad perspective is needed to effectively manage inter-team collaboration in large-scale ASD. This broad perspective is fruitful for organizations because it can reduce obstacles facing the achievement of effective inter-team collaboration in large-scale ASD. In addition, using the factor-best practice overview, the beneficial effects of factors on the effectiveness of inter-team collaboration can be strengthened by applying the related best practices. Managers can assess their inter-team collaboration to understand what factors

negatively affect their inter-team collaboration, and proceed from there to identify best practices that can potentially reduce it. It is important to regularly analyze and review inter-team collaboration to remain as effective as possible.

Then, the managerial implications for CM.com follow. Given the detailed elaborations, whereby the influence on the effectiveness of inter-team collaboration within the R&D department is reflected per factor, allows CM.com to see for each factor how it relates to the effectiveness of their inter-team collaboration. CM.com can use this broad elaboration from each factor to recognize what the strengths and weaknesses are within the R&D department. Furthermore, inter-team collaboration within the R&D department is rated moderately by the interviewed practitioners, while a lot of best practices are implemented. Therefore I recommend reviewing the best practices being applied currently to ensure consistent and correct application by all teams. In addition, the visualization of the inter-team dependencies within the R&D department identified vulnerable teams (e.g. Mobile Marketing Cloud) and teams with potential positions of power (e.g. IT). Teams within the same business unit work primarily on the same product and depend less on teams outside their business unit to function, which is not the case for the SaaS business unit. Positioning the different products of the SaaS business unit each in their own business unit will create more consistency in the structure of CM.com's R&D department. Additionally, I recommend to implement two best practices to counteract the main obstacles for effective inter-team collaboration in CM.com's R&D department. These best practices are to standardize tools and processes and implementing objectives and key results (OKRs). Finally, I recommend to review and discuss the clarity of team names, and their roles and responsibilities within CM.com's R&D department.

Despite the careful planning and execution of this study, it is important to recognize its limitations. The first limitation is that the knowledge produced about factors and best practices that influence the effectiveness of inter-team collaboration in large-scale ASD is likely to be incomplete. The systematic literature review probably did not include all existing relevant literature because of the selected search strings, bibliographic databases and inclusion criteria. The expert interviews likely provided a subset of available perspectives on the effectiveness of inter-team collaboration due to the limited sample size and selection criteria. Finally, the synthesis of the identified literature sources, the identification of new factors, and the mirroring of the factors with best practices are based on my interpretations and reasoning. This subjectivity affects the validity of the findings.

The findings and limitations of the current study highlight three fruitful areas for future research. The first promising direction is to further investigate the influence of factors and best practices on the effectiveness of inter-team collaboration and, in particular, the newly identified factors to enhance the generalizability. The second is to investigate the dynamics of factors by re-examining the influence of factors on the effectiveness of inter-team collaboration, for example, in the same organization 1 year after the publication of this study. The third could explore the similarities or synergies between the identified factors and best practices by examining their influence on each other and on the effectiveness of inter-team collaboration in large-scale ASD at a more detailed level.

Conclusion

This research aimed to provide a coherent, evidence-based understanding on how inter-team collaboration can be effectively managed in large-scale ASD. By identifying and summarizing the existing knowledge on inter-team collaboration effectiveness in large-scale ASD and by further extending the existing knowledge with qualitative research, this study provided the most complete work to date. The insights and factor-best practice overview ensures an understanding of how inter-team collaboration can be managed more effectively, and thereby answering the research question of this study.

Content

1. Introduction

Agile development has emerged in the software development industry in the beginning of the 21st century (Dingsøyr & Moe, 2014). Since the formulation of the agile manifesto, agile methods have transformed the practice of software development by placing a strong emphasis on change tolerance, evolutionary delivery, and active end-user involvement (Dingsøyr et al., 2012). Agile development has garnered widespread interest, where Scrum is now the standard agile method for software development in many countries. While agile has become established as the gold standard for small teams developing software, implementing agile on a larger scale is perceived as challenging (Dingsøyr & Moe, 2014). Agile was originally intended for autonomous teams so its implementation on a large scale results in a challenge for the organization to keep inter-team collaboration effective (Dingsøyr, Bjørnson, et al., 2018). In this study, effective inter-team collaboration is defined as an evolving process in which two or more teams actively and reciprocally engage in joint tasks and depend on each other with respect to operational functioning and the pursuit of at least one overarching organizational goal, with minimal overhead for the organization to achieve and maintain their desired level (Bedwell et al., 2012; Bosch & Bosch-Sijtsema, 2010; Cha et al., 2015). This rising challenge to keep inter-team collaboration effective is to the disadvantage of organizations because it is recognized as significant predictor of organizational effectiveness and as critical performance driver (Berntzen et al., 2021).

The literature identified several factors and best practices that influence the effectiveness of inter-team collaboration in large-scale agile software development (ASD). Given a few articles that study how inter-team collaboration can be effectively managed, the disparate results of the current literature become apparent. Evbota et al. (2016) found in their case study at Ericsson that planning is a major challenge for effective inter-team collaboration due to unclear requirements, unclear role of operational product owners and unbalanced involvement of teams. While Berntzen et al. (2021) found four key aspects in their case study, namely aligning autonomous teams, maintaining overview in the large-scale setting, managing prioritizations and managing architecture and technical dependencies for effective inter-team collaboration. The study by Martini et al. (2013) provided recommendations to manage their identified factors to complement current Agile best practices so that they can be applied in large software organizations. For example, for the "lack of common time" factor, they recommended sharing calendars to achieve better alignment. While Stray et al. (2019) outlined 20 different best practices that address dependencies between teams and seek to increase the effectiveness of team collaboration in large-scale ASD.

As demonstrated above, the literature shows different approaches and little consistency when it comes to which factors and best practices influence the effectiveness of inter-team collaboration in large-scale ASD. More interestingly, most studies propose different factors and best practices, indicating the fragmented and disjointed nature of the field. Moreover, I did not find any study that made an attempt to bring together the scattered knowledge on this topic. Therefore, this study has identified the following gap in the literature:

Literature gap 1: The current literature on factors and best practices, affecting effective inter-team collaboration in large-scale agile software development, is incoherent.

Finally, given the exploratory nature of the current body of literature and primarily applied case studies, it is likely that existing knowledge about factors influencing the effectiveness of inter-team collaboration in large-scale ASD is not only fragmented, but also incomplete. Therefore, the second gap in the current literature this study exposes is the following:

Literature gap 2: The current literature on factors affecting effective inter-team collaboration in large-scale agile software development, is likely incomplete.

Due to the scattered, exploratory and underdeveloped state of academic knowledge, both academics and practitioners demand a coherent and evidence-based overview to guide their reasoning about effectively managing inter-team collaboration in large-scale ASD. This demand is fulfilled in this study. To ensure that the findings of this research have both academic and practical value, the study is conducted in collaboration with a software company applying agile on a large scale. CM.com, the case company of this study, wants to gain insights into how to manage their inter-team collaboration in the research and development (R&D) department effectively. The factors and best practices affecting the effectiveness of inter-team collaboration that arise in fast-growing agile software companies, are analyzed at CM.com. The following subsection will provide the empirical context of this study.

1.1 Empirical context of study

To ensure that the findings of this research have both academic and practical value, the study is conducted in partnership with a software company using agile on a large scale. This section provides general information of CM.com, a description of the organizational structure, an elaboration of the used Scrum-method and lastly a sketch of their inter-team collaboration.

General information

The company was founded in 1999 by two students from Eindhoven University of Technology. During their studies they came up with the idea of creating and selling a system for paid group SMS messages and approached several discotheques. As a name for their company they came up with the abbreviation CM which stands for Club Message. CM.com identified the transition of communication to mobile devices when it was in its early stages. This transition is also taking place for mobile commerce. Mobile commerce can be defined as conducting transactions with financial value via a mobile network (Clarke, 2001). CM.com creates an environment for companies where mobile communication and mobile commerce converge. This environment is constantly being developed to shape the future of conversational commerce. Conversational commerce implies the ability that consumers can chat with company representatives, get customer support, ask questions, get personalized recommendations, read reviews, and are able to purchase without leaving the messaging apps (Shopify, 2022). Nowadays, CM.com is a global leader in cloud software for conversational commerce that enables businesses to deliver a superior customer experience. Their communications- and payments platform empowers marketing, sales and customer support to automate engagement with customers across multiple mobile channels, blended with seamless payment capabilities that drive sales, gain customers and increase customer satisfaction. These communications- and payments platforms include modules as mobile service cloud, conversational AI cloud (chatbots), mobile marketing cloud (campaigns), payments, ticketing and signing. These operations are managed by a team of employees of approximately 950 with 25 different nationalities (*CM-Annual-Report-2021*, n.d.). CM.com is headquartered in Breda.

Organizational structure

CM.com is a fast-growing technology-company and has organically grown in a non-hierarchical way (*CM-Annual-Report-2021*, n.d.). This structure allows for small self-managed autonomous teams. A visualization of the team tree and structure of CM.com is provided in Appendix A. To get an idea of the organizational structure within cm.com, the structure of the research & development (R&D) department will be elaborated in more detail. The R&D department is composed of six business units and more than 30 autonomous teams. The six different business units are: CPaaS (Communication platform as a Service), Ticketing, Online payments, SaaS (Software as a Service), POS payments (Point of Sale) and Core platform. Within the business unit CPaaS, the autonomous teams are divided in for example, Carrier channels (e.g. SMS) and Channels one (e.g. Facebook Messenger). In order to deliver projects

in a more productive manner and to tackle problems quickly (i.e. agile), the Scrum-method is used by almost all teams in the R&D department.

Scrum-method

The scrum-method implies working in autonomous teams consisting of different specialists and Scrum roles/responsibilities (Schwaber & Sutherland, 2020). The 'group lead' manages the autonomous teams within their business unit. The person who supervises the Scrum process within the autonomous team is called the 'Scrum Master' and ensures that the team performs optimally. The development team collaborate together to deliver a potentially releasable product increment at the end of each process. The developers are distinguished by experience and skills into 'developers', 'senior developers' and 'lead developers'. In addition, there is the 'Product Owner', who acts as an intermediary to ensure that customer's requirements and wishes will be implemented in the product. These requirements are also called user stories and are listed on a list, the product backlog. Here, the highest priority requirements are included in the sprint backlog, which refers to the tasks to be worked on during a sprint. A sprint refers to a defined period of 2 weeks. A sprint starts with a sprint planning, and ends with a sprint review and sprint retrospective meeting. How many sprints are needed varies from project to project. Within the 2-week period, multiple tasks are conducted by the development team. Once the designated team members have completed their task they become responsible to complete tasks of other team members. In order to properly perform the tasks within a sprint, mutual consultation between team members is necessary. Therefore, the team has a short meeting every morning; the Stand Up. After each sprint a (partial) product is delivered, after which an evaluation follows and feedback is provided by the customer. This is done to ensure that the Scrum team improves in short cycles and delivers as much value as possible in as little time as possible (Schwaber & Sutherland, 2020). After the review, the retrospective takes place where the team evaluates their content and collaboration during the sprint. After these moments of evaluation, this process will start again in the next sprint. In addition to the scrum activities that take place at the team level, scrum-of-scrum meetings are organized within CM.com. A scrum-of-scrum meeting is a stand-up meeting only with the ambassadors of each autonomous team within their specific business unit, which is held once in the two weeks (Bick et al., 2018).

Inter-team collaboration

As mentioned before, one of the strategies described by CM.com is to develop own in-house innovations combined with acquisitions to realize a fully integrated suite of conversational commerce. This strategy requires collaboration between the autonomous teams, so that all software modules could blend together in this integrated suite. During several informal explorative interviews with product leads, product owners, scrum masters and developers, it appears that the different business units in the R&D department are focused in optimizing their own part of the module and collaboration occurs primarily with teams working in the same business unit. This focus on proprietary innovation is reflected in the approach whereby some autonomous teams choose to apply the Kanban method. The Kanban method is similar to the scrum method, but allows for more flexibility and continuity within the 2 weekly sprints, whereas the Scrum method is more structured. To maintain collaboration between teams, a number of tools are utilized. Although these tools are not applied in all business units. Despite recognizing the importance of inter-team collaboration, there is a lack of an understanding of inter-team collaboration within the organization. Therefore CM.com want to gain insights into how to manage their inter-team collaboration in the research and development (R&D) department effectively. The following subsection provides the research questions of this study.

1.2 Research questions

The focus of this research is to explore how effective inter-team collaboration in a large-scale ASD setting can be managed. To address the questions as thoroughly as possible, an exploratory global search for relevant literature is conducted. The following research question is proposed:

RQ: How to manage inter-team collaboration effectively in large-scale agile software development?

To answer this question thoroughly, three sub-questions are formulated. By addressing the three sub-questions, the research question is answered in terms of a tailored overview and recommendations.

SQ1: What is effective inter-team collaboration in large-scale agile software development?

This sub-question established what effective inter-team collaboration in large-scale ASD is and summarizes the viewpoints of the literature. It discussed in detail how large-scale ASD emerged and how inter-team collaboration changed due to this evolution.

SQ2: What factors and best practices, that affect the effectiveness of inter-team collaboration in large-scale agile software development, can be identified in literature?

This sub-question identified the factors and best practices, that affect the effectiveness of inter-team collaboration in large-scale ASD, in the relevant literature and provided in a structured manner.

SQ3: What affects the effectiveness of inter-team collaboration within the R&D department of CM.com?

This sub-question aimed to determine how effective the current situation of inter-team collaboration is within the R&D department of CM.com. Based on this assessment, insights are generated about the effectiveness of inter-team collaboration within the R&D department of CM.com. The following subsection provides the deliverables of this study.

1.3 Deliverables

Through addressing the research questions presented above, the goal of this study is to provide insights on how to manage effective inter-team collaboration in large-scale ASD. This goal is accomplished by coherently and insightfully conveying and supplementing existing insights about factors and best practices that influence the effectiveness of inter-team collaboration in large-scale ASD. These insights are gained by separately analyzing and synthesizing the relevant literature on factors and best practices. In addition, practice revealed new factors that are not identified before in the context of large-scale ASD. Eventually, the identified factors and new factors are related to the best practices generating an orderly coherent overview on how to effectively manage inter-team collaboration in large-scale ASD. The relevance of addressing this research from an academic and a practitioner perspective is discussed below.

Answering the research question is considered to be relevant for academics because of the following. First, this study synthesized the existing literature of factors and best practices that affect the effectiveness of inter-team collaboration in large-scale ASD. Second, this study expanded the existing knowledge of factors affecting the effectiveness of inter-team collaboration in large-scale ASD. Third, this study synthesized existing literature and created the factor-best practice overview offering value because it provides a clear overview of the latest available academic knowledge on the topic at hand.

From a practitioner's perspective, this study provide three important insights by the following. First, insights are provided in a coherent manner to generate broader understanding of the factors and best practices that influence the effectiveness of inter-team collaboration in large-scale ASD. Second, the factor-best practice overview provides which best practices to apply to strengthen the beneficial effects of factors on the effectiveness of inter-team collaboration. Finally, case-specific managerial implications for CM.com are provided based on the outlined situation of inter-team collaboration within CM.com's R&D department and the findings from the literature. Effective inter-team collaboration in large-scale agile settings is becoming a more frequently mentioned challenge within the software development (Edison et al., 2021; Uludag et al., 2018). In this rapidly growing industry, it is important to remain relevant, so insights based on the most relevant literature can contribute to this.

2. Literature background

This section covers the theoretical background of this study. With the research questions formulated, it is important to analyze the core concepts of this study and develop solid definitions. The core concepts 'agile software development (ASD)', 'large-scale agile' and 'effective inter-team collaboration', are respectively elaborated in section 2.1, 2.2 and 2.3. The purpose of this literature background is to answer the first research question of this study (SQ 1).

2.1 Agile software development

Agile development has emerged in the software development industry in the beginning of the 21st century (Dingsøyr & Moe, 2014). In 2001, a group of software professionals created and published the Manifesto for ASD. This manifesto consists of twelve principles focused on four key aspects: Individuals and interactions, customer collaboration, working software, and, finally, responding to change (Fowler & Highsmith, 2001). Agile has been widely accepted as an answer to the major problems of traditional methods of software development, especially in the areas of maintenance and changes at the request of the user (Al-Saqqa et al., 2020). ASD should accelerate development and respond effectively to requested changes (Al-Saqqa et al., 2020). Cockburn (2000) proposes five "sweet spots" for effective ASD: Two to eight people in one room, onsite usage experts, one-month increments, short increments, fully automated regression tests and experienced developers. Conboy (2009) defined agility in the context of software development as:

> *The continuous willingness to create change rapidly or inherently, embrace change proactively or reactively, and learn from it while contributing perceived customer value (economy, quality, and simplicity), through its collective components and connections to its environment.*

Since the formulation of the agile manifesto, agile methods have transformed the practice of software development by placing a strong emphasis on change tolerance, evolutionary delivery, and active end-user involvement (Dingsøyr et al., 2012). Agile development has garnered widespread interest, where Scrum is now the standard agile method for software development in many countries. Other methods such as extreme programming and Kanban are also in widespread use (Acharya & Colomo-Palacios, 2019; Dingsøyr & Moe, 2014).

2.2 Large-scale agile software development

The success of agile methods for small, collaborative teams has inspired use of it on large-scale projects (Dingsøyr & Moe, 2014). Increasingly, large organizations are trying to take advantage of the benefits that agile development offers on a small scale (Bick et al., 2018). In particular, workforce flexibility and adaptability represent significant improvements compared to traditional work methods (Bick et al., 2018). Based on the definition of Dingsøyr & Moe (2014), large-scale ASD is defined in this study as:

> *Agile development initiatives involving more than two teams.*

While agile has become established as the gold standard for small teams developing software, implementing agile on a larger scale is perceived as challenging (Dingsøyr & Moe, 2014). Adopting agile methods and practices on a larger scale entails challenges and difficulties, such as maintaining a larger number of stakeholders, additional complexity in coordination activities, and increasing difficulties in structural integration (Badampudi et al., 2013; Boehm & Turner, 2005; Paasivaara & Lassenius, 2014). A deeper understanding of these challenges is key to harnessing the benefits of agile in large-scale settings (Kettunen & Laanti, 2008). In general, small-scale agile methodologies, such as Scrum, are not easily transferable to larger projects because preferences and priorities between multiple

teams have a tendency to vary significantly (Vlietland & van Vliet, 2015). In addition, the internal coordination of large numbers of tasks and individuals is both logistically and cognitively overwhelming for team members (Badampudi et al., 2013). Furthermore, stakeholders expect different process requirements with larger and thus more costly and critical projects (Badampudi et al., 2013). As a result, organizational decisions can rarely be made at the team level because their limited time and interaction with the customer (Edison et al., 2021; Kettunen & Laanti, 2008).

Various practices and frameworks to scale agile have been proposed over the years. One of the first practices to address the scaling problem that has been described is the Scrum of Scrums (Bick et al., 2018). This is a scaled form of the daily stand-up meeting where smaller teams are represented by their ambassador addressing the same items as the daily meeting of a single team (Bick et al., 2018). Another best practice provided in literature, to address the scaling problems, is communities of practice. A community of practice (CoP), which is an informal group of experts who want to share and deepen their knowledge on a common topic, has proven to be an important success factor in supporting knowledge management and coordination in large-scale ASD (Bick et al., 2018; Paasivaara, 2017). In addition to these practices, a number of frameworks have been proposed in the literature to adapt agile development to a larger scale. Examples of these frameworks include Large Scale Scrum (LeSS), the Scaled Agile Framework (SAFe), Scrum-at-scale and the Spotify model (Edison et al., 2021). All of these frameworks attempt to provide guidance for large organizations looking to scale agile by offering specific principles, roles and practices (Bick et al., 2018). The implementation of large-scale methods has been proven to be very challenging, with a few successful implementations till 2017 (Paasivaara, 2017). These scaled-up methods are struggling to deal with the exponentially large complexities and interdependencies of large-scale development (Edison et al., 2021).

2.3 Effective inter-team collaboration in large-scale agile software development

Several studies suggest that the interchangeably used constructs coordination, cooperation, teamwork and collaboration, are all needed in- and between teams in large-scale ASD (Bick et al., 2018; Boehm & Turner, 2005; Dingsøyr & Moe, 2014; Gustavsson, 2020; Scheerer et al., 2014; Stray et al., 2019; Strode, 2016). According to Bedwell et al. (2012) coordination refers to the sequence of interdependencies to accomplish work tasks as efficiently as possible, where reciprocity is not a requirement compared to collaboration. Cooperation refers to two party interaction, which is an attitudinal construct that helps to facilitate the process of collaboration (Bedwell et al., 2012). Teamwork refers to interdependent team activities that orchestrate taskwork in the teams interests of a common goal and can be described as instantiation for collaboration (Bedwell et al., 2012). In this way, coordination, cooperation and teamwork are conceptualized as requirements for effective collaboration. Bedwell et al. (2012) considered collaboration as a superordinate construct, which includes and overlaps the aforementioned constructs, which is visualized in Figure 1. The construct collaboration is explained in the following.

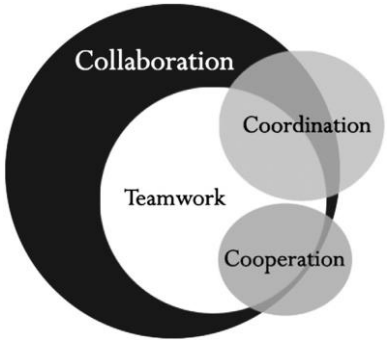

Figure 1. Shared criterion space among collaboration and related constructs (Bedwell et al., 2012)

Bedwell et al. (2012) defines collaboration as an evolving process whereby two or more social entities actively and reciprocally engage in joint activities aimed at achieving at least one shared goal. Bedwell et al.'s definition was used as the foundation for defining effective inter-team collaboration. The chosen constructs are implemented in their definition because of the following. The definition of collaboration is noted as a process because it is dynamic and evolving, not a prescribed state of relationships (Bedwell et al., 2012). Furthermore, collaboration requires mutual engagement in the collaborative process and cannot be one-sided, which explains the inclusion of reciprocity in the definition (Bedwell et al., 2012). The process of collaboration occurs only if the involved parties have at least one mutually correspondingly defined goal, otherwise there is no reason for the parties to collaborate at all (Bedwell et al., 2012). With clarification of the construct collaboration, the explanation of inter-team collaboration follows.

Inter-team collaboration is perhaps the most important lever for achieving high quality, efficient and effective software engineering practices in almost every software developing organization (Bosch & Bosch-Sijtsema, 2010). In addition, inter-team collaboration is recognized as a significant predictor of organizational effectiveness (Cha et al., 2015). Within companies where teams function interdependently with other organizational teams, inter-team collaboration is seen as a critical performance driver (Cha et al., 2015; Drach-Zahavy & Somech, 2010). Inter-team collaboration is defined as the degree of collaboration of a team with other teams in a company, where teams are interdependent with respect to operational functioning and the pursuit of overarching organizational goals (Cha et al., 2015). With the clarification of the constructs collaboration and inter-team collaboration, the explanation of effective inter-team collaboration follows.

Achieving effective inter-team collaboration, however, has proven to be a major challenge in many organizations, which results in failed or late projects, products or systems not aligned with customer requirements, clashes between the R&D department and the rest of the company, etc. (Bosch & Bosch-Sijtsema, 2010). Bosch & Bosch-Sijtsema (2010) considered inter-team collaboration to be effective when it generates minimal overhead for the organization to achieve and maintain their desired level while avoiding these problems. Therefore, in this study, based on the definitions of constructs described above, effective inter-team collaboration is formulated and defined as:

An evolving process in which two or more teams actively and reciprocally engage in joint tasks and depend on each other with respect to operational functioning and the pursuit of at least one overarching organizational goal, with minimal overhead for the organization to achieve and maintain their desired level (Bedwell et al., 2012; Bosch & Bosch-Sijtsema, 2010; Cha et al., 2015).

An example indicating the importance of inter-team collaboration is the loss of the Mars climate orbiter satellite in 1999 (Shuffler & Carter, 2018). Several teams shared the common goal of getting the spacecraft into space to obtain information about the climate and the ground. The mishap investigation report notes that the following factors contributed the multiteam system goal failure: Inadequate inter-team communication (process loss), inter-team differences regarding measurement, inadequate inter-team training, inadequate inter-team coordination during transition periods, and limited boundary-spanning mechanisms for inter-team quality checks and validation (Shuffler & Carter, 2018).

Agile was originally intended for autonomous teams so its implementation on a large scale results in a challenge for the organization to keep inter-team collaboration effective (Dingsøyr, Bjørnson, et al., 2018). Some even highlight inter-team coordination as the most prominent challenge in scaled agile (Bick et al., 2018; Gustavsson, 2017; Soderqvist et al., 2019). The literature identified several factors that affect the effectiveness of inter-team collaboration. For example, Evbota et al. (2016) found that planning is a major factor due to unclear requirements, unclear role of operational product owner and unbalanced involvement of teams. Another example is provided by Uludag et al. (2018) who categorized

challenges in large-scale agile development . For example, synchronizing sprints in the large-scale agile development program, and explaining requirements to stakeholders belong to the factor ‘communication and coordination’ (Uludag et al., 2018). It is important to overcome these challenge because successful implementation of agile practices on a large scale has been shown to positively impact the organization (Badampudi et al., 2013).

In addition to analyzing the factors, effective inter-team collaboration in a large-scale ASD setting is approached from a theoretical perspective, and best practices are prescribed to reduce the probability that those obstacles occur. Bick et al. (2018) has found in their theoretical approach that a lack of dependency awareness is a key explanation of ineffective inter-team coordination. This lack of dependency awareness emerges from misaligned planning activities of specification, prioritization, estimation and allocation between teams (Bick et al., 2018). Stray et al. (2019) provided 20 different best practices to improve the effectiveness of inter-team collaboration in large-scale ASD and argues that Scrum of Scrums, Team leader meetings, Daily Stand-ups, Ad hoc conversations, Communication tools, Kanban board and Open Work Area are the best practices to manage as many dependencies as possible. This glimpse into the literature revealed the identified diverse factors and best practices, indicating the fragmented and disjointed nature of the field.

The literature identified several factors and best practices that influence the effectiveness of team collaboration in large-scale agile software development (ASD). The scattered, exploratory and underdeveloped state of academic knowledge leaves both academics and practitioners deprived of a coherent and evidence-based overview to guide their reasoning about effectively managing inter-team collaboration in large-scale ASD. To gain this coherent and evidence-based overview, this study conducted a systematic literature review. The methodological approach of this systematic literature review is elaborated in the next section and the results are provided in chapter results.

3. Research methodology

3.1 Systematic literature review

A systematic literature review can be explained as a systematic, explicit, comprehensive, and reproducible method for identifying, evaluating, and synthesizing the existing body work produced by researchers, scholars, and practitioners (Okoli & Schabram, 2010). The purpose of a systematized literature review is to understand, by reviewing relevant literature, the breadth and depth of existing work. The validity and quality of existing work can be evaluated as well as revealing weaknesses, inconsistencies, and contradictions (Paré et al., 2015). The aim of the systematic literature review is to answer the second research question of this study. SQ 2 is formulated as, "*What factors, that affect effectiveness of inter-team collaboration in large-scale agile software development, can be identified in literature?*"

The systematic literature review is supported by the methodology provided by Xiao & Watson (2019). They argue that a successful systematic literature review involves three main phases: planning the review, conducting the review, and reporting the review. In the planning phase, the purpose of the review is ascertained, research questions are specified, and a review protocol is established. Conducting the review involves selecting primary studies, collecting data, analyzing data, and synthesizing the data. When reporting the review, the findings from the literature review are reported. This methodology is selected because the study is designed to provide guidance in conducting a systematic literature review and builds on a synthesis of known methodologies for systematic literature reviews. The following section outlines the first phase of the systematic literature review, the planning phase.

3.1.1 Planning the review

In the planning phase, the purpose of the systematic literature review is identified by drafting a research question. In addition, the review protocol is established that will be used when conducting the systematic literature review (Xiao & Watson, 2019). To identify the factors that affect effective inter-team collaboration in large-scale agile software development (ASD), I conducted a literature search in the following online academic databases: ProQuest, Scopus, and Web of Science. This research relied on five core constructs, namely 'inter-team', 'collaboration', 'large-scale', 'agile' and 'software development' in a variety of combinations. I created the following search string to find relevant literature concerning factors and best practices that affect the effectiveness of inter-team collaboration in a large-scale ASD environment.

('inter-team' OR 'multiteam' OR 'multidisciplinary') AND ('cooperation' OR 'collaboration' OR 'coordination' OR 'teamwork' OR 'management' OR 'communication' OR 'managing') AND ('large-scale' OR 'extensive' OR 'scaling') AND ('agile' OR 'scrum') AND ('software development' OR 'application development' OR 'software project management' OR 'software engineering')

Next, the obtained results were scanned to see whether they were valuable for this review. To obtain the most recent relevant literature, only literature published between 2010 and the present was selected (Dingsøyr & Moe, 2014). Agile software development is a rapidly growing environment making it important to obtain recent findings from the literature. I used the following inclusion criteria to determine whether an article should be included or not:

- Year of publication: 2010 – now
- Language: English
- Topic: Must address at least one factor or best practice that affect effective inter-team collaboration (or synonym) in large-scale agile software development

Finally, I used the snowballing method. Snowballing refers to using the reference list of a paper to identify additional relevant titles (Wohlin, 2014). To ensure the relevance and quality of the identified literature, these sources were also checked using the same set of inclusion criteria as described above.

3.1.2 Conducting the review

The results of the review process are shown as flow diagram in figure 2.

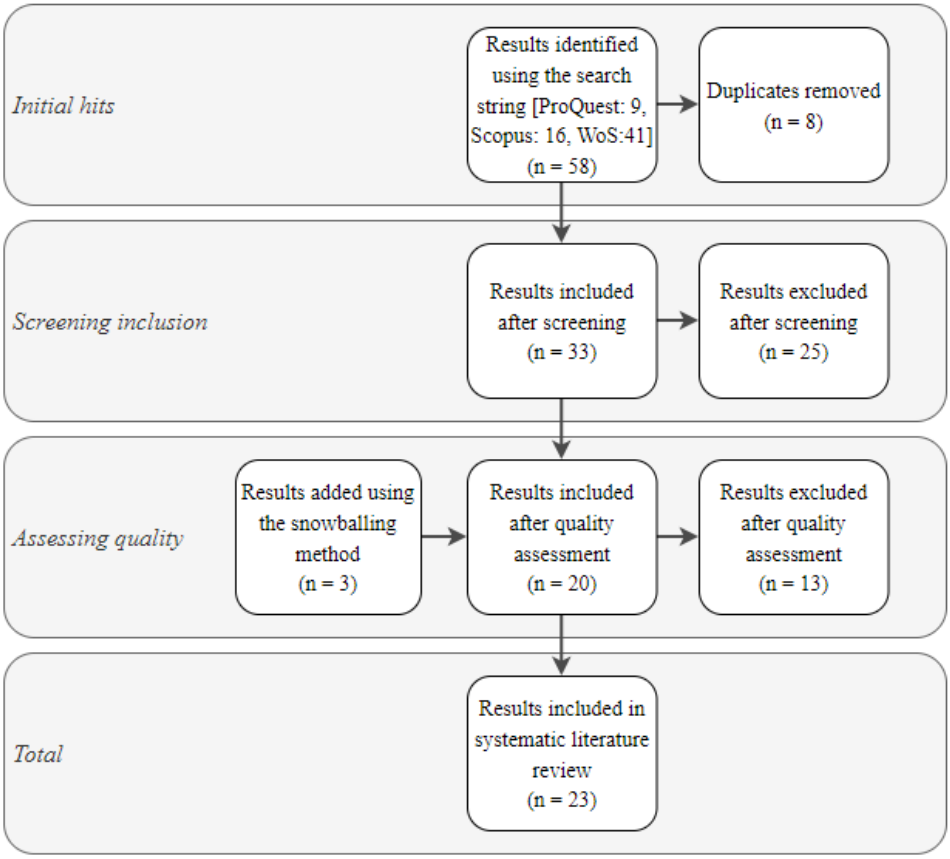

Figure 2. Systematic literature review process

As can be seen in figure 2, for each bibliographic database the number of relevant results decreases, making the increasingly specific filters described in the planning review visualizable. Interestingly, the search string produces a limited range of literature. A final note is that some of the sources were retrieved from more than one database, resulting in higher results per database. Ultimately, the search string generated 23 uniquely relevant pieces of literature.

Subsequently, I used the snowball method to find additional relevant literature. The snowball method provided three additional sources that were not found in the primary search. The final list of literature that was included in the literature review is shown in Table 1.

Table 1. Final selection included literature

	Author(s)	Year	Title	Type of article	Source
1	Berntzen., Stray, Moe	2021	Coordination strategies: managing inter-team coordination challenges in large-scale agile	*Case study*	*International Conference on Agile Software Development*
2	Bick, Scheerer, Spohrer	2016	Inter-team coordination in large agile software development settings: Five ways of practicing agile at scale	*Multiple case study*	*Proceedings of the Scientific Workshop Proceedings of XP2016*
3	Bick, Spohrer, Hoda, Scheerer, Heinzl	2018	Coordination Challenges in Large-Scale Software Development: A Case Study of Planning Misalignment in Hybrid Settings	*Case study*	*IEEE Transactions on Software Engineering*
4	Bjarnason, Gislason Bern, Svedberg	2022	Inter-team communication in large-scale co-located software engineering: a case study	*Case study*	*Empirical Software Engineering*
5	Bjørnson, Vestues	2016	Knowledge sharing and process improvement in large-scale agile development	*Comparative case study*	*Proceedings of the Scientific Workshop Proceedings of XP2016*
6	Bjørnson, Wijnmaalen, Stettina, Dingsøyr	2018	Inter-team coordination in large-scale agile development: A case study of three enabling mechanisms	*Case study*	*International Conference on Agile Software Development*
7	Christopher, De Vries	2020	Selecting a scaled agile approach for a fin-tech company	*Case study*	*South African Journal of Industrial Engineering*
8	Crowston, Chudoba, Watson-Manheim, Rahmati	2016	Inter-team coordination in large-scale agile development: A test of organizational discontinuity theory	*Mixed-method study*	*Proceedings of the Scientific Workshop Proceedings of XP2016*
9	Dingsøyr, Moe	2014	Towards principles of large-scale agile development	*Workshop*	*International Conference on Agile Software Development*
10	Dingsøyr, Moe, Seim	2018	Coordinating knowledge work in multiteam programs: findings from a large-scale agile development program	*Case study*	*Project Management Journal*
11	Dingsøyr, Moe, Fægri, Seim	2018	Exploring software development at the very large-scale: a revelatory case study and research agenda for agile method adaptation	*Case study*	*Empirical Software Engineering*
12	Evbota, Knauss, Sandberg	2016	Scaling up the planning game: Collaboration challenges	*Case study*	*International Conference on Agile Software Development*
13	Figalist, Elsner, Bosch, Olsson	2019	Scaling agile beyond organizational boundaries: coordination challenges in software ecosystems	*Case study*	*International Conference on Agile Software Development*
14	Gustavsson	2019	Changes over time in a planned inter-team coordination routine	*Empirical field study*	*International Conference on Agile Software Development*
15	Gustavsson	2020	Inter-team Coordination in Large-Scale Agile Software Development Projects	*Thesis*	*Doctoral dissertation, Karlstads universitet*
16	Martini, Pareto, Bosch	2013	Improving businesses success by managing interactions among agile teams in large organizations	*Multiple case study*	*International Conference of Software Business*
17	Moe, Dingsøyr, Rolland	2018	To schedule or not to schedule? An investigation of meetings as an inter-team coordination mechanism in large-scale agile software development	*Multiple case study*	*International Journal of Information Systems and Project Management*
18	Nyrud, Stray	2017	Inter-Team Coordination Mechanisms in Large-Scale Agile	*Case study*	*Proceedings of the XP2017 scientific workshops*
19	Paasivaara, Lassenius, Heikkilä	2012	Inter-team coordination in large-scale globally distributed scrum: Do scrum-of-scrums really work?	*Multiple case study*	*Proceedings of the ACM-IEEE international symposium on Empirical software engineering and measurement*
20	Santos, Goldman, Martins, Cortés	2014	The influence of organizational factors on inter-team knowledge sharing effectiveness in agile environments	*Multiple case study*	*47th Hawaii International Conference on System Sciences*
21	Scheerer, Hildenbrand, Kude	2014	Coordination in large-scale agile software development: A multiteam systems perspective	*Theory based research*	*47th Hawaii International Conference on System Sciences*
22	Stray, Moe, Aasheim	2019	Dependency management in large-scale agile: a case study of DevOps teams	*Case study*	*52th Hawaii International Conference on System Sciences*
23	Uludag, Kleehaus, Caprano, Matthes	2018	Identifying and structuring challenges in large-scale agile development based on a structured literature review	*Structured literature review*	*IEEE 22nd International Enterprise Distributed Object Computing Conference*

After identifying and selecting relevant literature, the next step was to analyze and synthesize the literature found. In conducting the analysis, I first read all literature sources in detail. After reading all literature sources, I reviewed the sources for a second time. During this second review, I maintained two documents, one for factors and one for best practices, in which text and explanation of the respective source was added for each of the identified factor and best practice. As such, both documents had multiple factors and best practices derived from the selected literature.

In the next step, the synthesis, the documents containing the identified factors and best practices were analyzed to find strong similarities or overlaps. This process was repeated until I had an ultimate distribution and overlapping content of the different sources for each factor and best practice. As a final step, the content of each of the sources was combined for each factor and best practice. Regarding the nomenclature of the factors and best practices, I chose whatever best represented the content. Thus, the nomenclature may differ from that in the literature.

The findings of the systematic literature review are reported in the chapter results. The identified factors and best practices that affect the effectiveness of inter-team collaboration in large-scale ASD are presented herein.

3.2 Interviews

As described in the introduction, CM.com wants to gain insights about the effectiveness of inter-team collaboration within their R&D department. To gain in-depth information about the effectiveness of inter-team collaboration, a qualitative method is chosen. In this study semi-structured interviews with practitioners are conducted. The semi-structured approach was chosen because it provides more flexibility during the interviews, which enabled the possibility to dive deeper in certain topics (Rowley, 2012). This study also used field research and unofficial conversations with practitioners to gain additional details about the current situation of inter-team collaboration within CM.com's R&D department. The aim of conducting interviews is to answer the third research question of this study. SQ 3 is formulated as, *"What affects the effectiveness of inter-team collaboration within the R&D department of CM.com?"*. This section details the methodological considerations of the semi-structured interviews.

3.2.1 Participants

Selecting the potential participants is done by asking the question: Who is in a position to answer the questions or to provide the insights (Rowley, 2012)? This method of sampling is called 'purposive sampling' in which participants were selected based on the judgement of the researcher. This judgement is based on my opinion, because I believe that the chosen participants provided the best information to answer the research question (Etikan, 2017). In addition, the 'snowball sampling' method is used whereby at the end of the interview, people are asked to recommend other potential interviewees within CM.com (Rowley, 2012). Given the purpose of the study, it is important to collect insights about the collaboration with other teams working in large-scale ASD. I chose to include each role within a team in this research in order to gain insights from all perspectives. By interviewing only product owners or lead developers, a distorted picture could emerge. A total of four product owners, five developers and three managers are selected within the R&D department. Table 2 presents an overview of the interviewee sample. The teams at the case company consist of developers and a product owner. The developers are distinguished by experience and skills into 'junior developers', 'medior developers', 'senior developers', 'principal developers' or 'lead developers'. Every business unit, consisting of multiple teams, is managed by a 'group lead'. In addition, product owners who have a broader range of responsibilities are called managers.

Table 2. Table of participants

Nr.	Title	Business-unit	Team	Date
1.	Product owner	CPaaS	Channels one	5/7/2022
2.	Principal developer	Core platform	E-commerce	6/7/2022
3.	Lead developer	Online payments	PSP	12/7/2022
4.	Product owner	SaaS	Mobile marketing cloud	13/7/2022
5.	Lead developer	CPaaS	Messaging apps	19/7/2022
6.	Senior product manager	Online payments	Central	27/7/2022
7.	Developer	CPaaS	Channels one	27/7/2022
8.	Developer	Online payments	Point of sale	27/7/2022
9.	Quality & delivery manager	Core platform	PaaS	29/7/2022
10.	Senior product owner	SaaS	CAIC	2/8/2022
11.	Product owner	Ticketing	Global ticket	3/8/2022
12.	Senior product manager	Core platform	E-commerce	9/8/2022

3.2.2 Interview protocol

The interviews were prepared by adapting the four-phase protocol used by Castillo-Montoya, (2016) including: (1) ensuring that interview questions align with the research question, (2) constructing an inquiry-based conversation, (3) receiving feedback on interview protocols, and (4) piloting the interview protocol. To shape the interview protocol towards an inquiry-based conversation, Castillo-Montoya (2016) recommended to include in the interview protocol introductory questions, transitions to the key questions, and a conclusion with simpler questions.

The interview protocol was structured by the following. I started the interviews with a personal introduction. This was followed by an introduction of the research and matters of confidentiality concerning the information. Consent to record the interviews was also asked. Next, I asked for background information of the interviewee and his or her team. Then I asked if the interviewee agreed with the definition of effective inter-team collaboration to create concept alignment. This contributes to the reliability of the obtained information. Next, I asked for factors that interviewees thought should affect the effectiveness of inter-team collaboration. For this question, the factors previously identified in the literature were not yet named, as this might influence the interviewees. To substantiate the factors the interviewees named, they were asked to provide explanations and examples. Next, the factors that the interviewees had not named yet, but were identified by the literature, were discussed. Again, explanations and examples were requested. Additionally, the interviewees were asked for possible additional insights that could improve the effectiveness of inter-team collaboration within CM.com. Before concluding the interviews, the interviewees was asked to share additional relevant information that had not been mentioned yet and to recommend other potential candidates to interview. Based on the open exploration and the guidance of the identified factors in the literature, insights were generated for answering SQ 3. The final interview protocol can be found in Appendix B.

3.2.3 Conducting interviews

Prior to conducting the interviews, the interview protocol mentioned above was sent to the participants. This provided an opportunity for the participant to prepare the interview. The definition of effective inter-team collaboration was deliberately extracted from this interview in order to first identify any prior thoughts the interviewees had. Moreover, it was up to the participant to choose in which language, English or Dutch, the interview was conducted. Using the protocol as a guide, I conducted the interviews in an informal manner. The interviews took place physically at different locations in the Netherlands. In doing so, possible unexpected directions were explored with follow-up questions and interviewees had time to explain their perceptions. The interviews lasted 50 minutes on average and took place from 05-07-2022 to 09-08-2022. In total, data was collected from 12 interviews.

3.2.4 Data analysis

Qualitative data analysis involves the identification of categories and themes in data and the relationship between them to better understand the phenomenon that is studied (Hilal & Alabri, 2013). In order to convert the voice recordings of the interviews into transcripts, the collected data is transcribed. An online speech-to-text conversation software, called Trint, is used for the transcription process (*Trint*, n.d.). After using this software, the transcriptions are checked manually by listening to and correcting the transcripts if necessary. Once the transcripts were ready and analyzed for insights thoroughly, the coding of the data started. To facilitate the coding and data analysis process, a qualitative data analysis software package called NVivo is used (NVivo, 2022).

3.2.4.1 Deductive data analysis

In this research, the template approach is used to gain insights regarding the factors identified in the existing literature. The template approach has a theory-driven focus and uses a fixed, predefined coding scheme, which is applied on the generated qualitative data (Blair, 2015). The literature review acted as the basis for the coding scheme and is applied to the transcripts. The parts of the transcript are coded that correspond to previously identified factors affecting the effectiveness of inter-team collaboration in large-scale ASD. The final coding scheme of the coding process can be found in Appendix C. Interview transcripts containing new factors are left uncoded, because they do not match the predefined codes and are approached by the method described below.

3.2.4.2 Inductive data analysis

The new factors the interviewees provided are analyzed using a method proposed by Gioia et al. (2013). This method consists of a first phase, called the "1st order concepts", a second phase, called the "2nd order themes", and a third phase, called the "aggregate dimensions". During the 1st order concepts phase, I attempt to categorize the perspectives based on the words that the interviewees used. In the 2nd order themes phase, I refined the 1st-order codes by merging codes with similar content, splitting codes that contained multiple insights, and removing codes that were not appropriate for analysis. These different concepts are combined to generate specified factors. In the third phase, the factors are combined, on further reflection, to form the aggregate dimension. Once all of these phases were executed, a data structure was generated (Gioia et al., 2013). This coding scheme structure visualizes the data analysis process of this study. The resulting coding scheme can be found in Appendix E. Next, the Gioia method advocates to compare the relevant literature with the identified factors and sub-factors to determine whether new concepts have actually emerged (Gioia et al., 2013). Interestingly, all factors and sub-factors identified in the inductive analysis are considered new, in regard to effective inter-team collaboration in large-scale ASD. The novelty of the factors will be further discussed in the chapter discussion.

A side note is that in both the inductive and deductive analyses, the views of the interviewees were not weighted differently in case of differences in level of experience or position.

4. Results

4.1 Factors originating from literature

This first section presents the factors that affect the effectiveness of inter-team collaboration in large-scale agile software development (ASD) that have been identified in the existing literature. This section provides an overview and synthesis of all the available knowledge I was able to gather about the factors. Table 3 provides an overview of the identified factors and subfactors.

Table 3. Factors and subfactors identified in selected literature

Factors	Sources
1. Inter-team dependencies	(Berntzen et al., 2021; Bick et al., 2016, 2018; Christopher & de Vries, 2020; Evbota et al., 2016; Gustavsson, 2020; Stray et al., 2019; Uludag et al., 2018)
Dependency awareness	(Berntzen et al., 2021; Bick et al., 2018; Bjarnason et al., 2022; Christopher & de Vries, 2020; Martini et al., 2013)
2. Planning alignment	(Berntzen et al., 2021; Bick et al., 2018; Dingsøyr, Moe, Fægri, et al., 2018; Evbota et al., 2016; Figalist et al., 2019; Gustavsson, 2020)
Task prioritization	(Berntzen et al., 2021; Bick et al., 2018; Evbota et al., 2016; Figalist et al., 2019; Gustavsson, 2020; Martini et al., 2013)
Task specification	(Bick et al., 2018; Dingsøyr, Moe, Fægri, et al., 2018; Evbota et al., 2016)
Task estimation	(Bick et al., 2018; Evbota et al., 2016)
Task allocation	(Bick et al., 2018)
3. Knowledge sharing	(Berntzen et al., 2021; Bjørnson & Vestues, 2016; Dingsøyr, Moe, & Seim, 2018; Dingsøyr & Moe, 2014; Evbota et al., 2016; Martini et al., 2013; Santos et al., 2014; Uludag et al., 2018)
Knowledge accessibility	(Evbota et al., 2016; Martini et al., 2013)
4. Communication	(Berntzen et al., 2021; Bjornson et al., 2018; Crowston et al., 2016; Evbota et al., 2016; Figalist et al., 2019; Martini et al., 2013; Santos et al., 2014; Scheerer et al., 2014; Uludag et al., 2018)
Communication style	(Martini et al., 2013; Nyrud & Stray, 2017; Scheerer et al., 2014)
Interaction frequency	(Bjarnason et al., 2022; Martini et al., 2013; Moe et al., 2018)
5. Team autonomy	(Berntzen et al., 2021; Christopher & de Vries, 2020; Dingsøyr, Moe, & Seim, 2018; Gustavsson, 2020; Uludag et al., 2018)
Decision making	(Bjornson et al., 2018; Dingsøyr, Moe, & Seim, 2018; Dingsøyr & Moe, 2014; Uludag et al., 2018)
6. Personal differences	(Bjarnason et al., 2022; Bjornson et al., 2018; Gustavsson, 2020; Martini et al., 2013; Uludag et al., 2018)
7. Clarity of roles and responsibilities	(Bjornson et al., 2018; Evbota et al., 2016; Gustavsson, 2020; Nyrud & Stray, 2017; Uludag et al., 2018)
8. Collaborativeness of organizational structure	(Dingsøyr, Moe, Fægri, et al., 2018; Dingsøyr & Moe, 2014; Martini et al., 2013; Scheerer et al., 2014; Uludag et al., 2018)
Geographical distribution	(Bjarnason et al., 2022; Martini et al., 2013; Uludag et al., 2018)
9. Collaborativeness of organizational culture	(Berntzen et al., 2021; Bjarnason et al., 2022; Martini et al., 2013; Uludag et al., 2018)
Trust	(Bjornson et al., 2018; Figalist et al., 2019; Scheerer et al., 2014; Uludag et al., 2018)

Table 3 lists all identified factors and subfactors. After the open exploration of factors, the interviewees were asked whether they recognized if the factor affects inter-team collaboration and could provide an example to illustrate this. The open exploration and the list of factors is used to illustrate how inter-team collaboration is managed at the R&D department of CM.com. The illustrations per factor are visualized by a deductive coding scheme, which is provided in Appendix C.

During the interviews, practitioners were asked to rate the inter-team collaboration with teams inside and outside their business unit on a scale of 1 to 10. The interviewed practitioners rated the inter-team collaboration with teams inside their business unit with an average score of 6.92. Inter-team collaboration with teams outside their business unit is rated with an average score of 6.54.

It is important to mention that some available insights about the factors are unevenly distributed which meant that some are covered more extensively than others. In addition, I synthesized and labeled the identified factors and best practices based on their content and my own assumptions. As a result, the labels of the identified factors and best practices may differ from those in the literature in some cases. Finally, this section identified the factors that influence the effectiveness of team collaboration, it does not examine which factor is more impactful in this regard. In the following, the identified factors and subfactors are addressed in more detail.

4.1.1 Factor 1: Inter-team dependencies

The first factor affecting inter-team collaboration in large-scale ASD I identified in the selected literature is inter-team dependencies (Berntzen et al., 2021; Bick et al., 2016, 2018; Christopher & de Vries, 2020; Evbota et al., 2016; Gustavsson, 2020; Stray et al., 2019; Uludag et al., 2018). Inter-team dependency in large-scale companies occurs when the output of one team is required as input for another team's work or vice versa (Berntzen et al., 2021). Scaling up ASD implies that more and new dependencies arise (Berntzen et al., 2021). These dependencies arise, for instance, because different software components from different teams need to interact (Berntzen et al., 2021). The effective coordination of these dependencies becomes critical for the success of the company (Stray et al., 2019). The study of Bick et al. (2016) mentioned the effectiveness of applying proactive inter-team dependency management for the organization, especially for teams working on more integrated and tightly coupled products. In addition, effective coordination of inter-team dependencies provides overview and transparency within the organization (Berntzen et al., 2021; Gustavsson, 2020). Interviewee 5 illustrates this importance by stating: "*If you are transparent what it is going to happen at that moment and that they are depending on you until that moment, that is going to make a huge difference*". To conclude, literature proves that effective management of inter-team dependencies positively affects the effectiveness of inter-team collaboration in large-scale ASD (Berntzen et al., 2021; Bick et al., 2018; Christopher & de Vries, 2020; Evbota et al., 2016; Martini et al., 2013; Uludag et al., 2018).

According to the literature, dependencies between teams can be classified into three different types of dependencies. The first type is knowledge dependency which occurs when team members need information from another team about a requirement, task, technical information or past decision (Berntzen et al., 2021; Stray et al., 2019). Knowledge dependencies emerge in the large-scale organization since more information is needed across teams (Berntzen et al., 2021). A practical example of this category is given by interviewee 4: "*Then you miss some information which makes it not so nice to work together*". The second type is process dependency which occurs when a team needs a finished task of another team to complete their production process (Berntzen et al., 2021; Stray et al., 2019). process-related dependencies arise in large-scale development because development activities must be completed across teams for integrations (Berntzen et al., 2021). A practical example of this category is given by interviewee 8: "*Of course, depending on each other can also be a pitfall when you're really waiting on each other and you can't go any further, because that team still has to finish something".* The final type is resource dependency which can block the workflow of a team when a required resource from another team is not available yet (Berntzen et al., 2021; Stray et al., 2019). A practical example of this category is given by interviewee 11: "*it is busy on all fronts, on all fronts more resources would be really welcome from either development side or the product side*". The selected literature provides a subfactor of inter-team dependency which is addressed next.

4.1.1.1 Dependency awareness

The subfactor that I identified in the literature is dependency awareness (Berntzen et al., 2021; Bick et al., 2018; Bjarnason et al., 2022; Christopher & de Vries, 2020; Martini et al., 2013). Dependency awareness refers to the identified, acknowledged, and established shared understanding of the existence of dependencies and potential resulting alignment issues between teams (Bick et al., 2018).

Dependencies of which people are unaware, also called unidentified dependencies, can cause problematic situations for inter-team collaboration such as blockages between teams, escalations in the middle of a sprint or delays (Bick et al., 2018; Martini et al., 2013). Interviewee 10 illustrates the consequence of an unidentified dependency by stating: "*They depend sometimes on the performance of our system in order to ensure the performance of their system. And you need to be aware of that, because that went wrong once*". Empirical studies suggest that dependency awareness affects inter-team communication and inter-team coordination positively (Bick et al., 2016; Bjarnason et al., 2022) which enhances the collaboration process.

The exploratory case study of Bjarnason et al. (2022) suggests that dependency awareness is negatively affected by cognitive distance (i.e. differences in domain knowledge). When there is a large cognitive distance (e.g. between software development teams and legal teams) it requires additional effort to ensure uniform understanding (Evbota et al., 2016). Interviewee 6 illustrates this by stating: "*They had their own little world and their own ecosystem. Now it's slowly starting to become more unified, but that takes time. But you still see that there is a lack of understanding and that people don't understand things from each other or don't want to understand*". Having awareness of cognitive distance of other teams can reduce the likelihood of misunderstandings (Bjarnason et al., 2022). Also physical proximity of teams (e.g. same building or adjacent buildings) positively affects dependency awareness because it is easier to get into contact with the other team (Bjarnason et al. 2020). In the following, the impact of inter-team dependencies on inter-team collaboration is illustrated at CM.com.

Inter-team collaboration and inter-team dependencies at CM.com

CM.com possesses a wide range of products which are researched and developed in six different business units. CM.com strives to offer a full suite of conversational commerce solutions to stay ahead of their competitors. This full suite of conversational commerce requires many integrations of the various products. Because of the large amount of integrations, many teams depend on each other. The inter-team dependencies in the R&D department of CM.com are visualized in figure 5 and 6. These figures are generated using the UCINET software. Every team in the R&D department is asked to mention on which teams they depend on in order to operate effectively. This information is obtained from the relevant product owners or team lead of each team. In addition, the information were validated by the group leads of the business units. This data is visualized in the inter-team dependency matrix, which is attached in Appendix D. Most product owners and team leads were aware of their inter-team dependencies, however, a number of adjustments were made by the group leads which indicates unawareness of their dependencies.

In figure 5, the inter-team dependency is visualized by having the node size determined by the amount of incoming dependencies. In other words, the output of teams with a larger node is required for the input of more teams compared to teams with a smaller node. As can be seen in figure 5, many teams depend on the teams IT, Order to Invoice and E-commerce, which are part of the Core Platform business unit. This high amount of dependencies means that these teams are significant for the overall inter-team collaboration process. In addition, it is noteworthy that Tracedock has no incoming dependencies. This suggests that Tracedock's output is not required by other teams.

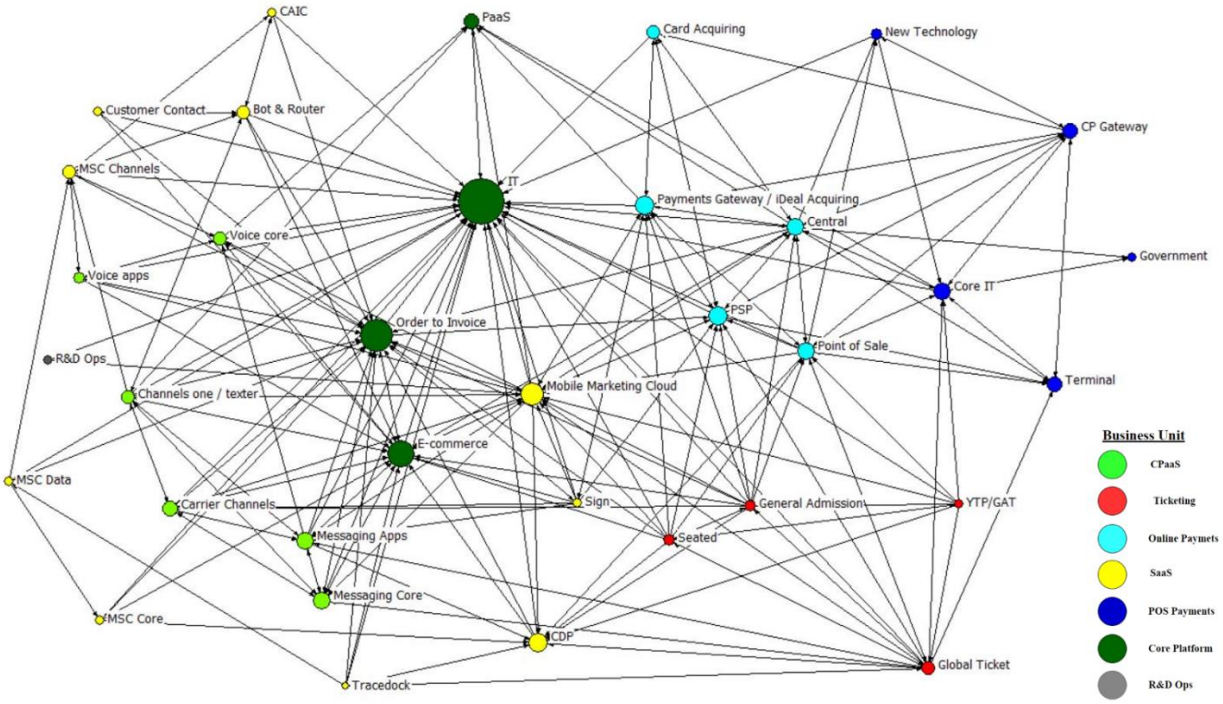

Figure 3. Visualization inter-team dependencies matrix with node size based on incoming dependencies at CM.com

In figure 6, the dependency between teams is visualized by having the size of the node determined by the amount of outgoing dependencies. In other words, teams with a larger node are more dependent on the output of the other teams. As shown in figure 6, team Mobile marketing cloud, which is part of the SaaS business unit, and team Central, which is part of Online payments, are dependent on most of the teams in the R&D department. This high degree of dependency on other teams reveals the vulnerability of these teams. So for these teams it is particularly essential that dependencies are managed well and collaborations proceed efficiently.

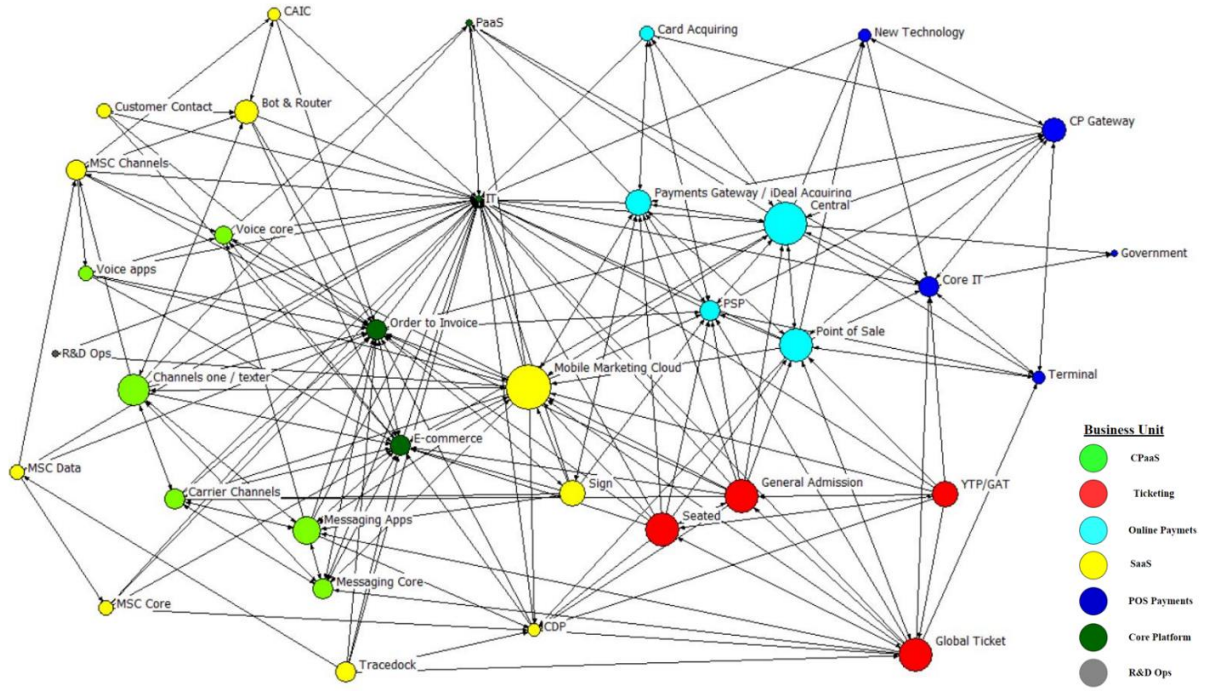

Figure 4. Visualization inter-team dependencies matrix with node size based on outgoing dependencies at CM.com

The inter-team dependencies matrix was analyzed by applying the ratio approximation. The ratio approximation measures how the approximate solution compares to the optimal solution. In this approximation that is shown in table 4, the inter-team dependencies are divided into inter-team dependencies within the business unit and inter-team dependencies with the entire R&D department. As expected, the inter-team dependency ratios are higher within the business unit. This was expected because within the business unit work is being done on components of the same product or on equivalent products. Noteworthy is the low inter-team dependency ratio in the SaaS business unit.

Table 4. Inter-team dependency ratios for the Business Units in the R&D department at CM.com

Business unit	Inter-team dependency ratio in Business unit	Inter-team dependency ratio in R&D department
CPaaS	0.50	0.20
Ticketing	0.75	0.31
Online payments	0.85	0.26
SaaS	0.16	0.18
POS Payments	0.55	0.12
Core Platform	0.42	0.11

It can be concluded from the interviews with practitioners that the lack of awareness of other teams' progress is a recurring problem within the organization. This is evidenced by the fact that teams are (almost) finished with their specific tasks while the relevant dependent teams are not informed or notified of this. Consequently, this creates delays that could have been avoided. Another problem at CM.com is that awareness of dependencies seems to arise only when something goes wrong, causing delays and uncertainty. Conversely, it is suggested by some practitioners to what extent one should be aware of each other's dependencies. Teams are responsible for delivering their components or products, and if other teams use them without further collaboration, awareness of dependencies is not top of mind. Given the problems mentioned above, it can be concluded that ineffective inter-team dependency management negatively affects the effectiveness of inter-team collaboration at CM.com.

4.1.2 Factor 2: Planning alignment

The second factor I discovered in the literature that affects inter-team collaboration in large-scale ASD is planning alignment (Berntzen et al., 2021; Bick et al., 2018; Dingsøyr, Moe, Fægri, et al., 2018; Evbota et al., 2016; Figalist et al., 2019; Gustavsson, 2020). Planning alignment is defined as the degree of coherence between prioritization, specification, estimation and allocation of tasks at the inter-team level (Bick, 2018). Planning alignment at inter-team level is in the literature frequently indicated as a major challenge for organizational operations such as inter-team collaborations (Berntzen et al., 2021; Bick et al., 2018; Dingsøyr, Moe, Fægri, et al., 2018; Evbota et al., 2016; Figalist et al., 2019; Gustavsson, 2020). Interviewee 5 illustrates this challenge by stating: "*You notice that the business units are separated by such a wide distance that in terms of planning, it's really complicated to reach an agreement. And that is also where you see that they have pushed three or four projects a month past the appointed deadline"*.

Literature argues that planning alignment is related to inter-team dependencies and dependency awareness (Berntzen et al., 2021; Bick et al., 2018). Bick et al. (2018) suggest that a misaligned planning correlates with unawareness of dependencies; and when there is no dependency awareness, coordination becomes inefficient. This is supported by the study of Berntzen et al. (2021) who found that misaligned planning negatively affected the coordination of technical dependencies between teams. And I observed the same at CM.com. Interviewee 1: *"Every product owner has their own roadmap with committed items because they believe they are important. So if you start a project that is less urgent for that owner, you will get a lack of priority from their team because they work on something else. So if you are dependent on that team, you may not get the speed of response or speed of cooperation that you would like".* So it

is important to align inter-team planning given the potential danger of planning misalignment on effective inter-team collaboration. Based on the selected literature, planning alignment between teams can be discerned in four sub-factors. These sub-factors are addressed next.

4.1.2.1 Task prioritizations

The first identified sub-factor that affects inter-team collaboration are prioritizations (Berntzen et al., 2021; Bick et al., 2018; Evbota et al., 2016; Figalist et al., 2019; Gustavsson, 2020; Martini et al., 2013). Prioritization refers to the process of deciding on the importance or urgency of a task. The autonomous teams in large-scale ASD have their own priorities. The divergence in priorities may cause a particular task to be stopped or postponed to prioritize something else with a higher priority, as a result other teams could be hampered and delayed (Berntzen et al., 2021; Bick et al., 2018; Evbota et al., 2016; Figalist et al., 2019; Gustavsson, 2020; Martini et al., 2013). This challenge arise due to the difficulty to achieve a shared vision in large-scale agile settings with many stakeholders (Evbota et al., 2016). A lack of clarity in the prioritization process is also noted by Berntzen et al. (2021). An example of this problem is illustrated by interviewee 4: "*I do think that the priorities are not the same everywhere. What is prioritized for us is obviously not a priority for another team therefore it is difficult to make agreements sometimes, whereas within SaaS those priorities are possibly a little closer together*". Literature proves that aligning prioritizations of collaborating teams is an important sub-factor towards effective inter-team collaboration.

Bick et al. (2018) analyzed the differences in prioritization between hierarchical levels in the organization. At the development team level, prioritization occurs through the product owner who uses his knowledge to prioritize sprints and reprioritize current backlog items (Bick et al., 2018). At the higher-level central team, a high-level prioritization is done based on their overall vision. This central team provides the development teams with an order of execution of the priorities (Bick et al., 2018). However, the issue identified is that important information is only available within the teams and not visible to other teams and the central team. This results in ineffective inter-team collaboration and misalignments (Evbota et al., 2016). A practical example is illustrated by: "*Sometimes , of course, you have things that are said from a higher level, this is what we are going to do. For example, there might be a big customer who wants to pay for something. That actually overrules your own planning"*. So the key is to properly align priorities from higher-level teams with the teams that actually address the priorities.

4.1.2.2 Task specification

The second sub-factor that affects alignment is specification of tasks (Bick et al., 2018; Dingsøyr, Moe, Fægri, et al., 2018; Evbota et al., 2016). This sub-factor refers to the degree of detail of tasks (Bick et al., 2018). The degree of detail is more fine-grained at the team level in terms of requirements and tasks, compared to teams at higher hierarchical levels (Bick et al., 2018). Furthermore, research suggests that the degree of specified details in software solution descriptions reduces gradually because people gain experience and knowledge over time, thus reducing their need for specification (Dingsøyr, Moe, Fægri, et al., 2018). Misalignment in specification can greatly affect estimation of tasks or projects and prioritization between teams because team members differ in their need for specification as they differ in knowledge and experience (Evbota et al., 2016). An example of this sub-factor is illustrated by interviewee 5: *"What you see a lot within CM is that something is agreed upon, which is not clarified at all. So a statement is made, mobile push as a channel is available for self-servicing via the channel system. Yes that sounds very clear, but then mobile push has to be implemented and that has certain details involved. And those details, they decide if you finish your project it in a month or in three months suddenly"*. Literature proves that aligning specifications between teams is an important sub-factor towards effective inter-team collaboration.

4.1.2.3 Task estimation

The third sub-factor I identified is task estimation (Bick et al., 2018; Evbota et al., 2016). Estimation of tasks is a planning activity using knowledge from previous iterations and experience (Evbota et al., 2016). According to research by Evbota et al (2016), it is extremely challenging to do long-term estimations. The fast pace and growth of the business leads to a significant amount of troubleshooting, which is difficult to foresee and affects the resources available during a sprint. Bick et al. (2018) found that inaccurate estimations can cause misalignment due to inaccurate top-down estimations of effort and a lack of feedback mechanisms for bottom-up estimation adjustments. Interviewee 8 illustrated this challenge by stating: *"Yes there could perhaps be a little more clarity in terms of planning, because it's always difficult to plan software development"*. Literature proves that accurate task estimation is an important sub-factor towards effective inter-team collaboration.

4.1.2.4 Task allocation

The fourth and final sub-factor I identified in the relevant literature is task allocation (Bick et al., 2018). Allocating tasks is a planning activity to divide tasks to individuals and teams based on capacity and individual expertise. Conversely, higher hierarchical teams are allocating their planning based on their vision and experience (Bick et al., 2018). It is important to allocate tasks to the most appropriate individual or team. Interviewee 10 illustrated the importance of allocation by stating: *"Which domain does that belong to, does it belong to us or to you? If that is clear, you can also collaborate more effectively"*. Literature proves that suitable task allocation is an important sub-factor towards effective inter-team collaboration. Next the relation between planning alignment and inter-team collaboration at CM.com is illustrated.

Inter-team collaboration and planning alignment at CM.com

Each development team within CM.com operates in an agile format where outstanding tasks for the next sprint are specified, prioritized, estimated and distributed through internal discussions. This is done alternately with the entire team or just the product owner and lead developer. If any new information or circumstances causes the initial schedule to be unrealistic, tasks are re-estimated. The allocation of tasks is usually based on the capabilities and expertise of each team member. The Product owners are responsible for the roadmaps and the day to day development of products. The roadmaps set out the vision of where the products should go. This vision is translated into smaller manageable tickets which are divided among team members. While creating the roadmap, teams need to make agreements with each other. Since June 2022, all roadmaps should be published on Monday (a project management platform) , however, most teams within CM.com have not published their roadmap yet. This is unfortunate because sharing roadmaps provides insight in the current and future projects of other teams which in turn enable insights into the capabilities other teams have.

The alignment between teams at CM.com frequently fails. Situations arise in which certain committed agreements in the planning are not fulfilled by teams. In such cases, the other team assigns priority to something else without discussing the matter. A difference in priority means that you do not get the speed of response or collaboration that you would like. To align teams within the business unit more effectively, most business units organize a scrum of scrum meeting once every two weeks. In this meeting the larger items are discussed in order to possibly address them together, because teams within the business unit usually work on the same product. In this meeting, the roadmap progress is discussed, incidents are reflected on, financial results are reviewed and critical questions are raised. A similar meeting, called the product alignment meeting, is held with all product owners and team leads within the entire R&D department. In this meeting, the focus is mainly on the content and progress of the roadmaps. A critical aspect of these meetings is that some teams have little professional overlap with each other, making it in some cases an unnecessarily important meeting. Given the current process of planning alignment between teams, certain improvements could be made at CM.com towards effective inter-team collaboration.

4.1.3 Factor 3: Knowledge sharing

The third factor I identified in literature that affects inter-team collaboration is knowledge sharing (Berntzen et al., 2021; Bjørnson & Vestues, 2016; Dingsøyr, Moe, & Seim, 2018; Dingsøyr & Moe, 2014; Evbota et al., 2016; Martini et al., 2013; Santos et al., 2014; Uludag et al., 2018). Santos et al. (2014) found that sharing knowledge between teams, strengthens the relationships and collaboration between people. By sharing information, the cognitive distance between teams will reduce and the awareness towards others improves. To share important knowledge, it is important to use appropriate channels to do so (Evbota et al., 2016). Knowledge channels are an easy way for developers to share knowledge and reach people they do not know (Berntzen et al., 2021). Interviewee 7 illustrates the use of knowledge channels: "*We have some documentation and wiki systems internally. That's mainly how we share knowledge within the company and within CPaaS".*

The importance of knowledge sharing is evident in the principles for large-scale agile development established by Dingsøyr & Moe (2014). The principle states that effective knowledge networks are essential in large-scale development because of the knowledge-intensive nature of software development. This principle is supported by two case studies studied by Bjørnson & Vestues (2016). They found that Omega used a static approach with informal arenas supported by specific roles and projects to ensure knowledge sharing and process improvement, while Ericsson relied on a more dynamic model with Communities of Practices that relied on volunteers of people who were passionate about the topic to share knowledge. Both approaches seemed to work for their respective case, but Ericsson's dynamic approach is seen as more essential for larger projects (Bjørnson & Vestues, 2016). Similarly, Dingsøyr, Moe, & Seim, (2018) have conducted additional research on the continuous change of knowledge sharing practices, due to the major impact on information sharing, fluidity of workflows between teams, and efficiency of executing projects (Dietrich et al., 2013).

The process of knowledge sharing is only effective if the recipient can absorb the content of the message (knowledge) and make use of it (Santos et al., 2014). The type of knowledge influences the absorption of the knowledge. The literature distinguishes two types of knowledge that are applicable in this context, namely tacit and explicit knowledge. Tacit knowledge refers to the knowledge that individuals possess, for example, experiences, expertise and intuitions (Wang et al., 2016). To share tacit knowledge it is important to use rich sharing channels (Santos et al., 2014). Personal interactions can be considered as rich sharing channel because it promotes mutual and immediate feedback, and use multiple forms of knowledge sharing, such as a demonstration of personal skills (Santos et al., 2014; van den Hooff & Ridder, 2004). Interviewee 11 illustrates an example of sharing tacit knowledge using a rich channel: *"They spoke to a lot of people at the Devdays at one time ..... so he has a lot of knowledge of that atmosphere and wants to share some ideas with us".* Explicit knowledge is codified as formal information that can be recorded and transferred within an organization, such as documents and reports, procedures and policies or manuals (Wang et al., 2016). To share explicit knowledge, channels such as blogs, wiki, mailing lists, and intranet with low richness are more suitable (Santos et al., 2014). These channels are often associated with agile methods and are applied more frequently within mature agile companies (Santos et al., 2014). For distributed teams in different locations, the use of channels with low richness is unavoidable (Santos et al., 2014). Given the differences and types of knowledge sharing, it is important to consider multiple approaches for the efficiency of inter-team collaboration. One subfactor is discovered in the literature that affects knowledge sharing. This subfactor is elaborated below.

4.1.3.1 Knowledge accessibility

The sub-factor affecting inter-team collaboration I identified in literature is knowledge accessibility (Evbota et al., 2016; Martini et al., 2013). The accessibility of knowledge is important because without access to the necessary information or knowledge, people or teams may decide to make assumptions by

themselves (Martini et al., 2013). These assumptions could lead to misinterpretations or delays and thus inefficient inter-team collaboration. Knowledge could become accessible in a variety of ways previously named above. Besides assumptions, the possibility exists that the person or team to retrieve information or knowledge from is not available which could cause delays (Martini et al., 2013). The accessibility of knowledge also affects the dependency between teams. When knowledge is sufficiently accessible for all teams, the knowledge dependencies within the organization will decrease (Martini et al., 2013). This dependency is illustrated by interviewee 5: "*If it's in a central location somewhere and it's accessible, then people can get that information there and they don't have to bother other people all the time. That way people can work more efficiently"*. So it is important to make knowledge accessible given the potential danger on inter-team collaboration. Next the relation between knowledge sharing and inter-team collaboration at CM.com is illustrated.

Inter-team collaboration and knowledge sharing at CM.com
Knowledge within CM.com is shared in a variety of ways. First of all, the website environment is used to share explicit knowledge by means of operational updates and product pages. The operational updates are shared by posts on the internal wiki page, and the product pages share general and commercial information about the different products CM.com offers. In addition, technical knowledge (e.g. coding, testing procedure, debugging) is documented by teams in their own way. Teams have their own wiki page such as Conference, Azure or Gridlab. This technical knowledge is most of the times incomplete and rarely shared. To gain the desired technical knowledge of other teams, the primarily used way is by asking the respective team. Due to this lack of knowledge sharing, the teams tends to reinvent the wheel themselves. Several teams are dealing with the same issues without knowing it from other teams. Individuals are approached to explain certain topics they created because of the lack of documentation and knowledge sharing. This provides extra unnecessary used time and creates knowledge related dependencies between teams. Lastly, CM.com hosts several informal gatherings where hopefully tacit knowledge is shared. The CPaaS business unit hosts a town hall meeting every six weeks. In these meetings, knowledge is shared informally within the business unit, which is considered to be effective and positive by multiple participants. The town hall meeting enables the developers a sense of involvement in the operational aspects of the organization. Other business units do not have such meetings. The whole R&D department hosts yearly Devdays: a whole week full of team building activities and interesting lectures by external and internal people. In addition, in-house activities such as sports and drinks are organized. The above mentioned problems and misaligned shared knowledge at CM.com reveals potential for the effectiveness of their inter-team collaboration.

4.1.4 Factor 4: Communication

The fourth factor I identified affecting inter-team collaboration is communication (Berntzen et al., 2021; Bjornson et al., 2018; Crowston et al., 2016; Evbota et al., 2016; Figalist et al., 2019; Martini et al., 2013; Santos et al., 2014; Scheerer et al., 2014; Uludag et al., 2018). Communication refers to the exchange of information (Bjornson et al., 2018). Interviewee 7 illustrates the importance of communication by stating: "*Communication is key for success"*. Communication both between and within teams is necessary to share information and create and maintain alignment (Berntzen et al., 2021; Bjornson et al., 2018; Santos et al., 2014). Taking into account that knowledge sharing and team alignment is intrinsically associated with inter-team collaboration. However, large-scale ASD raises significant communication challenges at the inter-team level as complex and unforeseen dependencies between units emerge (Crowston et al., 2016; Scheerer et al., 2014; Uludag et al., 2018). It leads to the challenge to communicate effective and avoid process loss due to miscommunication between teams (Figalist et al., 2019). In addition to process loss, a-synchronous communication can occur when communication is primarily not face-face (Evbota et al., 2016). The agile culture, in which teams are allowed to have their own style, reinforces the challenge of effective communication (Martini et al., 2013). Communication may also be hindered by team boundaries due to mistrust (Bjornson et al., 2018).

Mutual trust and shared cognition can be facilitated by more intensive communication (Scheerer et al., 2014). Interviewee 9 illustrates this by stating: "*It is important to have short lines of communication and transparent communication.*" In addition to more intensive communication, closed-loop communication is advised. Closed-loop communication adds a feedback loop checking whether the information has been received and interpreted correctly (Bjornson et al., 2018). To conclude, literature proves that effective communication positively affects the effectiveness of inter-team collaboration in large-scale ASD. I identified two subfactors in the selected literature which are addressed next.

4.1.4.1 Communication style

The first sub-factor I found to affect inter-team collaboration is communication style (Martini et al., 2013; Nyrud & Stray, 2017; Scheerer et al., 2014). Communication style refers to the way in which people approach the process of communication. Different teams can have different communication styles which can lead to ambiguity and delays (Martini et al., 2013). A team or organization can have a formal and planned form of preferred communication (Martini et al., 2013; Scheerer et al., 2014). In addition, a team or organization can have an informal and spontaneous form of communication for instance through face to face contact (Martini et al., 2013; Scheerer et al., 2014). Santos et al. (2014) even considers personal interaction as the most rich channel because of the mutual and immediate feedback, and use of multiple forms of communication such as body language and personal skills (van den Hooff & Ridder, 2004). This statement is substantiated by interviewee 10: "*Face to face communication is always better. With non-verbal communication you take notice of many more things. So you get a better understanding of what is expected or desired by each other."* Given the potential dangers for inter-team collaboration it is important to align the communication styles. In the following, the relation between inter-team collaboration and communication at CM.com is illustrated.

4.1.4.2 Interaction frequency

The second sub-factor I identified is interaction frequency (Bjarnason et al., 2022; Martini et al., 2013; Moe et al., 2018). Bjarnason et al. (2022) proved through focus groups that frequent interaction is a requirement for effective communication between teams. Similarly, Moe et al. (2018) found that frequent participation in forums and meetings increases the size of a team's social network. However, it is important for teams to plan available time to avoid a lack of communication or long waiting times (Martini et al., 2013). In addition, inter-team dependencies affect their frequency of interaction (Karlström & Runeson, 2005; Martini et al., 2013). Bjarnason et al. (2022) found that the frequency of interaction between teams is related to the ease of communication with each other. The ease of talking is affected by the cognitive distance and physical proximity. Teams with short cognitive distances interact more easily and need less frequent interaction to collaborate effectively. Physical proximity affects positively the interaction frequency by allowing individuals to encounter each other more easily. This is illustrated by interviewee 9: "*Indeed, you talk to each other a lot more face-to-face as well. For example, we do not meet with them every week because we spend all day actually talking to each other."* To create effective inter-team collaboration it is important to conduct the amount of interaction that is needed to collaborate efficient. In the following the relation between inter-team collaboration and interaction frequency at CM.com is illustrated.

Inter-team collaboration and communication at CM.com

The inter-team communication within the R&D department of CM.com occurs in an accessible manner. Primarily the chat and call function of Microsoft teams and face-to-face communication is used. This informal form of communication is experienced as pleasant. If collaboration is necessary, the communication is initially established between the product owners of the respective teams. This forms the initial line of contact and is the foundation from which an efficient collaboration can be developed. Ideally, communication occurs face-to-face, as non-verbal communication simplifies the process of mutual understanding. However, due to physical distance and the growth of the company, face-to-face

communication is not the most efficient option. Teams that are able to walk into each other's offices instead of online communication consider their collaboration to be highly effective.

The interaction frequency between teams in the R&D department of CM.com depends on the team or person collaborating with. The higher the frequency of interaction, the higher the probability that teams are aligned and mutual exchange of information occurs. As soon as there has been collaboration with another team before, the teams know what to expect and what is preferred in terms of alignment. If it is their first collaboration, a trial and error process takes place. For projects or products that require intensive collaboration, more frequent contact moments (meetings) take place. The idea behind the business units is that these teams require more interactivity. Therefore efforts are made to locate these teams more close to each other. As such the CPaaS business unit is primarily located at the first floor at the headquarter in Breda. This short physical proximity allow teams to walk into each other's offices when needed. However, it is important to balance the amount of interaction required. At some meetings, people lose interest as the frequency is excessive, the content irrelevant or the duration too long. Given the current status of inter-team communication at CM.com, it positively affects their inter-team collaboration, as long communication remains efficient for the collaborative parties.

4.1.5 Factor 5: Team autonomy

The fifth factor I recognized in the literature is team autonomy (Berntzen et al., 2021; Christopher & de Vries, 2020; Dingsøyr, Moe, & Seim, 2018; Gustavsson, 2020; Uludag et al., 2018). Team autonomy means that the team has (some) freedom to decide how they want to conduct their work (Schwaber & Sutherland, 2020), such as choosing their own tools for coding and automated testing (Gustavsson, 2020). Teams could also choose which agile method such as Scrum, Kanban, Scrumban they apply (Berntzen et al., 2021). This results in great task- and teamwork within teams, but it poses a challenge for managing inter-team collaboration (Christopher & de Vries, 2020; Uludag et al., 2018), even more so when teams have no knowledge of the other teams and their projects, and when there is no transparency about other teams products and processes (Christopher & de Vries, 2020). The high degree of autonomy in agile working methods can cause negligence, roadblocks and delays in collaborations (Berntzen et al., 2021). Finding alignment between autonomous teams is desired but also challenging (Berntzen, 2021), because teams may have different definitions of done (an agreed set of items that must be completed before a task can be considered complete), apply varying testing regimes, and use different documentation methods making it harder to align these teams (Berntzen, 2021). Interviewee 6 illustrates this by stating: "*We see the same thing in technology, how do we determine what environment we need or what language we are writing in? You can decide that yourself, so one uses Azure, another uses Google, another will use the internal environment, one goes into the cloud the other doesn't go into the cloud. This makes it a complicated arena."*

For teams to collaborate effectively, teams need to have a clear understanding of the work process, tasks and capabilities of other teams (Bjornson et al., 2018; Salas et al., 2005). Bjornson et al. (2018) appointed aligning autonomous teams as gaining a shared mental model among the organization. A shared mental model is crucial for effective collaboration because things are interpreted in the same way. It is important to maintain this shared mental model because in a rapidly changing environments the amount of explicit communication decreases (Salas et al., 2005). While communication between and within teams is necessary to share information, synchronize actions, and keep the shared mental model up-to-date (Bjornson et al., 2018). And so despite autonomous teams being central to agile, it is important to align autonomous teams in large-scale software development (Berntzen et al., 2021). To make inter-team collaboration more efficient, some autonomy must be sacrificed for the individual teams to align for a certain extent (Gustavsson, 2020). One subfactor is discovered in the literature that affects inter-team collaboration. This subfactor is elaborated below.

4.1.5.1 Decision making

The subfactor I found affecting inter-team collaboration is decision making (Bjornson et al., 2018; Dingsøyr, Moe, & Seim, 2018; Dingsøyr & Moe, 2014; Uludag et al., 2018). An autonomous team brings the authority of decision making to the operational level which enhances the speed and accuracy of problem solving (Dingsøyr, Moe, & Seim, 2018). Larger projects require decisions that involve multiple teams. To make decisions among and with autonomous teams is considered as major challenge in large-scale software development (Dingsøyr, Moe, & Seim, 2018; Uludag et al., 2018). Therefore, Dingsøyr (2014) included decision making in the eight principles of large-scale software development stating that continuous feedback from the upper-level ensures improved decision making that aligns to overarching organizational goals. Interviewee 11 illustrates this principle by stating: "*I think if you don't have a clear vision as a leader about decision making then it causes frustration and disinterest. This causes collaboration to head in the wrong direction."* Once decision making is communicated transparently and informally it produces trust within the organization (Bjornson et al., 2018). Given the potential dangers for inter-team collaboration it is important to provide more centralized decision-making in large-scale ASD. Next, the relation between inter-team collaboration and team autonomy at CM.com is illustrated.

Inter-team collaboration and team autonomy at CM.com

CM.com's R&D department works agile and is based on autonomous teams. The teams can select what agile method to apply. These agile methods are Scrum, Kanban, Scrumban or any other agile method. In addition, the tools to write software, monitor progress and store documentation varies widely across teams. The organization appreciates this freedom, however, the disadvantageous aspects are also mentioned. Teams have little insight into other teams because they are using different tools, processes, documentation, planning, working methods etcetera. in addition, decision-making occurs primarily at the team level. The product owners, team leads and group leads determine which direction and choices are chosen based on their own expertise. Decisions with a larger impact must first be approved by the higher management which create delays. As a result, many ad hoc decisions are made and certain decisions take longer than desired. Given the above mentioned problems, it can be concluded that the autonomy of teams at CM.com negatively affects the effectiveness of inter-team collaboration.

4.1.6 Factor 6: Personal differences

The sixth factor I recognized that affects inter-team collaboration in large-scale ASD is personal differences (Bjarnason et al., 2022; Bjornson et al., 2018; Gustavsson, 2020; Martini et al., 2013; Uludag et al., 2018). Personal differences influence how easy or difficult it is to communicate (Bjarnason et al., 2022). Some people are generally seen as easier to talk to while others are seen as more difficult to get along with (Bjarnason et al., 2022). This is illustrated by interviewee 10: "*You have individuals within a collaboration, where two individuals vary greatly in personality, one is very introverted and the other extroverted. Collaboration can be inefficient once the individuals are both introverted for example.*" Connection can vary greatly from person to person which can be related to the concept of psychological distance (Bjarnason et al., 2022). Teams with higher psychological distance reported to be less active at company-organized social events, indicating a less outward-going personality (Bjarnason et al., 2022). In addition, team members may be too shy to ask or provide information during meetings (Gustavsson, 2020). For their own sake, some team members do not want to share knowledge because they are afraid others will seek help from them more frequently or will not report anything because of their convenience (Gustavsson, 2020). Diversity of personality, as well as in age, gender and expertise, has been found to support higher productivity in software engineering organizations and facilitates communication within a software engineering organization (Bjarnason et al., 2022; Vasilescu et al., 2015). Given the potential dangers to inter-team collaboration, it is important to consider diversity in collaborations when forming teams and assigning tasks and responsibilities. In the following, the relation between inter-team collaboration and personal differences at CM.com is illustrated.

Inter-team collaboration and personal differences at CM.com:
The behaviors and attitudes of the people within the organization are perceived as very positive. Many people within CM.com are entrepreneurial and helpful. These qualities of colleagues are highly valued within the organization, and based on personality, mutual collaboration is considered to be very positive. In the recruitment of new employees and acquisitions, careful attention is paid to ensure that these people are entrepreneurial and helpful as well. Of course, not all individuals are an instant match and certain professionalism is expected of those dealing with these issues. So, the different personalities of the people at CM.com contribute towards effective inter-team collaboration.

4.1.7 Factor 7: Clarity of roles and responsibilities

The next factor I identified affecting inter-team collaboration in large-scale ASD is clarity of roles and responsibilities (Bjornson et al., 2018; Evbota et al., 2016; Gustavsson, 2020; Nyrud & Stray, 2017; Uludag et al., 2018). The clarity of roles and responsibilities refers to the ability to keep track of who is working on what, which becomes more difficult due to increasing size or number of teams in the organization (Berntzen et al., 2021). Having clear roles and responsibilities is a prominent challenge due to problems with information flow, locating information about other teams, and insufficient overview of tasks and responsibilities across teams (Bjornson et al., 2018; Evbota et al., 2016; Gustavsson, 2020; Uludag et al., 2018). This challenge is illustrated by interviewee 3 stating: "*sometimes it's a bit of a puzzle who I should have..... sometimes it's a bit unclear to me who is responsible for what."* knowing who is doing what and knowing who knows what are two important components for effective coordination (Moe et al., 2018). In large-scale agile development, many new roles are added, such as Chief Product Owner, to make someone responsible for the final product and coordination between teams (Gustavsson, 2020; Nyrud & Stray, 2017). The new role as Chief Product Owner is considered to be very valuable for the organization according to Nyrud & Stray (2017), while Gustavsson (2020) suggests that new roles actually lead to unclear responsibilities. Similarly, the study of Evbota et al. (2016) suggests that the role and responsibilities of operational product owners are unclear. Therefore, for effective inter-team collaboration it is important to define clear roles and responsibilities (Gustavsson, 2020). In the following, the relation between inter-team collaboration and roles and responsibilities at CM.com is illustrated.

Inter-team collaboration and clarity of roles and responsibilities at CM.com:
The roles and responsibilities within CM.com's R&D department are not considered clear by everyone. Finding the person responsible can be difficult, which slows down collaboration. Those who have been working within the organization for some time have less difficulty with this than new employees who spend months trying to get clarity on the necessary roles and responsibilities. The Team Tree is a widely used tool that aims to provide an overview in this regard. Despite this overview, team names, roles and responsibilities are still considered unclear. With the enormous growth of the company in recent years, many teams and people have joined and changed roles and/or responsibilities. As such, it is difficult for newcomers to ascertain exactly what a team does and its responsibilities based on its name. Today, more people have roles such as team lead or product owner. These roles are created to provide points of contact and to coordinate a schedule with other teams. The product owner or team lead should be able to guide you to the right person. These new roles create more clarity about roles and responsibilities at CM.com. The clarity of team names, roles and responsibilities is not optimal at CM.com, so certain improvements could be made to make collaboration between teams more effective.

4.1.8 Factor 8: Collaborativeness of organizational structure

The next factor I identified, affecting inter-team collaboration in large-scale software development, is the collaborativeness of organizational structure (Dingsøyr, Moe, Fægri, et al., 2018; Dingsøyr & Moe, 2014; Martini et al., 2013; Scheerer et al., 2014; Uludag et al., 2018). The terms structure and architecture are used interchangeably in the literature and both refer to the design of the organization.

Dingsøyr & Moe (2014) included architecture in the eight principles of large-scale ASD by stating that architecture has a key role in defining how work is coordinated in large-scale development efforts. In addition, Strode et al. (2012) found that providing structure enhances the effectiveness of coordination. Creating this structure involves several challenges according to Uludag et al. (2018), such as ensuring that the agile teams adhere to the architecture-related activities. Another challenge is illustrated by interviewee 7 stating: "*It's an interesting flat structure ..... You have a lot of freedom and you can manage quite well. The downside is that there is quite a bit of chaos and ad hoc action."* Given the challenges it is important to create an organizational structure where collaboration between teams is most effective. This is an open organizational structure that deconstructs silos and provides transparency through easy communication, but also retains some structural integrity for efficient coordination (Grynko et al., 2020; Stone, 2004). One subfactor is discovered in the literature that affects inter-team collaboration and part of the factor organizational structure. This subfactor is elaborated below.

4.1.8.1 Geographical distribution

The sub-factor I identified that affects inter-team collaboration is geographical distribution (Bjarnason et al., 2022; Martini et al., 2013; Uludag et al., 2018). Geographical distribution refers to the physical distance between teams (Bjarnason et al., 2022). Large organizations are forced to spread teams in different spaces. According to the study of Martini et al. (2013), even the distance of one leads to delays and lack of communication and engagement. If one floor already cause delays and misunderstandings in the communication, being geographically distributed in different location will do even more (Bjarnason et al., 2022). In order to synchronize teams, common available time is required (Martini et al., 2013). Due to different locations or different time zones, coordination and collaborations become challenging (Uludag et al., 2018). This challenge is illustrated by interviewee 9: "*What I do notice, we have some people located in the Netherlands and Madrid or remote. We're not fully organized for that, because we conduct a lot of conversations in the office because that's where most of the people are. And that' s the place you discuss things that people online are not involved in."* So it is important to create interaction between teams to reduce the distance given the potential danger of geographical distribution on inter-team collaboration. Next, the relation between inter-team collaboration and the organizational structure at CM.com is illustrated.

Inter-team collaboration and collaborativeness of the organizational structure at CM.com:

The organizational structure can be characterized as organic and non-hierarchical at CM.com (*CM-Annual-Report-2021*, n.d.), which is regarded in a favorable way. The organizational structure is visualized in Appendix A. The structure is one that provides a lot of freedom as well as chaos. One does not have to go up through three hierarchical floors to ask permission for particular matters, but consequently more ad hoc activities take place. From the management's perspective, this allows for relatively straightforward management at the detail level, as there are no multiple layers of management in between.

In addition, CM.com has grown to the point where they operate in multiple locations nationally and internationally. The geographical distances are perceived as a constraint for collaborations due to the fact that a lot of communication happens face-to-face. Currently, most people of the R&D department are located at the headquarters in Breda. However, people working in different locations sometimes feel outsiders or excluded. For collaborations with other locations, efforts are made to structurally schedule contact moments with each other and to create involvement. Similarly, when meetings are scheduled with teams or individuals in other time zones, times are adjusted to what fit both teams, which is not perceived as obstacle. However, the closer you are to the teams, the more efficient the inter-team collaboration is according to the interviewees. The organic and non-hierarchical organizational structure at CM.com is perceived as beneficial towards the effectiveness of inter-team collaboration, although the level of disorder could be reduced.

4.1.9 Factor 9: Collaborativeness of organizational culture

The last factor I found in the literature affecting inter-team collaboration in large-scale ASD is the collaborativeness of the organizational culture (Berntzen et al., 2021; Bjarnason et al., 2022; Martini et al., 2013; Uludag et al., 2018). The analyzed organization in the study of Bjarnason et al. (2022) operates actively with cultural values such as acting as one, being open and helpful, which are communicated at all levels within the organization. Consistently working with these cultural values has a clear impact on the ease in which team members communicate and collaborate with each other. The positive influence of cultural values is illustrated by interviewee 2: *"Another factor that I really like at CM is when there are real problems. There is no team - at least I have never experienced it - that doesn't have the time. Everyone helps out, I really appreciate that at CM."* However, the size and growth of the organization could make it more difficult to act in line with the corporate culture. It has become more difficult to operate according to their core values now that they are so many in the organization (Bjarnason et al., 2022). Uludag et al. (2018) supports this by mentioning several cultural challenges that arise once agile is applied on a larger scale. his study identifies challenges such as establishing a culture of continuous improvement, creating team spirit, and dealing with interference from upper management. The Agile culture is flexible and encourages teams to set up their own processes (Berntzen et al., 2021; Martini et al., 2013). This agile culture encourages the cultural challenges of a growing agile organization (Martini et al., 2013). Hastwell (2021) provides the six elements of a great company culture which should provide unity, fairness, trust, innovation, caring and a trustworthy management. Cultural values such as the six elements by Hastwell (2021) enhance the effectiveness of inter-team collaboration within the organization, as long these cultural values are maintained as the organization grows. One subfactor is discovered in the literature that affects inter-team collaboration and part of organizational culture. This subfactor is elaborated below.

4.1.9.1 Trust

The sub-factor I identified that affects inter-team collaboration is trust (Bjornson et al., 2018; Figalist et al., 2019; Scheerer et al., 2014; Uludag et al., 2018). Trust is defined as the shared belief that teams will carry out their tasks and protect the interests of their colleagues (Bjornson et al., 2018; Salas et al., 2005). The importance of trust is illustrated by interviewee 12 by stating: *"If you cannot trust each other, well then, what is the purpose of collaboration?"* Once organizations grow and become a large-scale agile organization challenges arise, such as the creation of boundaries between teams allowing an attitude of us-and-them (Bjarnason et al., 2022; Santos et al., 2014; Uludag et al., 2018). These boundaries hinder collaboration between these teams because of delays and corrupted information (Martini et al., 2013). Literature suggests that trust does not develop easily across team boundaries and that it affects the amount of communication (Bjornson et al., 2018). The essence of trust in large-scale development is confirmed by Uludag et al. (2018) who considers the importance of trust in agile teams and agile practices. Agile methods and best practices with a focus on transparency and feedback loops are well suited to develop trust (Bjornson et al., 2018; Figalist et al., 2019). In addition, the literature shows that trust develops through increased interpersonal contact and more intensive communication (Bjornson et al., 2018; Scheerer et al., 2014). Given the foundational nature of trust, it is important to facilitate its existence in order to create and maintain effective inter-team collaboration. In the following, the relation between inter-team collaboration and organizational culture at CM.com is illustrated.

Inter-team collaboration and collaborativeness of the organizational culture at CM.com:

The organizational culture at CM.com is perceived as strong, open, informal and professional. The barriers are low and people are easy to approach and collaborate with. In addition, everyone is ready to support and respect each other. Furthermore, entrepreneurship and innovative ideas are highly valued within the organization. The ideas that are thought up are allowed to be developed and implemented by the respective person or persons. Due to the open culture, a high degree of independence is expected from the employees because no one is continually telling them what is expected from them. Certain

people were in need of a certain structure and direction, so they left the organization. Therefore, CM.com selects new people at the front who are assertive because of the cultural fit and more smooth collaborations. given the pleasant culture and high level of trust that facilitate at CM.com, it can be concluded that they enhance the effectiveness of inter-team collaboration.

4.2 New factors originating from practice

This second section presents the new factors that affect the effectiveness of inter-team collaboration in large-scale ASD that emerged from the interviews with practitioners. Table 4 provides an overview of the newly identified factors and subfactors.

Table 4 New factors mentioned by interviewees at CM.com

	Recognized by												
	Interviewee 1	Interviewee 2	Interviewee 3	Interviewee 4	Interviewee 5	Interviewee 6	Interviewee 7	Interviewee 8	Interviewee 9	Interviewee 10	Interviewee 11	Interviewee 12	*Total interviewees*
10. Clarity of organizational strategy		✓	✓					✓	✓	✓		✓	*6*
11. Human resources	✓					✓	✓				✓		*4*
12. Organizational growth					✓	✓		✓					*3*

Table 4 lists all novel factors and subfactors, and for each, it indicates which interviewed practitioner recognized them. In addition, for each new factor and subfactor, the total number of interviewees who recognized them is shown. In addition, for each factor and subfactor, it is indicated in which interview they were identified. As can be seen, the last novel subfactor is suggested by interviewee 5, indicating data saturation. In total, the interviews revealed three new factors. The illustrations per factor are visualized by a inductive coding scheme, which is provided in Appendix E.

Before explaining the novel factors, I briefly note that external factors have been identified as well. Inferring from the interviews, the external factors refer to factors the company cannot control themselves. Interviewee 5 emphasizes this by stating: "*In particular, external factors affect the effectiveness of collaboration here at CM."* In particular, the interviewees mentioned two external factors. these two external factors are competition, which refers rival organizations operating in the same market, and technological development, which refers to the development of technological products and processes in the market. CM.com operates in a highly competitive and technological market in which new developments occur at a rapid pace. Because of this reason, the aforementioned external factors are not included as a new factor, but considered as characteristic of the context in which this study was conducted. In the following, the novel factors are addressed in detail.

4.2.1 Factor 10: Clarity of organizational strategy

The first novel factor suggested by the interviewees is the clarity of the organizational strategy. According to the interviewees, organizational strategy refers to the direction in which the organization is going. This factor is recognized in the literature I examined, but is only mentioned as a factor affecting the effectiveness of knowledge sharing and knowledge management in agile environments once the organizational strategy is consistent (Santos et al., 2014; Uludag et al., 2018). A clearly formulated organizational strategy can facilitate and ease collaborations. This well-defined organizational strategy is lacking, according to the interviewees at CM.com; people lost track of the direction CM.com wants to take and are missing guidance. The importance of this problem is illustrated by interviewee 8: "*I think that in communicating, telling and involving people in this strategy, there is profit to be made. Then you*

can also see clearly about how your team relates to the other teams in that strategy; What do we require of whom to achieve that collectively?"

The interviewees indicated that the overarching strategy is not clear and that it is difficult to act on it as a team. As a result, actions are taken from the perspectives of an individual team. One team may see a market in the development of its product, whereas the other team, required for collaboration, may not consider it as important. As a result, teams start pushing their own agendas and implement them by themselves based upon what they believe is the best. If the organizational strategy is formulated and disseminated more clearly, the importance and rationale behind collaborations can be understood easier. CM.com uses cross-selling as a way to enter the customer and sell multiple products from that starting point. So the more products that are connected, the more opportunity there is to sell more products. So ultimately, each team benefits from collaborating with another team as it can increase the business of any team. However, most teams at CM.com are unaware of this strategy. Therefore, it is important to establish a well-formulated organizational strategy and communicate its importance to all employees to facilitate inter-team collaboration. Given the explanation mentioned above, it can be hypothesized that a well-defined organizational strategy is a factor that positively affects the effectiveness of inter-team collaboration.

4.2.2 Factor 11: Human resources

The second novel factor suggested by the interviewees is human resources. This factor is not yet recognized in literature as factor affecting inter-team collaboration in large-scale ASD. Inferring from the interviews, human resources referred to the amount of available man hours. The access to an appropriate amount of man hours should encourage collaboration between teams. At present, some collaborations at CM.com are not working well or take longer than initiated, because teams remain busy and limited time is available to communicate. This problem is illustrated by interviewee 11 by stating: "*Because people are busy and have to do other things in between, they forget to communicate or communicate inadequate.*" Having more available time will increase the likelihood that people document, provide feedback or other collaborative related actions. So for that reason it is essential to have a sufficient amount of human resources available to ensure efficient inter-team collaboration. However, if it is impossible to obtain additional human resources, investing in human capital to create more efficient inter-team collaboration is an option. Human capital is defined as the skills possessed by the labor force and is considered a resource or asset (Goldin, 2016). Investing in human capital can be done, for instance, by providing personnel with appropriate education or training. Given the explanation mentioned above, it can be hypothesized that sufficient amount of human resources is a factor that positively affects the effectiveness of inter-team collaboration.

4.2.3 Factor 12: Organizational growth

The third novel factor suggested by the interviewees is organizational growth. This factor is not yet recognized in literature as factor affecting inter-team collaboration in large-scale ASD. According to the interviewees, organizational growth refers to the increasing number of teams, staff and products. CM.com has received financial resources to grow substantially through the listing. This financial boost has triggered tremendous growth of the organization, partly due to multiple acquisitions. These companies are acquired by CM.com because of their technology, their potential expanding market share or potential cost savings (*CM-Annual-Report-2021*, n.d.). This rapid expansion introduced several challenges with negative influence on the effectiveness of inter-team collaboration. First, the inter-team collaboration with recently acquired teams hampers because the acquired staff needs to adapt to the new environment which takes more time than expected. Second, the fast growth creates chaos and ambiguity within the organization. As a result, roles and responsibilities frequently change due to larger teams or new acquisitions. This chaos and lack of clarity negatively affects the effectiveness of inter-team collaboration. Third, the growth causes additional pressure on personnel. The CM.com's sales and

marketing department is growing tremendously, which increases the pressure on the R&D department to deliver. Fourth, the organization and the availability of workstations and meeting rooms does not grow proportionately. The unavailability of workstations and meeting rooms reduces the tendency to physically meet. While, as mentioned before, face-to-face interaction is considered the most rich channel because of mutual and immediate feedback and the use of multiple forms of communication such as body language and personal skills (Santos et al., 2014; van den Hooff & Ridder, 2004). Finally, the growth of the company creates more involvement of people in decision making. On the one hand, it helps to have more eyes to consider an idea or potential risks, but on the other hand, you have to keep everyone on board to make sure you are heading towards the same end goal. These additional stakeholders introduce delays in the decision making process and affect the efficiency of inter-team collaboration. So it is important to grow proportionately as an organization relative to (new) personnel, materials and the workload. Given the obstacles mentioned above, it can be hypothesized that organizational growth is a factor that negatively affects the effectiveness of inter-team collaboration.

4.3 Best practices originating from literature

This third section presents the best practices to improve the effectiveness of inter-team collaboration in large-scale ASD that have been identified in the existing literature. This section provides an overview and synthesis of all the available knowledge this research was able to gather about the best practices. Table 5 provides an overview of the best practices.

Table 5. Strategies and best practices identified in selected literature

	Best practices	Sources
Activities	1. Inter-team meetings	(Berntzen et al., 2021; Dingsøyr, Moe, & Seim, 2018; Moe et al., 2018; Nyrud & Stray, 2017)
	2. Communities of practices	(Berntzen et al., 2021; Bjørnson & Vestues, 2016; Dingsøyr, Moe, & Seim, 2018; Moe et al., 2018).
	3. Task force teams	(Berntzen et al., 2021; Moe et al., 2018)
	4. Mini-demos	(Bjornson et al., 2018; Dingsøyr, Moe, & Seim, 2018).
	5. Cross-organizational events and activities	(Dingsøyr, Moe, & Seim, 2018; Santos et al., 2014)
Tools and artefacts	6. Instant messaging channels	(Berntzen et al., 2021; Bjarnason & Sharp, 2017; Dingsøyr, Moe, & Seim, 2018; Moe et al., 2018)
	7. Process standardization	(Berntzen et al., 2021)
	8. Objectives and key results (OKRs)	(Berntzen et al., 2021)
	9. Facilitate face to face communication	(Bjarnason et al., 2022; Dingsøyr, Moe, & Seim, 2018)
	10. Roadmap sharing	(Berntzen et al., 2021)
	11. Organization map	(Berntzen et al., 2021)
	12. Shared backlog	(Berntzen et al., 2021)
	13. Knowledge sharing tools	(Dingsøyr, Moe, & Seim, 2018; Santos et al., 2014)
	14. Job and office rotation	(Bjarnason et al., 2022; Dingsøyr, Moe, & Seim, 2018; Santos et al., 2014)
	15. Iterative higher-planning planning	(Bick et al., 2016; Bjørnson & Vestues, 2016)
Structure	16. Large-scale agile frameworks	(Bjornson et al., 2018; Christopher & de Vries, 2020; Gustavsson, 2020)
	17. Co-location	(Bjarnason et al., 2022; Bjornson et al., 2018; Moe et al., 2018)
	18. Open office space	(Berntzen et al., 2021; Dingsøyr, Moe, & Seim, 2018; Moe et al., 2018; Nyrud & Stray, 2017)
	19. Permanent support teams	(Berntzen et al., 2021).
	20. Bridgeheads	(Bjarnason et al., 2022; Martini et al., 2013; Nyrud & Stray, 2017)

Table 5 lists all identified best practices. The best practices are aggregated in the categories activities, tools and artefacts, and structures. These categories are based on the perception of the users once implemented within the organization. For example, the structure-based best practices are recognized as structural adaptations once implemented. In total, the selected literature revealed 20 unique best

practices. These best practices are mentioned because they increase effective inter-team collaboration in large-ASD. An important fact is that the best practices in this section, most likely due to the selection of literature, do not include the basic elements of collaboration, such as agreements on decision-making and processes. This may be due to the fact that the literature is focused on the context large-scale software development, where the basic elements of collaboration should already be implemented in the organizations. Despite the fact that aspects such as prior agreements on decision-making and processes are not included in the following synthesized literature, it is necessary to evaluate these for the effectiveness of inter-team collaboration.

The literature on best practices is provided with an important sidenote that the adoption of best practices is not stable but dynamic, and changes over time (Bjørnson & Vestues, 2016; Dingsøyr, Moe, & Seim, 2018; Gustavsson, 2019, 2020; Moe et al., 2018). Emerging best practices are used as the needs changed during project operations (Dingsøyr, Moe, & Seim, 2018). It is therefore important to be aware of this, as well as continually evaluate and change best practices over time as projects progress (Gustavsson, 2020; Moe et al., 2018). These changes in best practices can occur bottom-up or they can be established top-down by managers in the organization (Gustavsson, 2020; Moe et al., 2018). So it is important to keep a dynamic view on the identified best practices in this section, as there is an expectation that they will change over time within the organization.

Although some best practices change over time, the established coordination practices related to the agile method Scrum remain (Moe et al., 2018). The team-specific Scrum practices such as daily stand up meeting and retrospective meeting continue to be applied at the team level and are therefore not included among the best practices in this section which focusses on improving effective inter-team collaboration. In the following, the identified best practices are addressed in more detail.

4.3.1 Activity-based best practices

The first best practices are aggregated as activity-based best practices. The best practices are included in this section because it expects activity from one or more team members for its implementation.

4.3.1.1 Inter-team meetings

The first activity-based best practice identified is inter-team meetings (Berntzen et al., 2021; Dingsøyr, Moe, & Seim, 2018; Moe et al., 2018; Nyrud & Stray, 2017). An inter-team meeting is a scheduled or unscheduled meeting in which at least one member from at least two different teams discusses a predetermined topic (e.g. bugs or planning). Inter-team meetings are perceived as a well-functioning practice to coordinate across multiple teams (Dingsøyr, Moe, & Seim, 2018; Moe et al., 2018; Nyrud & Stray, 2017). Inter-team meetings are recommended to host because they obtain overview of what is going on in the teams and serves to manage coordination between teams (Berntzen et al., 2021; Nyrud & Stray, 2017). The advantage of scheduled meetings between teams is that everyone is engaged and receives the same information (Nyrud & Stray, 2017). In addition, frequent participation in meetings increases a team' social network size and provides the team a clear overview of what is going on in the projects and within other teams (Moe et al., 2018). Also, these inter-team meetings can be held on a virtual basis. However, coordinating in these inter-team meetings is important. Nyrud & Stray's (2017) study indicated that coordination accounted for only 7% of the meeting and the focus was rather focused on going through the outstanding Jira tasks (work management tool). In addition, account must be taken that not too much time is spent in (irrelevant) meetings (Evbota et al., 2016; Gustavsson, 2019, 2020). Furthermore, Inter-team meetings seem to work poorly when they have too many participants with disjointed interests and concerns (Paasivaara et al., 2012). So inter-team meetings appear to be recommended best practices with beneficial effects towards the effectiveness of inter-team collaboration, as long as coordination actually takes place and balance is sought regarding relevance and attendees.

The literature covers a wide variety of inter-team meeting types. The following inter-team meetings are identified: Scrum of scrums (Berntzen et al., 2021; Dingsøyr, Moe, & Seim, 2018; Moe et al., 2018), architecture project meeting (Dingsøyr, Moe, Fægri, et al., 2018; Moe et al., 2018), business project meeting (Dingsøyr, Moe, & Seim, 2018), meta scrum (Dingsøyr, Moe, Fægri, et al., 2018; Moe et al., 2018), test project meeting (Berntzen et al., 2021; Dingsøyr, Moe, & Seim, 2018), product owner meeting (Moe et al., 2018), subproject meetings (Moe et al., 2018), ready-to-sprint meeting (Moe et al., 2018) and bug board (Moe et al., 2018). All these inter-team meetings function as a scheduled moment to discuss relevant topics (e.g. projects, interdependencies, errors) with respect to the participants. These participants such as product owners, functional architects or managers vary per type of inter-team meeting.

4.3.1.2 Communities of practices

The second best practice is communities of practice (CoP) (Berntzen et al., 2021; Bjørnson & Vestues, 2016; Dingsøyr, Moe, & Seim, 2018; Moe et al., 2018). CoPs refers to a meeting or forum to share experience about relevant topics to learn from each other. CoPs aim to share knowledge and provide overview, of aspects such as dependencies, across teams (Berntzen et al., 2021). The implementation of CoPs is proven to work successfully in some cases (Bjørnson & Vestues, 2016). Moe et al. (2018) found that frequent participation in forums and meetings increases the size of a team's social networks and gives the team insights of what is going on in the projects. According to Berntzen et al. (2021), it is prudent to convene biweekly gatherings with the attendees and create an online page where agendas and notes are posted. While there is value in hosting communities of practices it does not work in all cases (Dingsøyr, Moe, Fægri, et al., 2018; Paasivaara & Lassenius, 2014). It may be difficult to represent all teams and when interest is high, keeping the topics relevant to everyone and including everyone in the discussions is difficult (Berntzen et al., 2021; Bjørnson & Vestues, 2016). Given the fact that CoPs enable knowledge sharing and provide overview across teams, this best practice contributes to the effectiveness of inter-team collaboration.

The following five types of communities of practice have been identified in the literature: Tech lead forum (Berntzen et al., 2021), experience forum (Dingsøyr, Moe, Fægri, et al., 2018; Moe et al., 2018), technical corner (Dingsøyr, Moe, Fægri, et al., 2018; Moe et al., 2018), lunch seminars (Dingsøyr, Moe, Fægri, et al., 2018; Moe et al., 2018) and open space (Dingsøyr, Moe, Fægri, et al., 2018; Moe et al., 2018). All these types of CoPs aim to share experiences between teams on a variety of topics. These experiences are shared in discussions, presentations or forums, and participation in these communities was voluntary (Moe et al., 2018).

4.3.1.3 Task force teams

The next best practice I have found is task force teams (Berntzen et al., 2021; Moe et al., 2018). Task force teams are groups of individuals, from different teams, coming together to solve technical problems and tasks with priority (Berntzen et al., 2021; Moe et al., 2018). These tend to be technical problems such as security issues and performance problems (Moe et al., 2018). To solve these as quickly as possible, members are put together with full focus to solve the problem (Berntzen et al., 2021). So task force teams appear to be a recommended best practice with beneficial effects towards the effectiveness of inter-team collaboration.

4.3.1.4 Mini-demos

Hosting mini-demos is the next best practice identified in the literature (Bjornson et al., 2018; Dingsøyr, Moe, & Seim, 2018). Mini-demos are videos or meetings where development updates are shown to customers and stakeholders literature (Bjornson et al., 2018; Dingsøyr, Moe, & Seim, 2018). Hosting minidemos is recommended to improve closed-loop communication between the developer and its stakeholders (Bjornson, 2018). Closed-loop communication validates whether information has been

received and interpreted correctly, by adding an additional feedback loop in communication (Bjornson, 2018). This way, by implementing mini-demos misunderstandings and conflicts can be avoided which enhances the effectiveness of inter-team collaboration.

4.3.1.5 Cross-organizational events and activities

The last activity-based best practice I identified is cross-organizational events and activities (Dingsøyr, Moe, & Seim, 2018; Santos et al., 2014). Organizing cross-organizational events and activities brings people from different parts of the organization together with the main goal of establishing social interaction between teams and thus increasing their interaction frequency. Cultural values can be incorporated into these cross-organizational events and activities. Examples of cross-organizational events and activities are coding dojos (Santos et al., 2014), lunches, coffee breaks and trips (Dingsøyr, Moe, & Seim, 2018). Given the stated benefits in regards of inter-team collaboration, hosting cross-organizational events and activities positively affects its effectiveness.

4.3.2 Tools and artefacts

The following best practices are aggregated under the heading of tools and artifacts. The best practices are included in this section because they need integration into work methods and organizational systems.

4.3.2.1 Instant messaging channels

The first best practice tool is instant messaging channels (Berntzen et al., 2021; Bjarnason & Sharp, 2017; Dingsøyr, Moe, & Seim, 2018; Moe et al., 2018). Instant messaging channels refer to instruments that facilitate asynchronous communication between team members (Dingsyor, 2018). Instant messaging channels such as Slack and Teams provide an convenient way to share knowledge and reach people (Berntzen et al., 2021). As the organization grows, the distances between teams increase as they are placed under different managers, in different buildings in different floors, as well as working on a larger number of products (Bjarnason et al., 2022). These distances are bridged to some extent by the use of instant messaging channels. Therefore it is important to ensure that each team has access and use the same channels to avoid delays and communication gaps (Bjarnason et al., 2022). Additional benefits of instant messaging channels are the integrated history log due to communication history, and group chat functions which can be used to ask several people for help without interrupting (Bjarnason et al., 2022; Moe et al., 2018). Nevertheless, instant messaging channels are narrower and more impersonal compared to direct communication, which can lead to additional efforts to communicate effectively between teams (Bjarnason et al., 2022). Instant messaging channels thus appear to be a recommended best practice with a beneficial effect on the effectiveness of inter-team collaboration, as long as, in addition, face to face communication remains to exist.

4.3.2.2 Process standardization

The next best practice I have discovered is process standardization. Process standardization is a process of ensuring that things adhere to specific standards, aiming to align autonomous teams (Berntzen et al., 2021). Standardized processes such as shared documentation routines, shared delivery routines, a shared definition of done (an agreed set of items that must be completed before a task can be considered complete) and common testing routines are recommended (Berntzen et al., 2021). Guidelines for designing graphical user interfaces, how to use the Java programming language, how to store documentation and how to perform specific programming tasks are examples that can be standardized (Dingsøyr, Moe, & Seim, 2018). However, ensuring that everyone follows these standardized actions is important. In fact, in Dingsøyr, Moe, & Seim's (2018) study, they found that guidelines, rules and processes were not being followed by all because of their inflexibility and large amount to sustain overview. Given the stated benefit to align autonomous teams in regards of inter-team collaboration, standardization positively affects its effectiveness, as long autonomy and overview is maintained.

4.3.2.3 Objectives and key results

Next the best practice objectives and key results (OKRs) is identified in the selected literature (Berntzen et al., 2021). OKRs is a critical thinking framework and ongoing discipline that seeks to ensure that employees collaborate and focus their efforts on measurable contributions that move the organization forward (Berntzen et al., 2021; Niven & Lamorte, 2016). The use of OKRs provides overview and in the increasingly complex development process (Berntzen et al., 2021). OKRs allows for better assessment on where to focus within the company, increase state awareness across teams, identifies constraints and bottlenecks that may slow down the delivery speed, and simplifies the decision making process (Berntzen et al., 2021). To ensure OKRs benefit the effectiveness of inter-team collaboration in large-scale ASD, it is important to share them widely so that everyone, from top to bottom, can see objectives and key results from throughout the organization (Niven & Lamorte, 2016). Given the above mentioned benefits, OKRs appear to be a recommended best practice with a beneficial impact on the effectiveness of inter-team collaboration.

4.3.2.4 Facilitating face to face communication

The following best practice I identified is to facilitate face to face communication (Bjarnason et al., 2022; Dingsøyr, Moe, & Seim, 2018). Facilitating face to face communication refers to actively supporting employees to talk to each other instead of relying solely on communication through emails, teams, etc. (Bjarnason et al., 2022). A combination of planned and unplanned meetings is necessary to enable collaborations within a large development organization (Bjarnason et al., 2022). Thus, it is important to facilitate enough meeting points so that people can talk and realize that talking to each other is necessary (Dingsøyr, Moe, & Seim, 2018). So facilitating face to face communication appears to be a recommended best practices towards the effectiveness of inter-team collaboration.

4.3.2.5 Roadmap sharing

The next best practice is roadmap sharing (Berntzen et al., 2021). Sharing teams' roadmaps promotes visibility into other teams' processes (Berntzen et al., 2021). In addition, physically or digitally disclosing each other's priorities is essential for managing priorities between teams (Berntzen et al., 2021). Sharing roadmaps physically, potentially creates discussions around the roadmaps, which promotes coordination (Dingsøyr, Moe, & Seim, 2018). Given the stated benefits, roadmap sharing is a best practice that positively impacts the effectiveness of inter-team collaborations.

4.3.2.6 Organization map

The next best practice I discovered is organization mapping (Berntzen et al., 2021). Organization map refers to a document or tool where employees can identify each other by name and/or photo helps to generate overview across teams (Berntzen et al., 2021). Since it generates overview, organization mapping is seen as a best practice that works in a positive way on the effectiveness of inter-team collaboration.

4.3.2.7 Shared backlog

Having a shared backlog is the next best practice I found in the literature. A shared backlog refers to the ability to take over outstanding tasks from other teams (Berntzen et al., 2021). Having a detailed shared backlog enables insights in the progress and tasks of other teams and allows delayed tasks to be picked up by other teams (Berntzen et al., 2021). Given the stated benefits regarding inter-team collaboration, a shared backlog positively affects its effectiveness.

4.3.2.8 Knowledge sharing tools

Subsequently, I identified the best practice knowledge sharing tools (Dingsøyr, Moe, & Seim, 2018; Santos et al., 2014). Knowledge sharing tools refer to tools such as Wiki, intranet or mailing lists, which are used to share knowledge. Santos et al. (2014) found that mature agile working companies use more knowledge sharing tools between teams. For example, process description documents, expectations,

guidelines and checklists can be made available on a wiki (an internal page or website) (Dingsøyr, Moe, & Seim, 2018). The content of these tools should be updated regularly to keep the knowledge relevant (Dingsøyr, Moe, & Seim, 2018). Although, knowledge sharing tools are only effective if the recipient can absorb the knowledge and make use of it (Santos et al., 2014). Knowledge sharing tools thus appear to be a recommended best practice with a beneficial effect on the effectiveness of inter-team collaboration, as long the knowledge is absorbed and used.

4.3.2.9 Job and office rotation

Job and office rotation is another best practice I have discovered in the literature (Bjarnason et al., 2022; Dingsøyr, Moe, & Seim, 2018; Santos et al., 2014). Job and office rotation refers to the rotation of members between teams and office location within the organization (Dingsøyr, Moe, & Seim, 2018). Rotating employees between teams and office location is a means of promoting familiarity and knowledge of other teams within the growing organization (Bjarnason et al., 2022; Santos et al., 2014). Through this practice, employees gain new insights and get to know more people, which facilitates communication between teams. Job rotation also increases personal contacts and reduces psychological distance (Bjarnason et al., 2022). However, Bjarnason et al. (2022) also identified resistance to this best practice because of losing important team members. Therefore, the suggestion was made that rotation on a temporary basis was preferable. Job and office rotation thus appear to be a recommended best practice with a beneficial effect on the effectiveness of inter-team collaboration, in which the possibility of temporality should be considered.

4.3.2.10 Iterative higher-level planning

The last best practice of this section is iterative higher-level planning (Bick et al., 2016; Bjørnson & Vestues, 2016). Iterative higher-level planning refers to decision-making at higher level management rather than at the team level, including assistance of experienced team members (Bick et al., 2016). Establishing iterative planning and the required feedback on the agenda of higher level management may in fact improve inter-team coordination according to Bick et al. (2016). Bjørnson & Vestues (2016) mentioned the importance of achieving a good balance between self-management and higher-level control for the teams. Given the stated benefits regarding inter-team collaboration, iterative higher-level planning positively affects its effectiveness, as long balance is maintained between the autonomy of teams and higher-level control.

4.3.3 Structure-based best practices

The following best practices are grouped together under the heading of structure-based best practices. The best practices are included in this section because implementing them involves changes to the structure of the organization.

4.3.3.1 Large-scale agile frameworks

The first structure-based best practice I identified is large-scale agile frameworks (Bjornson et al., 2018; Christopher & de Vries, 2020; Gustavsson, 2020). Large-scale agile frameworks are multi-team designed frames that can be applied to large-scale agile working teams (Gustavsson, 2020). Large-scale agile frameworks such as SAFe (Scaled Agile Framework) and LeSS (Large-Scale Scrum) are frequently cited in the literature as a solution to keep agile working methodologies effective on a large scale. In short, a large-scale agile framework identifies and improves steps in the value stream for products, and eliminates steps that do not create value for higher management (Gustavsson, 2020). At the team level, it provides a more structured way for planning precision for all teams, and other routines for inter-team coordination (Gustavsson, 2020). The literature holds different opinions about the application of large-scale agile frameworks. The advantages of these frameworks are the provided structure, flexibility and overview within the organization (Bjornson et al., 2018; Christopher & de

Vries, 2020; Gustavsson, 2020). The disadvantages include the high degree of complexity, lack of clarity and high expectations of staff (Bjornson et al., 2018; Christopher & de Vries, 2020; Gustavsson, 2020). Research found that companies rarely incorporate software development frameworks in their totality, but choose and combine individual components of different frameworks to address their particular needs (Bick et al., 2018; Edison et al., 2021). Many different frameworks exist and novel frameworks are emerging continuously, therefore it depends per company which framework is best to apply (Bjornson et al., 2018; Christopher & de Vries, 2020). So large-scale agile frameworks appear to be recommended best practices with beneficial effects towards the effectiveness of inter-team collaboration, as long as coordination actually takes place.

4.3.3.2 Co-location

The next best practice I identified in the relevant literature is co-location (Bjarnason et al., 2022; Bjornson et al., 2018; Moe et al., 2018). Co-location means that multiple teams are placed within a single location. Since people are located together, coordination can easily occur through, for example, coffee breaks and the easy spillover to other teams (Moe et al., 2018). Co-location thus appears to effectively support coordination between teams rather than relying entirely on online collaboration (Moe et al., 2018). In addition Bjornson et al. (2018) advised to position collaborating teams as close by as possible and preferably on the same floor. This allows team members to walk past and talk to other teams to see what they are working on (Bjornson et al., 2018). Furthermore Bjarnason et al. (2022) research claims that co-location has a strong positive effect on team collaboration because teams and individuals are easier to find (Bjarnason et al., 2022). Co-location thus appear to be a recommended best practice with a beneficial effect on the effectiveness of inter-team collaboration.

4.3.3.3 Open office space

Next, I noted the best practice open office in the relevant literature (Berntzen et al., 2021; Dingsøyr, Moe, & Seim, 2018; Moe et al., 2018; Nyrud & Stray, 2017). The office space supports overview and a common understanding of each teams' work (Berntzen et al., 2021). The open office space facilitates knowledge sharing and spontaneous informal discussions (Berntzen et al., 2021; Dingsøyr, Moe, & Seim, 2018; Moe et al., 2018; Nyrud & Stray, 2017). Nyrud and Stray (2017) found that teams being together in an open office resulted in the emergence of informal and ad hoc conversations. Also, many of the decisions in projects between relevant stakeholders are discussed informally in the open workspace (Moe et al., 2018). However, a major drawback is that open office space has been proven to cause decreased employee satisfaction (Brennan et al., 2002). In addition, loud discussions in the open landscape cause some to isolate themselves through, for example, headphones, which hinders collaboration (Dingsøyr, Moe, & Seim, 2018). Given the advantages and disadvantages mentioned regarding inter-team collaboration, it is difficult to determine the impact of the open office on its effectiveness.

4.3.3.4 Permanent support teams

The next best practice I identified is permanent support teams. permanent support teams are teams (such as platform or test teams) that have the responsibility of supporting the development teams in the areas of implementation, testing, monitoring and logging (Berntzen et al., 2021). Creating these teams supports the development teams, helps to better manage technical dependencies and ensures alignment (Berntzen et al., 2021). Given the beneficial effects of permanent support teams on the effectiveness of inter-team collaboration, the best practice is recommended.

4.3.3.5 Bridgeheads

The last structure-based best practice I identified is bridgeheads (Bjarnason et al., 2022; Martini et al., 2013; Nyrud & Stray, 2017). Bridgeheads refer to persons that connect multiple teams with their technical insights to coordinate (Martini et al., 2013; Nyrud & Stray, 2017). These bridgeheads provide knowledge sharing, overview of dependencies and alignment in communication and planning, because

they contain the overview within the organization and know where what expertise is to link them together (Martini et al., 2013). Damian et al. recommend to identify team members with exceptional knowledge of an application domain or system component and make sure that these key individuals can share their knowledge within the organization without being overwhelmed with interaction requests (Damian et al., 2013). A risk of implementing bridgeheads is that they can disrupt communication between teams when interaction between teams is not facilitated and encouraged (Catolino et al., 2020). Also, imposing overly strict and narrow channels for communication between teams can have negative effects on inter-team collaborations (Bjarnason et al., 2022). Given the valuable benefits regarding inter-team collaboration in large-scale ASD, bridgeheads positively affects its effectiveness, as long the bridgeheads facilitates and encourage collaboration.

Bjarnason et al. (2022) identified two types of bridgeheads, formal and informal bridgeheads. Informal contacts act as natural bridgeheads because of their large social network within the organization, often created by seniority and job rotation combined with competence and an outgoing and helpful personality (Bjarnason et al., 2022). Formal contacts are reputed within the organization and designated for this role because of technical understanding and competence to coordinate. A disadvantage of informal bridgeheads over formal bridgeheads is that it is difficult to know who they are (Bjarnason et al., 2022). Formally assigned bridgeheads can shorten the time it takes to find a suitable person (Bjarnason et al., 2022). Another positive effect of formal bridgeheads is that knowledge is concentrated by a few people who can transmit it (Bjarnason et al., 2022). In contrast, the vulnerability of having all the knowledge concentrated among a few people in case of absence or departure. Having a formal bridgehead within a team improves the efficiency of communication between teams, but reduces the overall amount of interaction between individuals, which can reduce the overall awareness of other teams (Bjarnason et al., 2022).

4.4 Results synthesis

In this final section I present the synthesis of the results found in previous sections. The factors identified in the literature plus the novel factors mentioned by practitioners are related to the best practices found in the literature. The results of the synthesis are provided in a factor-best practice overview, shown in table 6.

In terms of the factor-best practice overview, it includes both the factors that, according to the existing literature, influence the effectiveness of inter-team collaboration in large-scale ASD and the new factors suggested by the experts interviewed. To clearly delineate these two starting perspectives, the new factors are mentioned in italics in the tool. Thus, to better manage inter-team dependencies and thereby increase the effectiveness of inter-team collaboration in large-scale ASD, an organization can implement inter-team meetings, communities of practices, OKRs and so on. It is not necessary to tick all relevant best practices per factor to increase the effectiveness of inter-team collaboration. As an organization, it is important to investigate in which areas the effectiveness of inter-team collaboration is low while providing potential and from there, identify which best practices can be implemented the best within the organization. It is important to maintain a broad and dynamic view on effectively managing inter-team collaboration in large-scale ASD, as some factors and best practices change over time within an organization. For each identified factor, an explicit reflection on the best practices is provided to indicate how the factor in relation to the best practices contributes to the effectiveness of inter-team collaboration in large-scale ASD. These relationships are based on previously mentioned findings and my own assumptions about the factors identified in the literature, the new factors identified by practitioners and the best practices identified in the literature. For more detailed information about the mentioned factors and best practices, I refer to previous sections of this chapter.

Table 6. Factor-best practice overview

		Best practices																			
		Activities					*Tools and artefacts*										*Structure*				
		Inter-team meetings	Communities of practices	Task force teams	Mini-demos	Cross-organizational events and activities	Instant messaging channels	Process standardization	Objectives and key results (OKRs)	Facilitate face to face communication	Roadmap sharing	Organization map	Shared backlog	Knowledge sharing tools	Job and office rotation	Iterative higher-level planning	Large-scale agile frameworks	Co-location of teams	Open office space	Permanent support teams	Bridgeheads
Factors	1. Inter-team dependencies	✓	✓						✓			✓	✓	✓			✓		✓	✓	✓
	2. Planning alignment	✓		✓				✓	✓		✓		✓			✓	✓			✓	✓
	3. Knowledge sharing	✓	✓		✓		✓							✓	✓				✓		✓
	4. Communication					✓	✓			✓								✓	✓		✓
	5. Team autonomy	✓						✓								✓		✓	✓		
	6. Personal differences																				
	7. Clarity of roles and responsibilities											✓			✓						
	8. Collaborativeness of organizational structure	✓								✓							✓	✓			
	9. Collaborativeness of organizational culture					✓															
	10. Clarity of organizational strategy						✓		✓					✓							
	11. Human resources		✓											✓							
	12. Organizational growth																				

Inter-team dependencies

To ensure that inter-team dependencies are managed more effectively to create more effective inter-team collaboration in large-scale ASD, it is important to be aware of inter-team dependencies (Bick et al., 2018). This can be done by reducing cognitive distance (Bjarnason et al., 2022) and creating physical proximity (Bjarnason et al., 2022). The following best practices contribute to the awareness of inter-team dependencies. First, inter-team meetings contribute by increasing the social network size of teams and providing a clear overview of what is going on in the projects and within other teams (Berntzen et al., 2021; Moe et al., 2018; Nyrud & Stray, 2017). Second, CoPs contribute by sharing knowledge and experience which reduces cognitive distance (Berntzen et al., 2021; Moe et al., 2018). Third, OKRs contribute by providing overview in the development process and increase state awareness across teams (Berntzen et al., 2021). Fourth, knowledge sharing tools contribute by sharing knowledge across teams which reduces cognitive distance (Dingsøyr, Moe, & Seim, 2018; Santos et al., 2014). Fifth, permanent support teams contribute by managing technical dependencies. Sixth, bridgeheads contribute through better knowledge transfer and overview of dependencies (Martini et al., 2013). In addition, the best practices organization map, shared backlog, large-scale agile frameworks and open office space contribute by generating overview and insights into other teams work (Berntzen et al., 2021; Bjornson et al., 2018; Christopher & de Vries, 2020; Gustavsson, 2020).

Planning alignment

To ensure that inter-team planning is better aligned to create more effective inter-team collaboration in large-scale ASD, it is important to create coherence between prioritization, specification, estimation and allocation (Bick et al., 2018). The following best practices contribute to the alignment of inter-team planning. First, inter-team meetings contribute by potentially managing coordination between teams (Berntzen et al., 2021; Nyrud & Stray, 2017). Second, task force teams contribute by executing tasks with priority (Berntzen et al., 2021; Moe et al., 2018). Third, standardization contributes by ensuring

that things adhere to specific standards and aligning autonomous teams (Berntzen et al., 2021). Fourth, OKRs contribute by creating better assessment on what to prioritize within the organization and simplifies the decision making process (Berntzen et al., 2021). Fifth, roadmap sharing contributes by promoting visibility into other teams' processes and disclosing teams priorities (Berntzen et al., 2021). Sixth, a shared backlog contributes by providing insights in the progress and tasks of other teams and allows delayed tasks to be picked up by other teams (Berntzen et al., 2021). Seventh, iterative higher level planning contributes by seeking alignment earlier in the decision making process (Bick et al. 2016). Eighth, large-scale agile frameworks contribute by providing a more structured way for planning precision for all teams (Gustavsson, 2020). Ninth, permanent support teams contribute by ensuring alignment between the development teams (Berntzen et al., 2021). Finally, bridgeheads are related because they provide alignment in communication and planning (Martini et al., 2013).

Knowledge sharing

To ensure that knowledge is shared efficiently to create more effective inter-team collaboration in large-scale ASD, it is important to use appropriate channels and create accessibility for all relevant teams (Evbota et al., 2016; Martini et al., 2013). The following best practices contribute to the efficiency of sharing knowledge. First, inter-team meetings contribute due the fact that the necessary teams are engaged and receive the same information (Nyrud & Stray, 2017). Second, CoPs contribute by sharing experiences and knowledge about relevant topics where other teams could learn from (Berntzen et al., 2021). Third, mini-demos support by showing development updates and validates whether information has been received and interpreted correctly (Bjornson et al., 2018; Dingsøyr, Moe, & Seim, 2018). Fourth, job and office rotation supports due to the fact that rotating employees between teams and office locations is a means of promoting familiarity and knowledge of other teams (Bjarnason et al., 2022; Santos et al., 2014). Fifth, the open office space facilitates knowledge sharing because there are no walls to block it (Berntzen et al., 2021; Dingsøyr, Moe, & Seim, 2018; Moe et al., 2018; Nyrud & Stray, 2017). Finally, instant messaging channels, knowledge sharing tools and bridgeheads contribute by providing an convenient way to share knowledge (Berntzen et al., 2021; Martini et al., 2013; Santos et al., 2014).

Communication

To ensure effective communication to create more effective inter-team collaboration in large-scale ASD, it is important to align the communication styles (Martini et al., 2013) and conduct the amount of interaction that is needed to collaborate efficient (Bjarnason et al., 2022). The following best practices contribute to the effectiveness of communication. First, cross-organizational events and activities contribute by bringing people from different parts of the organization together to interact with each other (Dingsøyr, Moe, & Seim, 2018; Santos et al., 2014). Second, instant messaging channels contributes by providing an convenient way to share knowledge and reach out to people (Berntzen et al., 2021). Third, facilitating face to face communication contributes due to the fact that it supports employees to talk to each other instead of relying on instant messaging channels (Bjarnason et al., 2022). Fourth, co-location supports by allowing teams to walk past and talk to other teams (Bjornson et al., 2018). Fifth, open office space contribute due to the fact that it results in the emergence of informal and ad hoc conversations (Nyrud & Stray, 2017). Finally bridgeheads contribute by providing alignment in communication (Martini et al., 2013).

Team autonomy

To increase the effectiveness of inter-team collaboration in large-scale ASD, it is important to sacrifice some autonomy for the individual team (Gustavsson, 2020) and to provide more centralized decision-making (Dingsøyr & Moe, 2014). The following best practices contribute to this. First, inter-team meetings and open office space contribute due to the fact that they provide overview of what is going on within other teams (Berntzen et al., 2021; Moe et al., 2018; Nyrud & Stray, 2017). Second, standardization contributes to sacrificing autonomy because it ensures that things adhere to specific standards to align autonomous teams (Berntzen et al., 2021). Third, iterative higher-level planning

contributes by relocating the decision-making process to the higher level management with assistance of experienced team members, reducing teams autonomy (Bick et al., 2016). Fourth, co-location contributes by allowing teams to walk past other teams to see what they are working on (Bjornson et al., 2018). Finally, bridgeheads contribute by providing overview and connect autonomous teams with a bridgehead (Martini et al., 2013).

Personal differences

To increase the effectiveness of inter-team collaboration in large-scale ASD, it is important to manage personal differences in inter-team collaborations (Bjarnason et al., 2022). In the selected literature, no best practices were identified that contribute to this. Perhaps this is due to the inevitability of differences in personalities. If an organization seeks to control this, that responsibility belongs to the recruitment of the organization which is beyond the scope of this study.

Clarity of roles and responsibilities

To ensure clarity of roles and responsibilities to create more effective inter-team collaboration in large-scale ASD, it is important to create well-defined (team) roles and responsibilities (Gustavsson, 2020). The following best practices contribute to this. First, the organization map contributes by providing identification of others by name and/or photo to generate overview across teams (Berntzen et al., 2021). Second, job and office rotation contributes by rotating employees between teams and office locations to promote familiarity and knowledge of other teams (Bjarnason et al., 2022; Santos et al., 2014).

Organizational structure

To increase the effectiveness of inter-team collaboration in large-scale ASD, it is important to create an organizational structure that facilitates the most effective form of collaboration (Dingsøyr & Moe, 2014) and to reduce distances by creating interaction (Martini et al., 2013). The following best practices contribute towards this. First, inter-team meetings contribute due the fact that it creates interactions by engaging all relevant teams in a possible virtual environment (Nyrud & Stray, 2017). Second, facilitating face-to-face communication contributes by supporting employees to talk to each other enable collaborations (Bjarnason et al., 2022). Third, large-scale agile frameworks contribute by providing more structure and overview for the organization (Gustavsson, 2020). Finally, co-location contributes by reducing the geographical distance between collaborating teams (Bjornson et al., 2018).

Organizational culture

To increase the effectiveness of inter-team collaboration in large-scale ASD, it is important to sustain cultural values (Bjarnason et al., 2022), and facilitate trust (Bjornson et al., 2018; Scheerer et al., 2014). The best practice cross-organizational events and practices contribute to this because it brings people from different parts of the organization together to establish social interaction between teams which facilitates trust. In addition, cultural values can be incorporated into these cross-organizational events and activities.

Clarity of organizational strategy

To establish a clear organizational strategy to create more effective inter-team collaboration in large-scale ASD, it is essential to communicate its importance to everyone in the organization. The following best practices contribute to a brighter organizational strategy. First, instant messaging channels contribute by providing a convenient way to communicate the organizational strategy and reach out to people (Berntzen et al., 2021). Second, OKRs contribute by providing a clear translation of the organizational strategy and provides clarity on what to focus on in the organization (Berntzen et al., 2021). Finally, knowledge sharing tools support by providing a channel to share the organizational strategy and its importance (Dingsøyr, Moe, & Seim, 2018).

Human resources

To increase the effectiveness of inter-team collaboration in large-scale ASD, it is important to have sufficient number of staff available and adequate human capital. The selected literature did not contain best practices to provide a sufficient number of staff. However, the literature did offer the following best practices that contributes human capital. First, CoPs contribute by providing a meeting or forum to share experience about relevant topics and to learn from each other (Berntzen et al., 2021). Second, knowledge sharing tools contribute by providing channels to invest in human capital (Santos et al., 2014).

Organizational growth

To ensure a proportionate growth as organization to create more effective inter-team collaboration in large-scale ASD, it is essential to grow proportionately as an organization relative to (new) personnel, materials and workload. In the selected literature, no best practices were identified that contribute to this. Possibly no relevant literature was identified since organizational growth cannot be influenced by best practices but rather by managerial decisions.

5 Discussion

This research aimed to provide a coherent, evidence-based understanding on how inter-team collaboration can be effectively managed in large-scale ASD. As such, I aimed to answer the following research question: How to manage inter-team collaboration effectively in large-scale agile software development? To address the stated research question, I used two sequential research approaches in this study. First, a systematic literature review was conducted to identify and synthesize the existing knowledge on factors and best practices affecting the effectiveness of inter-team collaboration in large-scale ASD. Second, 12 semi-structured interviews with practitioners were conducted to form a comprehensive understanding about the effectiveness of inter-team collaboration in CM.com's R&D department.

Given the results of this study, I identified 9 factors totaling 11 corresponding subfactors that influence effective inter-team collaboration in large-scale ASD. These identified factors are: Inter-team dependencies, planning alignment, knowledge sharing, communication, team autonomy, personal differences, clarity of roles and responsibilities, collaborativeness of organizational structure and collaborativeness of organizational culture. In addition, 20 best practices were identified in the literature. These best practices were combined into overarching categories. These categories are: Activity-based best practices, tools and artifacts, and structure-based best practices. Building on the insights from 12 semi-structured interviews with practitioners from CM.com, I identified three new factors that affect to the effectiveness of inter-team collaboration in large-scale ASD. These new factors are: Clarity of organizational strategy, human resources and organizational growth. In addition, I described each of the identified factors and best practices and illustrated how a factor affects the effectiveness of inter-team collaboration within CM.com's R&D department. Furthermore, by iteratively synthesizing the above findings into an overview based on the relations specified in the existing literature and interviews, I developed the factor-best practice overview. Finally, it is important to maintain a broad and dynamic view on effectively managing inter-team collaboration in large-scale ASD, as some factors and best practices change over time within an organization.

Thus, the findings of this study enhance our understanding about effectively managing inter-team collaboration in large-scale ASD and provide important implications for theory and practice. Additionally, the results generated insight and enhanced understanding about the effectiveness of inter-team collaboration within CM.com's R&D department. The following sections critically reflect on the findings of this study and discuss their implications for theory and practice. Since no study or researcher is complete, the limitations of this study and suggestions for future research are discussed afterwards.

5.1 Theoretical implications

One of the objectives of the current study was to fill the identified gaps in the literature. These gaps are the following. Gap 1: *"The current literature on factors and best practices, affecting effective inter-team collaboration in large-scale agile software development, is incoherent.",* gap 2: *"The current literature on factors affecting effective inter-team collaboration in large-scale agile software development, is likely incomplete.*" Therefore, in the following sections I interpret and critically discuss the results and theoretical contributions of the current study which are reflected on the literature gaps.

5.1.1 Factors and best practices originating from literature

This study contributes to the existing literature by providing a coherent overview and description of existing research on factors and best practices affecting effective inter-team collaboration in large-scale agile software development (ASD). In addition, to my knowledge, no work exists that compiles all the factors and best practices that influence the effectiveness of inter-team collaboration in large-scale ASD

in a coherent overview. Therefore, the systematic literature review fulfills literature gap 1 and contributes to the current literature.

These factors and best practices were identified in 23 carefully selected literature sources. It is noteworthy that no single literature source listed all of the identified factors and best practices. The literature sources focused on specific components of inter-team collaboration in large-scale ASD with only a limited number of factors or best practices identified per source. Thus, the results confirm previous statements about the incoherent literature as well as emphasizing the value of synthesizing the existing literature.

Based on the results, I can justify some careful reflections and interpretations. First, the importance, comprehensiveness and complexity of effective inter-team collaboration in large-scale ASD calls for an overarching coherent understanding toward it. The literature reveals that the effectiveness of inter-team collaboration depends on a large number of factors and best practices. In addition, the challenges of achieving more effective inter-team collaboration in large-scale ASD are repeatedly highlighted from a fragmented view. For example, literature indicates that knowledge sharing is important to achieve effective inter-team collaboration (Berntzen et al., 2021; Santos et al., 2014). However, it is equally important to align the planning of teams and raise teams' awareness of their dependencies. Focusing on one component of effective inter-team collaboration can complicate another. For instance, a structured method of documentation can reduce communication and consequently decrease dependency awareness. The literature on organizational change provides a holistic approach towards the organization (Cameron & Green, 2009). For instance, according to McKinsey seven "S" model (Channon & Caldart, 2015), the organization is a set of interconnected and interdependent subsystems such as staff, strategy and structure. With the fact that effective inter-team collaboration is an evolving process (Bedwell et al., 2012), and the complexity given the large number of factors and best practices, it is important to apply a holistic approach to manage inter-team collaboration effectively in large-scale ASD.

Second, the influence of the identified factors and best practices on the effectiveness of team collaboration in large-scale ASD is highly case-specific. As an example, the results show that planning alignment contributes to the effectiveness of inter-team collaboration in large-scale ASD (Berntzen et al., 2021; Bick et al., 2018; Dingsøyr, Moe, Fægri, et al., 2018; Evbota et al., 2016; Figalist et al., 2019; Gustavsson, 2020). However, it is considerably easier for autonomous teams working separately on their own software product to align planning than autonomous teams working separately on components of the same product. Thus, while planning alignment can contribute to the effectiveness of inter-team collaboration, it is highly case-specific. This distinction renders insights of factors and best practices, that affect the effectiveness of inter-team collaboration in large-scale ASD, more applicable or useful than others, depending on the specific case.

Third, it is noteworthy that the identified best practices focus primarily on creating overview within organizational teams (Berntzen et al., 2021; Bjornson et al., 2018; Evbota et al., 2016; Gustavsson, 2020; Uludag et al., 2018). Since the best practices are primarily focused on creating overview within the organization, it appears that this is seen in the literature as a requisite for the effectiveness of inter-team collaboration in large-scale ASD. Furthermore, the focus of the best practices on creating overview within the organization also initiates that in terms of the effectiveness of inter-team collaboration in large-scale ASD, obscurity is the primary obstacle.

5.1.2 New factors originating from practice

This study contributes to the existing literature by suggesting new factors that may contribute to the effectiveness of inter-team collaboration in large-scale ASD. The insights of the 12 interviewed practitioners contribute to literature gap 2 and to the current literature. Thus, this study demonstrates that the current literature, regarding factors that affect inter-team collaboration in large-scale ASD, is arguably incomplete. Moreover, as discussed in the results section, data saturation was achieved in the

sample, which indicates that this study conducted a sufficient number of interviews for its research objectives.

Based on the findings, I can justify some tentative reflections and interpretations of the novel factors. The fact that these factors are not yet recognized in the relevant literature of effective inter-team collaboration in large-scale ASD is remarkable. Despite the fact that these novel factors could be case-specific and not generalizable, I obtained some theoretical implications. The first novel factor, clarity of organizational strategy, indicates the importance of clarifying the organizational strategy and the desired collaboration for the entire organization. The second novel factor, human resources, indicates the essence of having sufficient amount of available man hours. The third novel factor, organizational growth, suggests the essence of growing proportionally as organization.

Based on the results, I can justify some tentative overarching reflections and interpretations. First, it is noteworthy that three new factors came to light that were not apparent in the systematic literature review. This can be explained by the limited body of relevant literature on factors affecting the effectiveness of inter-team collaboration in large-scale ASD. So, the novel factors can contribute to a more complete body of literature about factors affecting the effectiveness of inter-team collaboration in large-scale ASD.

Second, the new identified factors do not represent new concepts. Every identified factor is a known factor for the effectiveness of inter-team collaborations, however, not yet in the context of large-scale ASD. The literary sources in which the identified factors influence the effectiveness of team collaboration are the following. A clear organizational strategy has been mentioned by Maccoby (2011) as an essential aspect that needs attention to prevent collaboration failure. Human resources has been identified by Mattessich et al. (1992) as a factor influencing collaboration between parties by having adequate funds and skills. And organizational growth has been identified by Weber (2000) as an important aspect in order to successfully collaborate, ideally with slow growth to sufficiently integrate new members. The literature on organizational change also emphasizes the importance of a clearly formulated strategy, having sufficient human resources and managing growth driven by acquisitions and mergers (Cameron & Green, 2009). The fact that the identified factors are well known in the literature does not diminish the value of the findings. Indeed, the well-developed nature of the factors contributes to a richer understanding of the factors and provides a more coherent picture of the impact these factors play on the effectiveness of inter-team collaborations in large-scale ASD.

The literature on organizational change also provides a holistic approach towards the organization. For instance, according to McKinsey seven "S" model, the organization is a set of interconnected and interdependent subsystems such as staff, strategy and structure. With the fact that effective inter-team collaboration is an evolving process, and the complexity given the large number of factors and best practices, it is important to apply a holistic approach.

5.1.3 Factor-best practice overview

To convey the insights gathered in this study in a coherent and insightful manner, I developed an overview that relates the identified and new factors, affecting the effectiveness of inter-team collaboration in large-scale ASD, to the identified best practices. The development of this overview contributes to the existing literature by providing a coherent conceptual overview of the available knowledge on how the factors, which influence the effectiveness of inter-team collaboration in large-scale ASD, can be leveraged by best practices. This tool possesses both the factors identified in the literature and new factors identified in the interviews. These factors together are related to the best practices found in the literature based on the literary and empirical findings. This overview visualizes the coherence, complexity and dynamics between factors and best practices that influence the effectiveness of inter-team collaboration in large-scale ASD. If multiple factors can be improved and multiple best practices can be incorporated, inter-team collaboration can be managed and improved more

effectively. Therefore, it is important to take a holistic view regarding the factors and best practices that affect the effectiveness of inter-team collaboration in large-scale ASD.

5.1.4 Overall implications

This section presents the overall theoretical implications of this study. First, by addressing the two identified gaps in the literature, this study has identified, summarized, and expanded existing knowledge about factors and best practices that influence the effectiveness of inter-team collaboration in large-scale ASD. This resulted in the most complete work on how inter-team collaboration can be effectively managed in large-scale ASD to date. As such, this research can serve as an overview of existing knowledge and a springboard for future research.

How to manage effective inter-team collaboration has been discussed in the literature in non-agile contexts as well. These contexts discuss similar aspects important for effective inter-team collaboration such as having a well-formulated project vision, efficient communication , proper alignment of planning and perspectives, face-to-face meetings, flexibility, transparency, culture and monitoring at different levels (Bedwell et al., 2012; Brocke & Lippe, 2015). The major difference between effective inter-team collaboration in large-scale ASD and in non-agile contexts, is that in the ASD context a high degree of autonomous teams are present and the industry rapidly changes. Also, it is noteworthy that more study has been conducted on inter-team collaboration in agile contexts. From this it can be concluded that inter-team collaboration in large-scale ASD is seen as more challenging and therefore has been and is treated more extensively.

5.2 Managerial implications

In addition on theoretical implications, the findings of the current study also offer valuable insights for managers who seek to use and integrate knowledge to most effectively establish team collaboration. I derived the managerial implications on the differences and similarities founded in prior literature and the empirical results of this study. General implications for managers are discussed first, followed by case-specific managerial implications and recommendations.

5.2.1 General managerial implications

Managers can first use the findings to generate broader understanding of the factors and best practices that influence the effectiveness of inter-team collaboration in large-scale ASD. In this way, they can generate more insight about how multiple teams collaborate within their organization. The impact and barriers of factors on inter-team collaboration provides a broad perspective with information each can utilize and apply in the organization in their own fashion. the same holds for the best practices that can be used to make inter-team collaboration more effective.

Second, the coherent overview provided by this study highlights the large number of factors and best practices that influence the effectiveness of inter-team collaboration in large-scale ASD. The factors and best practices each approach effective inter-team collaboration from their particular perspective. The results indicate that a dynamic and broad perspective is needed to effectively manage inter-team collaboration in large-scale ASD. This broad perspective is fruitful for organizations because it can reduce most of the obstacles facing the achievement of effective inter-team collaboration in large-scale ASD.

In addition, using the factor-best practice overview, the beneficial effects of factors on the effectiveness of inter-team collaboration can be strengthened by applying the related best practices. I compiled this overview based on the academic literature and empirical findings, which can help companies increase the effectiveness of inter-team collaboration. The company can assess their inter-team collaboration to understand what factors negatively affect their inter-team collaboration, and proceed from there to

identify best practices that can potentially reduce it. By incorporating best practices, companies in the large-scale ASD can improve the effectiveness of inter-team collaboration by, for example, generating overview or structure. An important note is that inter-team collaboration is a dynamic process and changes over time (Bedwell et al., 2012). As such, this also applies to the adoption of best practices (Bjørnson & Vestues, 2016; Dingsøyr, Moe, & Seim, 2018; Gustavsson, 2019, 2020; Moe et al., 2018). With this conscience, it is important to regularly analyze and review inter-team collaboration to remain as effective as possible.

5.2.2 Case-specific managerial implications

Drawing on the outlined situation of inter-team collaboration within CM.com's R&D department and the findings from the literature, a number of case-specific managerial implications and recommendations are provided to possibly improve the current level of effective inter-team collaboration in CM.com's R&D department.

First, my research examined the effectiveness of inter-team collaboration within CM.com's R&D department using the identified factors. The identified factors were used as a guide to describe the inter-team collaboration. This detailed elaboration, whereby the influence on the effectiveness of inter-team collaboration within the R&D department is reflected from each factor, allows CM.com to see for each factor how it relates to the effectiveness of their inter-team collaboration. For example, for the knowledge sharing factor, I outlined how knowledge is shared within CM.com's R&D department and found that the current form of knowledge sharing hinders the effectiveness of inter-team collaboration. CM.com can use this cohort elaboration from each factor to recognize where the strengths and weaknesses are within the R&D department in terms of their effectiveness of inter-team collaboration. As a result, CM.com knows exactly where to focus on to make their inter-team collaboration more effective.

Second, inter-team collaboration was rated by those interviewed on a scale of 1 to 10, with 1 representing the worst inter-team collaboration and 10 representing perfect inter-team collaboration. Inter-team collaboration with teams within the same business unit scored 6.92 and inter-team collaboration with teams outside the business unit scored 6.54. Besides giving an insight into how internally inter-team collaboration is evaluated, it appears that inter-team collaboration with teams both inside and outside the business unit is not yet optimal. It is noteworthy that inter-team collaboration within the R&D department is rated with a maximum score of 6.92, while many best practices are implemented. The following best practices are identified within the R&D department: Inter-team meetings (e.g., Scrum of scrum, product alignment meeting), communities of practices, task force teams, mini-demos (e.g., product updates), cross- organizational events and activities (e.g., Devdays) , instant messaging channels (e.g., Teams), facilitation of face to face communication, roadmap sharing, organization map (Team tree), knowledge sharing tools (e.g., Company feed), co-location of teams, open office space and permanent support teams (Core platform). So it seems important to me that CM.com evaluate the best practices implemented in the R&D department to potentially improve their current level of effective inter-team collaboration. For example, the town hall meeting is so far only applied within the CPaaS business unit and product alignment meetings take place at random times. So inter-team meetings are not structured and not applied proportionately within the R&D department. Therefore I recommend reviewing the best practices being applied currently to ensure consistent and correct application by all teams since this may prevent the best practices from achieving their intended effect.

Furthermore, the elaboration of the inter-team dependencies factor provided two interesting insights. First, by visualizing the inter-team dependencies within the R&D department (Figures 5 and 6), CM.com can gain insight into its inter-team dependencies. These could be dependencies such as requiring knowledge from another team, a required completed task from another team, or a blockage due to

another team's workflow (Berntzen et al., 2021; Stray et al., 2019). Both the teams that highly depend on others and the teams on which others heavily depend on are visualized in the visualization in such a way that the teams with the most dependencies stand out clearly. CM.com can use this information to identify both vulnerable teams and teams with potential positions of power. Teams that rely heavily on other teams, such as Mobile Marketing Cloud, may be considered vulnerable because the team's functioning depends on the output of lots of other teams which requires extensive management. Teams on whom other teams depend heavily, such as IT, can be seen as more powerful because many other teams depend on the output of this IT team. However, one can also perceive this as a vulnerability because once the IT team is not functioning, it immediately affects the functioning of a lot of other teams. So it is important to consider the vulnerability and power position of teams and incorporate this in certain decisions.

Second, by analyzing the inter-team dependency ratios, CM.com is able to conclude that dependency ratios with teams within the business unit are significantly greater than dependency ratios with teams outside their business unit. Teams within the same business unit work primarily on the same product and therefore depend less on teams outside their business unit to function. However, where all teams within the same business units have many dependencies with each other, this is not the case within the SaaS business unit. The SaaS business unit consists of teams working on multiple stand-alone products which makes them less dependent on each other for functioning. It is recommended that teams engaging in more inter-team collaboration should interact more with each other by reducing their physical- and cognitive distances (Bjarnason et al., 2022; Bjarnason & Sharp, 2017). Taking this into account, I advise to reconsider the composition of the SaaS business unit. Positioning the different products each in their own business unit will create more consistency in the structure of CM.com's R&D department.

Additionally, I recommend to implement two new best practices within CM's R&D department. These best practices are recommended to counteract the main obstacles, identified during the interviews, to effective inter-team collaboration in CM.com's R&D department. The first best practice I recommend is to standardize tools and processes to allow better alignment between autonomous teams (Berntzen et al., 2021). In particular, standardizing planning and the sharing of knowledge will make inter-team collaborations more effective. This can be accomplished, for example, by ensuring all teams to use the project management program Jira, which manages schedules and documentation. Based on empirical findings, standardization seems needed because teams have little understanding of other teams due to different tools, processes, documentation, planning and working methods. So, by integrating shared documentation routines, the same planning software or equivalent working methods, more alignment between the autonomous teams will be realized.

The second best practice I recommend is to implement objectives and key results (OKRs) to allow a better assessment about where to focus on within the company, to increase state awareness across teams, to identify constraints and bottlenecks that may slow down the delivery speed, and to simplify the decision making process (Berntzen et al., 2021). In particular, implementing overarching OKRs between multiple teams will make collaboration more effective (Castro, n.d.). This can be accomplished by establishing OKRs for each business unit and between teams that collaborate extensively (e.g., Channels One and Messaging Apps). Given the empirical findings, there is a lack of guidance due to an unclear organizational strategy and subsequent ad hoc decisions made by autonomous teams. Once OKRs are introduced at both the team and business unit levels, more guidance is created with more specific objectives.

Finally, multiple interviewees mentioned to experience unclarity about team names, and their roles and responsibilities. Having clear team roles and responsibilities are important for effective coordination (Moe et al, 2018) because it generates overview across teams and facilitates locating information (Bjornson et al, 2018; Evbota et al, 2016; Gustavsson, 2020; Uludag et al, 2018). Knowing who does what and knowing who knows what has a positive effect on the effectiveness of inter-team collaboration.

Besides the team tree, the literature did not provide a best practice to clarify team roles and responsibilities. Therefore, I recommend reviewing and discussing the clarity of team names, and their roles and responsibilities within CM.com's R&D department.

5.3 Limitations

Despite the careful planning and execution of this study, it is important to recognize its limitations. Starting with the limitations of the systematic literature review and synthesis. First, the list of factors and best practices produced is likely to be incomplete. The inclusion criteria for literature in the study resulted in exclusion of all languages other than English and exclusion of available literature prior to 2010. In addition, the search sets may not include all relevant synonyms of the core constructs. In addition, the three selected bibliographic databases may not include all relevant literature. The qualitative assessment of articles might also excluded sources with relevant information. Second, more than half of the selected literature is from Scandinavia. Most of the selected literature sources consist of case studies at Scandinavian companies and were written by Scandinavian professors. This results in findings that are not completely generalizable. Third, the explanations on how the identified factors and best practices contribute to the effectiveness of inter-team collaboration are likely incomplete and require further validation.

Next, the limitations of identifying new factors through expert interviews are discussed. First, the list of identified new factors is considered incomplete. It is possible that a sample of other practitioners, such as other teams or other companies, could provide new perspectives and insights. In the current sample, all interviewed practitioners were Dutch and working within CM.com's R&D department, which may have narrowed the perspectives on the topic of interest. Second, given the exploratory and qualitative nature of the method used to identify the emerging factors, this work can only serve as a starting point for future research. Third, the explanation of the new factors' influence on the effectiveness of inter-team collaboration in large-scale ASD, like that of the factors identified in the literature, is probably incomplete and needs to be validated.

In addition, the limitations of the factors with best practices tool are discussed. The factor-best practice tool, which was constructed based on the insights I obtained, should be interpreted solely as an illustrative first step.

Finally, the synthesis of the identified literature sources, the identification of new factors as well as the mirroring of the factors with best practices are based on my interpretations and reasoning. This subjectivity affects the validity of the findings. Because of their subjective nature, the findings cannot be considered complete until they are validated. The next section discusses opportunities for future research that can further validate and expand the understanding of the effectiveness of inter-team collaboration in large-scale ASD.

5.4 Future research

I think there are three important directions for future research to focus on. The first promising future research direction is to further explore the influence of factors and best practices on the effectiveness of inter-team collaboration and, in particular, the newly identified factors. This can be done through a similar qualitative design to this study that examines the views of new samples of practitioners. On the other hand, existing literature outside the large-scale ASD context can also be consulted for factors and best practices that influence the effectiveness of inter-team collaboration. With the second approach, extensive and well-developed literature from various contexts and related topics such as organizational change can be fruitful to consult. This future research direction will enhance the generalizability of the findings in this study.

Second, the literature reports that the adoption of best practices is not stable but dynamic and changes over time (Bjørnson & Vestues, 2016; Dingsøyr, Moe, & Seim, 2018; Gustavsson, 2019, 2020; Moe et al., 2018). In addition, the definition of effective inter-team collaboration establishes that it is an evolving process. Therefore, it is noteworthy that the literature does not take a dynamic perspective on the influence of factors on the effectiveness of inter-team collaborations in large-scale ASD. With insights on the dynamics of factors, organizations in large-scale ASD can better anticipate the complexities of effectively managing inter-team collaboration. These dynamics of factors can be studied by re-examining the influence of factors on the effectiveness of inter-team collaboration, for example, in the same organization 1 year after the publication of this study.

Finally, future research could explore the similarities or synergies between the identified factors and best practices. For example, current literature already discovered a relationship between planning alignment and inter-team dependencies (Berntzen et al., 2021; Bick et al., 2018). Examining the effects of similarities or synergies of the factors and best practices could provide more insight into their influence on the effectiveness of inter-team collaboration. With this further insight, the complexity regarding effective inter-team collaboration in large-scale ASD could be reduced and inter-team collaboration could potentially be managed more effectively in large-scale ASD. This future research can be done by examining the influence of multiple factors or best practices on each other and on the effectiveness of inter-team collaboration in large-scale ASD on a more detailed level.

6. Conclusion

Despite the fact that inter-team collaboration in large-scale agile software development (ASD) has been mentioned several times as major challenge, there is no coherent body of literature on how to make inter-team collaboration in large-scale ASD as effective as possible. Hence, this research aims to better understand this by studying what factors and best practices influence this. Not only is existing knowledge incoherent, but existing knowledge about factors and best practices that influence the effectiveness of inter-team collaboration in large-scale ASD is also fragmented. Therefore, this research aimed to provide a coherent, evidence-based understanding on how inter-team collaboration can be effectively managed in large-scale ASD. As such, I aimed to answer the research question: *How to manage inter-team collaboration effectively in large-scale agile software development?*

To guide this research, three sub-questions were formulated and answered in this study. The first sub-question (SQ1) focused on establishing the definition of effective inter-team collaboration. Through careful analysis of the existing literature, this study adopted the following well-researched and appropriate definition: "*An evolving process in which two or more teams actively and mutually engage in joint tasks and depend on each other with respect to operational functioning and the pursuit of at least one overarching organizational goal, with minimal overhead for the organization to achieve and maintain their desired level of performance.*" The second sub-question (SQ2) focused on identifying and synthesizing existing academic knowledge about factors and best practices affecting the effectiveness of inter-team collaboration in large-scale ASD. Through a systematic literature review and synthesis, this research identified the following factors with a total of 11 sub-factors: inter-team dependencies, planning alignment, knowledge sharing, communication, team autonomy, personal differences, clarity of roles and responsibilities, collaborativeness of organizational structure and collaborativeness of organizational culture. In addition, this research identified 20 best practices divided into the following categories: activity-based, tools and artifacts, and structure-based. The third sub-question (SQ3) aimed to contribute towards understanding what influences the effectiveness of team collaboration within CM.com's R&D department. Through field research and the insights of 12 interviewed practitioners, underpinned by the identified factors, a detailed understanding on how the effectiveness of inter-team collaboration within CM.com's R&D department is affected, was developed. In addition, the open exploration of factors during the semi-structured interviews identified three new factors, namely: clarity of organizational strategy, human resources and organizational growth.

By identifying and summarizing the existing knowledge on inter-team collaboration effectiveness in large-scale ASD and by further extending the existing knowledge with qualitative research, this study provided the most complete work to date. Managers can use the coherent overview and findings to better understand the factors and best practices that influence the effectiveness of inter-team collaboration in large-scale ASD. Synthesizing the knowledge from the studies described above into a factor-best practice overview provides both academics and practitioners with an overview of existing academic knowledge. Although it is important to maintain a broad and dynamic view of effectively managing team collaboration in large-scale ASD, as some factors and best practices change over time within an organization. The insights and factor-best practice overview ensures an understanding of how inter-team collaboration can be managed more effectively, and thereby answering the research question of this study. In addition, this study elaborated case-specific managerial implications that allow inter-team collaboration in the R&D department of CM.com to be managed more effectively. Even though the current study offers interesting insights for academics and practitioners, there are limitations to consider. Therefore, I encourage more studies to delve into this topic.

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Appendix A. Team tree

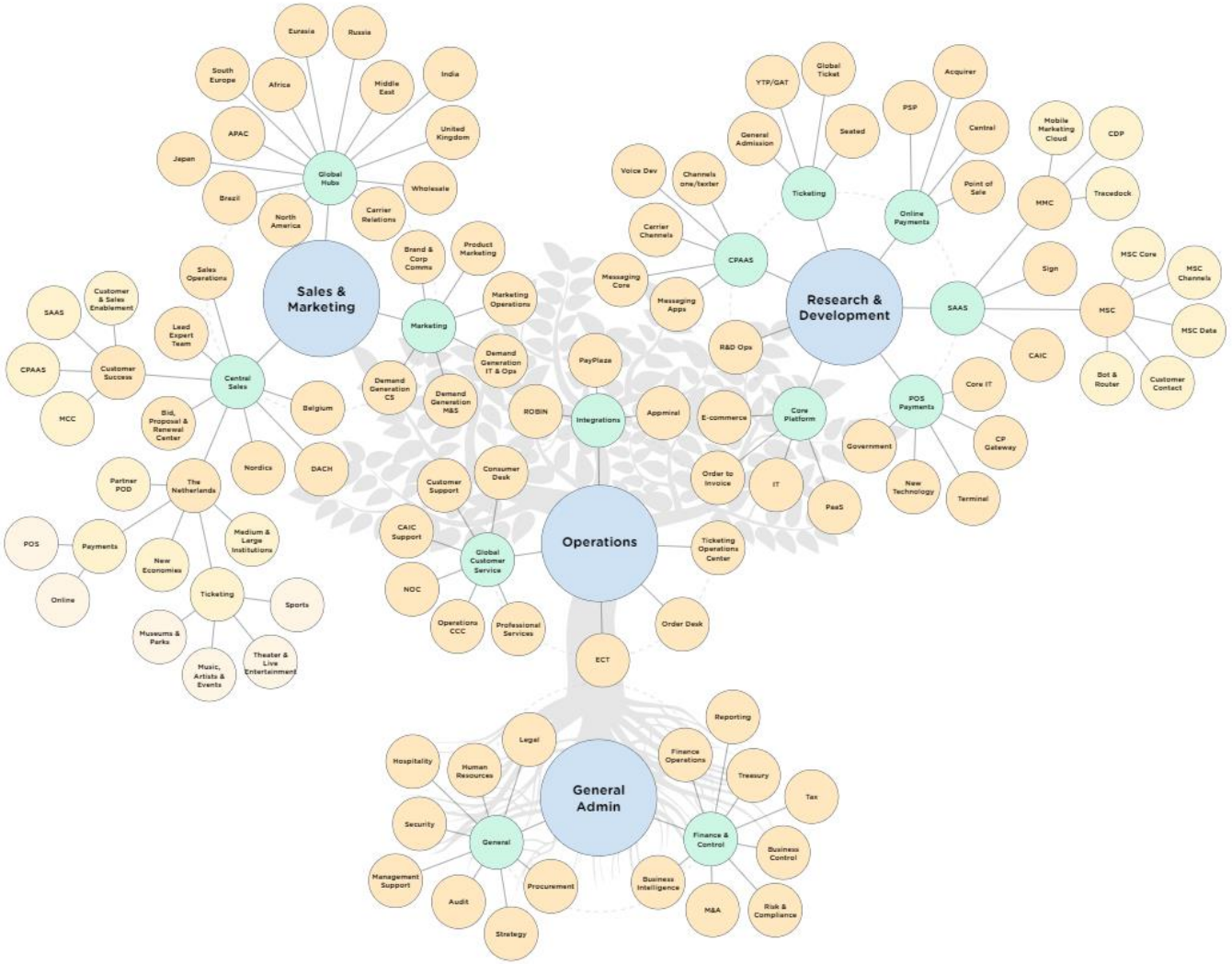


Figure 1 Team tree CM.com (CM.com, 2022)

Appendix B. Interview protocol

Introduction

I'd like to thank you for participating in the interview aspect of my study. My name is Koen Ormel and I am conducting my master thesis of the master Innovation Management at the Technical University Eindhoven, in collaboration with CM.com. The goal of this study is to gain insights on how to effectively manage inter-team collaboration in large-scale agile software development. Therefore the research question of this analysis is: How to manage inter-team collaboration effectively in in large-scale agile software development?

Our interview today will last approximately one hour. Participation in this interview is voluntary and all answers will be recorded. Following the completion of this study all recordings will be stored in accordance with regulations and CM.com policies. In fact the interview will be handled anonymously, however due to the possible publication of your job function this cannot be guaranteed. The job function could be important for the analysis and will therefore be noted (e.g. A product owner will be noted as product owner 1, product owner 2, etc.) . Do you agree with the above mentioned terms for our conversation today?

Background information interviewee and team

- Could you tell me something about your current function and your professional background?
    - What are your areas of responsibility?
    - How many years of relevant working experience do you have?
- Could you tell me something about the organization and structure of your team?
    - How is agile/scrum implemented in your team?
- How would you rate the collaboration between teams in your business-unit? (1-10)
- How would you rate the collaboration between teams outside your business-unit? (1-10)

Concept alignment

- How would you define effective inter-team collaboration?
- The following definition of effective inter-team collaboration is retrieved from literature. Do you agree with this definition? If not, why not?
    - "*An evolving process in which two or more teams actively and reciprocally engage in joint tasks and depend on each other with respect to operational functioning and the pursuit of at least one overarching organizational goal, with minimal overhead for the organization to achieve and maintain their desired level*."

Open exploration factors affecting the effectiveness of inter-team collaboration

- Do you experience factors that affect the effectiveness of inter-team collaboration within the R&D department? if yes, what factors do you experience?
    - Why does factor ….. affect the effectiveness of inter-team collaboration?
    - Could you provide an example of factor ….. ?
    - *Repeat for other factors*

Discuss insights from literature

- If insights mentioned in the literature are not mentioned in the open exploration:
    - Would you agree ……. is an factor that affect the effectiveness of inter-team collaboration? If not, could you elaborate your opinion?
    - Why does factor ….. (not) affect the effectiveness of inter-team collaboration?
    - Could you provide an example of factor ….. ?
    - *Repeat for other factors*

Open exploration opportunities for effective inter-team collaboration

- Do you experience opportunities that could improve the effectiveness of inter-team collaboration within the R&D department? If yes, what opportunities do you think of?

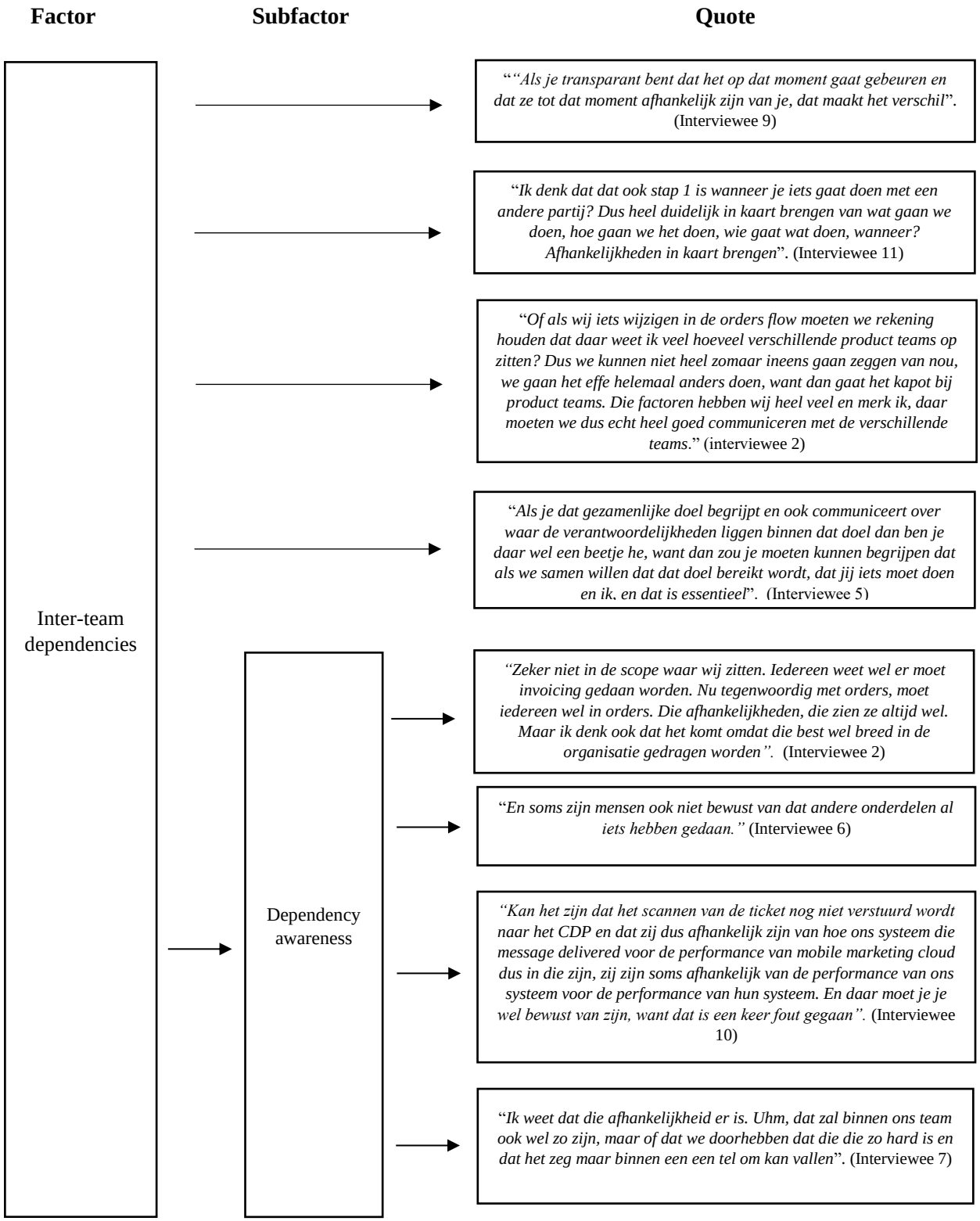
    - Why does opportunity ….. encourage the effectiveness of inter-team collaboration?
    - Could you provide an example of opportunity ….. ?
    - *Repeat for other opportunities*

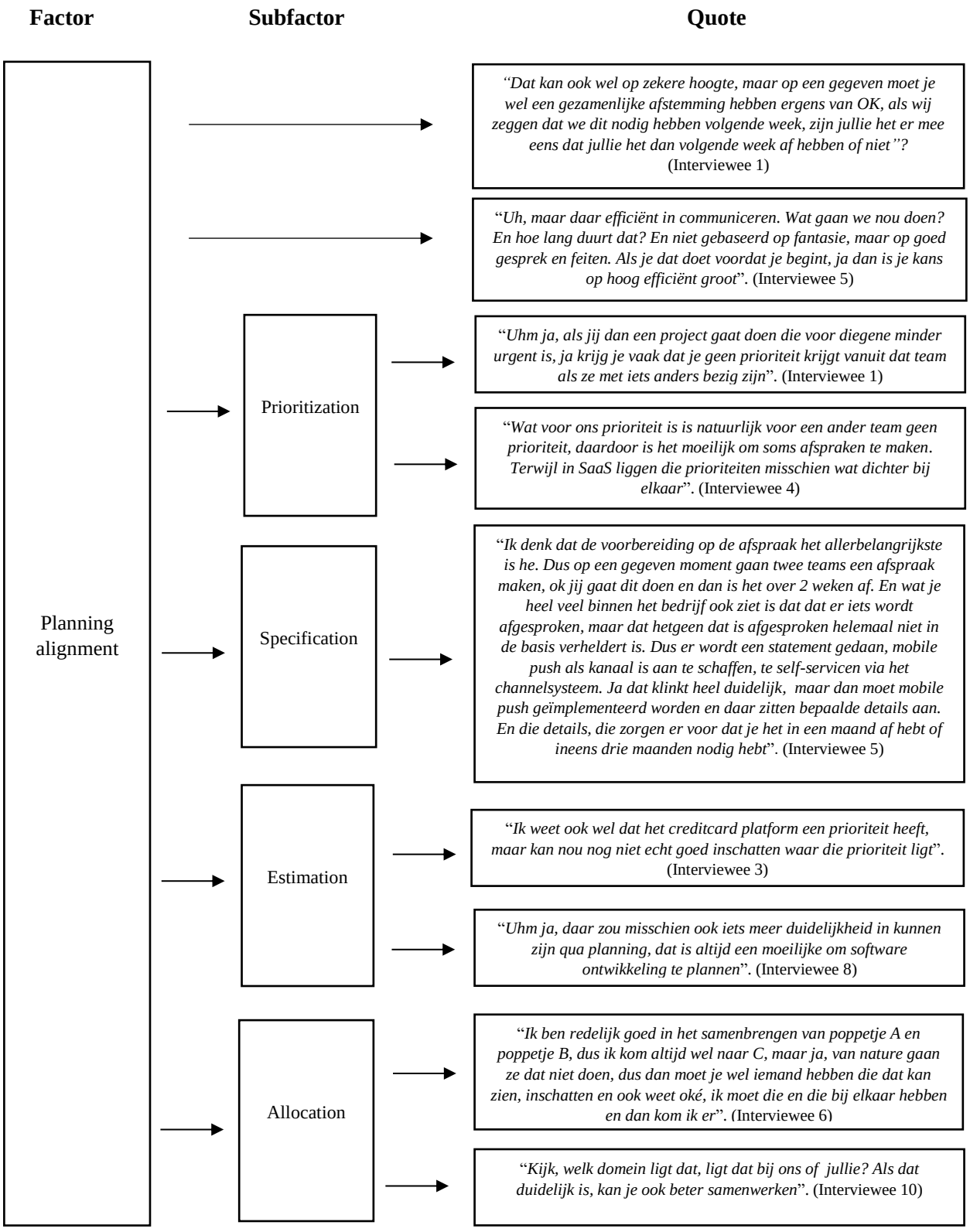
- When interviewee mentioned opportunities: To what extent are you willing to adopt the mentioned opportunities?
    - To what extent are you willing to adapt to the implementation of these opportunities?

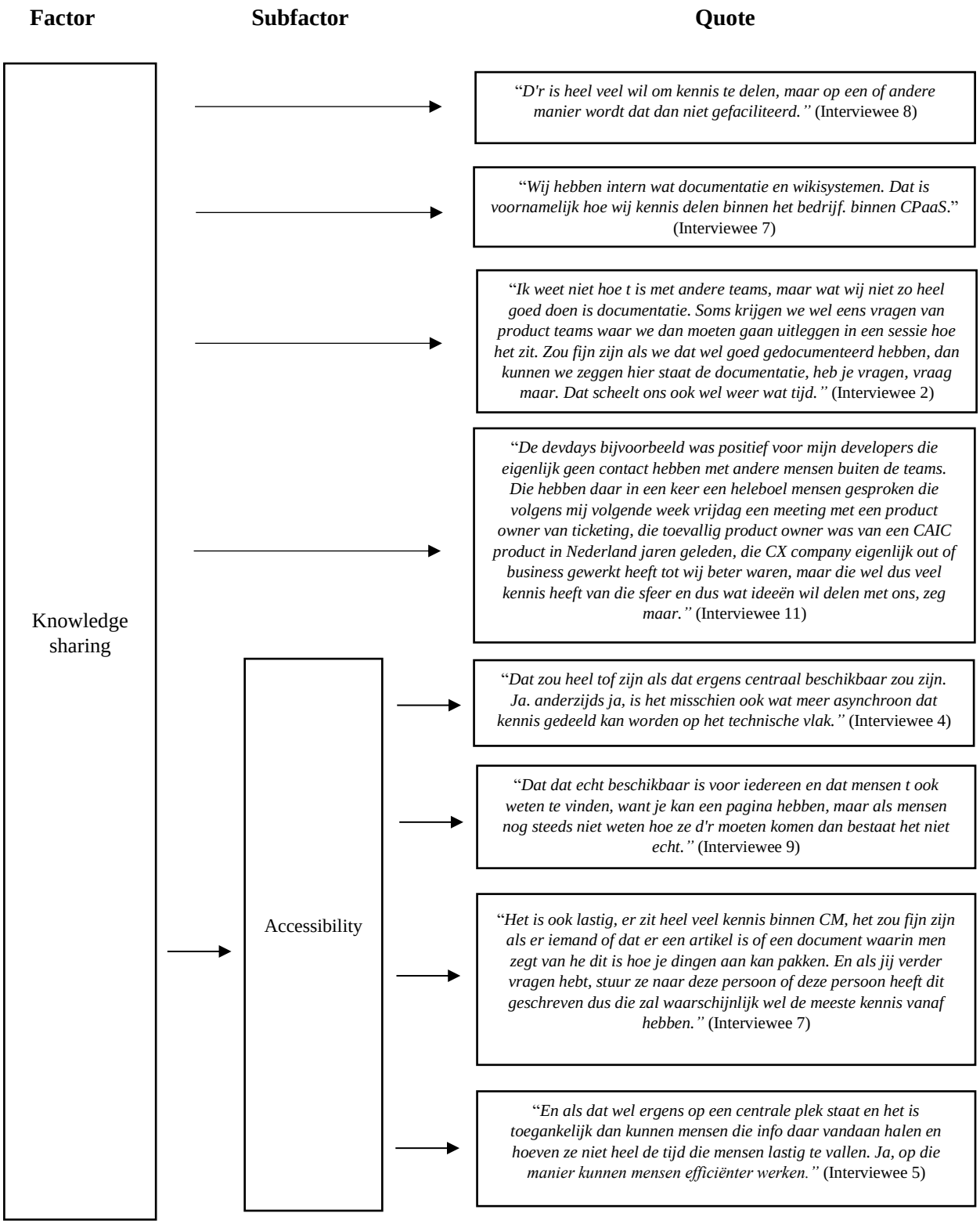
Concluding interview

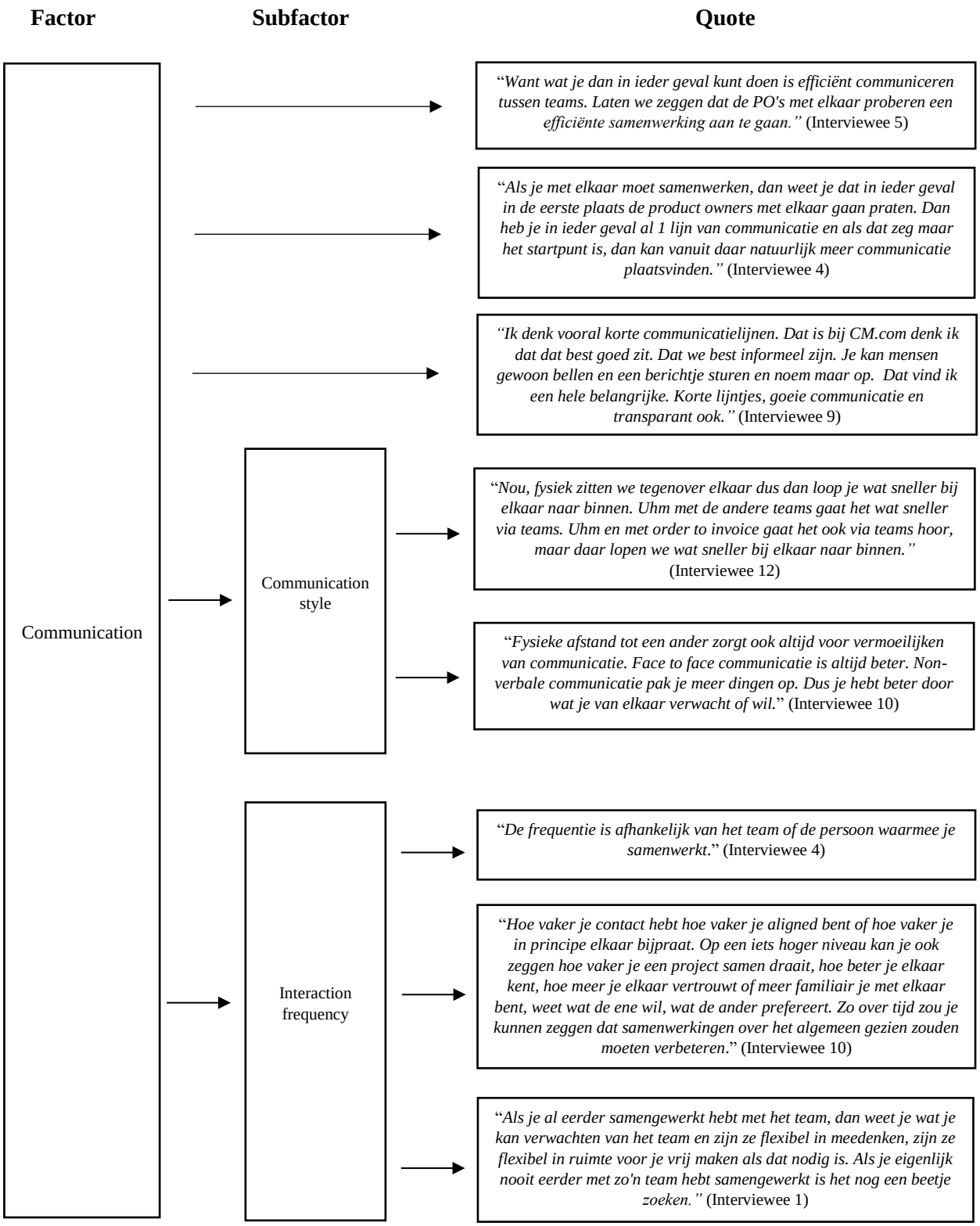
- Are there any additional insights that you feel are worth to mention that are not addressed yet?
- Would you recommend someone else that could provide important insights regarding this topic?
- Thank you for your participation.

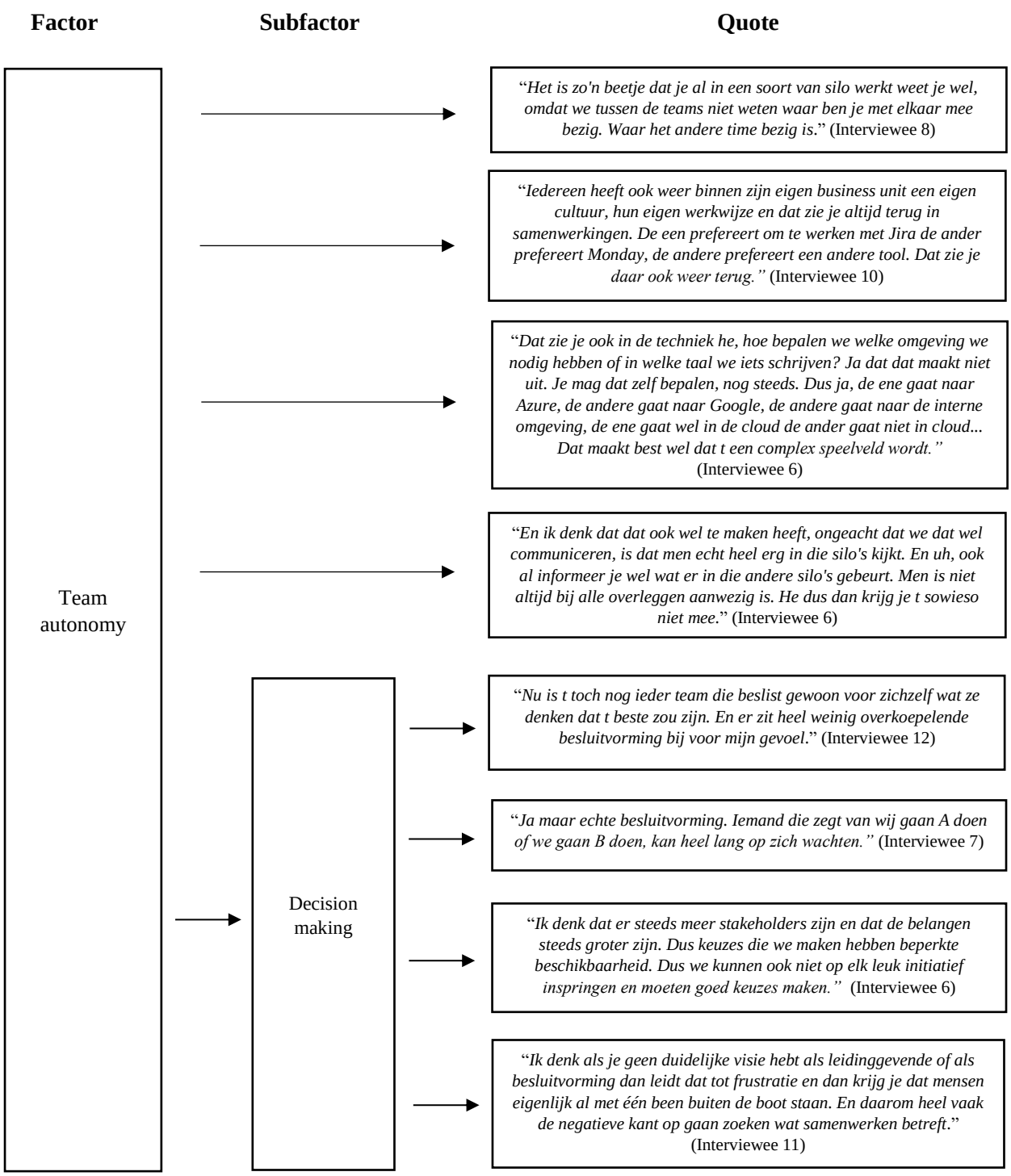
Appendix C. Deductive coding scheme

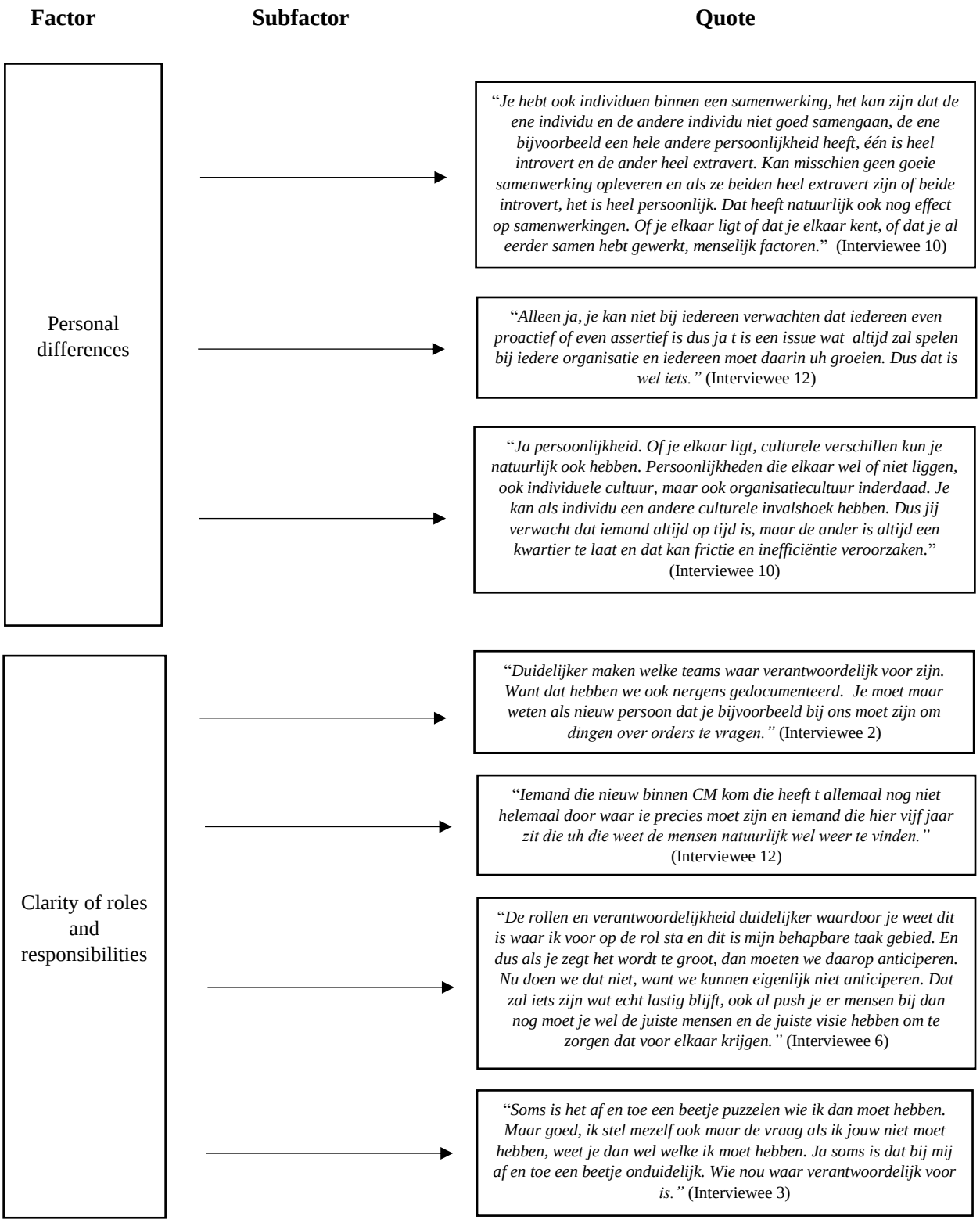


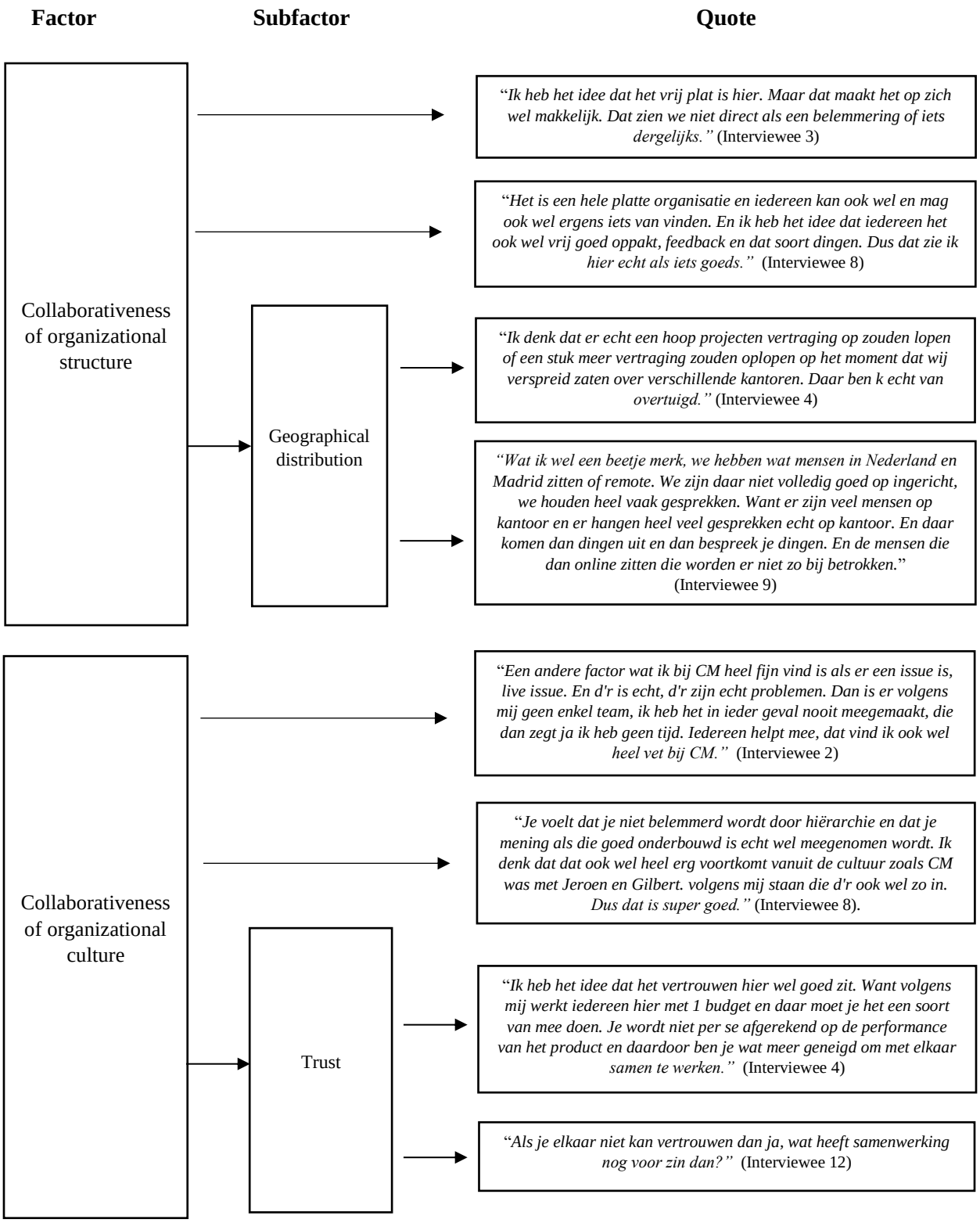

Factor
Subfactor
Quote
Planning alignment
Prioritization
Specification
Estimation
Allocation
"Dat kan ook wel op zekere hoogte, maar op een gegeven moet je wel een gezamenlijke afstemming hebben ergens van OK, als wij zeggen dat we dit nodig hebben volgende week, zijn jullie het er mee eens dat jullie het dan volgende week af hebben of niet"? (Interviewee 1)
"Uh, maar daar efficiënt in communiceren. Wat gaan we nou doen? En hoe lang duurt dat? En niet gebaseerd op fantasie, maar op goed gesprek en feiten. Als je dat doet voordat je begint, ja dan is je kans op hoog efficiënt groot". (Interviewee 5)
"Uhm ja, als jij dan een project gaat doen die voor diegene minder urgent is, ja krijg je vaak dat je geen prioriteit krijgt vanuit dat team als ze met iets anders bezig zijn". (Interviewee 1)
"Wat voor ons prioriteit is is natuurlijk voor een ander team geen prioriteit, daardoor is het moeilijk om soms afspraken te maken. Terwijl in SaaS liggen die prioriteiten misschien wat dichter bij elkaar". (Interviewee 4)
"Ik denk dat de voorbereiding op de afspraak het allerbelangrijkste is he. Dus op een gegeven moment gaan twee teams een afspraak maken, ok jij gaat dit doen en dan is het over 2 weken af. En wat je heel veel binnen het bedrijf ook ziet is dat dat er iets wordt afgesproken, maar dat hetgeen dat is afgesproken helemaal niet in de basis verheldert is. Dus er wordt een statement gedaan, mobile push als kanaal is aan te schaffen, te self-servicen via het channelsysteem. Ja dat klinkt heel duidelijk, maar dan moet mobile push geïmplementeerd worden en daar zitten bepaalde details aan. En die details, die zorgen er voor dat je het in een maand af hebt of ineens drie maanden nodig hebt". (Interviewee 5)
"Ik weet ook wel dat het creditcard platform een prioriteit heeft, maar kan nou nog niet echt goed inschatten waar die prioriteit ligt". (Interviewee 3)
"Uhm ja, daar zou misschien ook iets meer duidelijkheid in kunnen zijn qua planning, dat is altijd een moeilijke om software ontwikkeling te plannen". (Interviewee 8)
"Ik ben redelijk goed in het samenbrengen van poppetje A en poppetje B, dus ik kom altijd wel naar C, maar ja, van nature gaan ze dat niet doen, dus dan moet je wel iemand hebben die dat kan zien, inschatten en ook weet oké, ik moet die en die bij elkaar hebben en dan kom ik er". (Interviewee 6)
"Kijk, welk domein ligt dat, ligt dat bij ons of jullie? Als dat duidelijk is, kan je ook beter samenwerken". (Interviewee 10)


Factor
Subfactor
Quote
Knowledge sharing
Accessibility
"D'r is heel veel wil om kennis te delen, maar op een of andere manier wordt dat dan niet gefaciliteerd." (Interviewee 8)
"Wij hebben intern wat documentatie en wikisystemen. Dat is voornamelijk hoe wij kennis delen binnen het bedrijf. binnen CPaaS." (Interviewee 7)
"Ik weet niet hoe t is met andere teams, maar wat wij niet zo heel goed doen is documentatie. Soms krijgen we wel eens vragen van product teams waar we dan moeten gaan uitleggen in een sessie hoe het zit. Zou fijn zijn als we dat wel goed gedocumenteerd hebben, dan kunnen we zeggen hier staat de documentatie, heb je vragen, vraag maar. Dat scheelt ons ook wel weer wat tijd." (Interviewee 2)
"De devdays bijvoorbeeld was positief voor mijn developers die eigenlijk geen contact hebben met andere mensen buiten de teams. Die hebben daar in een keer een heleboel mensen gesproken die volgens mij volgende week vrijdag een meeting met een product owner van ticketing, die toevallig product owner was van een CAIC product in Nederland jaren geleden, die CX company eigenlijk out of business gewerkt heeft tot wij beter waren, maar die wel dus veel kennis heeft van die sfeer en dus wat ideeën wil delen met ons, zeg maar." (Interviewee 11)
"Dat zou heel tof zijn als dat ergens centraal beschikbaar zou zijn. Ja. anderzijds ja, is het misschien ook wat meer asynchroon dat kennis gedeeld kan worden op het technische vlak." (Interviewee 4)
"Dat dat echt beschikbaar is voor iedereen en dat mensen t ook weten te vinden, want je kan een pagina hebben, maar als mensen nog steeds niet weten hoe ze d'r moeten komen dan bestaat het niet echt." (Interviewee 9)
"Het is ook lastig, er zit heel veel kennis binnen CM, het zou fijn zijn als er iemand of dat er een artikel is of een document waarin men zegt van he dit is hoe je dingen aan kan pakken. En als jij verder vragen hebt, stuur ze naar deze persoon of deze persoon heeft dit geschreven dus die zal waarschijnlijk wel de meeste kennis vanaf hebben." (Interviewee 7)
"En als dat wel ergens op een centrale plek staat en het is toegankelijk dan kunnen mensen die info daar vandaan halen en hoeven ze niet heel de tijd die mensen lastig te vallen. Ja, op die manier kunnen mensen effiçiënter werken." (Interviewee 5)


Factor
Subfactor
Quote
Communication
Communication style
Interaction frequency
"Want wat je dan in ieder geval kunt doen is efficiënt communiceren tussen teams. Laten we zeggen dat de PO's met elkaar proberen een efficiënte samenwerking aan te gaan." (Interviewee 5)
"Als je met elkaar moet samenwerken, dan weet je dat in ieder geval in de eerste plaats de product owners met elkaar gaan praten. Dan heb je in ieder geval al 1 lijn van communicatie en als dat zeg maar het startpunt is, dan kan vanuit daar natuurlijk meer communicatie plaatsvinden." (Interviewee 4)
"Ik denk vooral korte communicatielijnen. Dat is bij CM.com denk ik dat dat best goed zit. Dat we best informeel zijn. Je kan mensen gewoon bellen en een berichtje sturen en noem maar op. Dat vind ik een hele belangrijke. Korte lijntjes, goeie communicatie en transparant ook." (Interviewee 9)
"Nou, fysiek zitten we tegenover elkaar dus dan loop je wat sneller bij elkaar naar binnen. Uhm met de andere teams gaat het wat sneller via teams. Uhm en met order to invoice gaat het ook via teams hoor, maar daar lopen we wat sneller bij elkaar naar binnen." (Interviewee 12)
"Fysieke afstand tot een ander zorgt ook altijd voor vermoeilijken van communicatie. Face to face communicatie is altijd beter. Non-verbale communicatie pak je meer dingen op. Dus je hebt beter door wat je van elkaar verwacht of wil." (Interviewee 10)
"De frequentie is afhankelijk van het team of de persoon waarmee je samenwerkt." (Interviewee 4)
"Hoe vaker je contact hebt hoe vaker je aligned bent of hoe vaker je in principe elkaar bijpraat. Op een iets hoger niveau kan je ook zeggen hoe vaker je een project samen draait, hoe beter je elkaar kent, hoe meer je elkaar vertrouwt of meer familiair je met elkaar bent, weet wat de ene wil, wat de ander prefereert. Zo over tijd zou je kunnen zeggen dat samenwerkingen over het algemeen gezien zouden moeten verbeteren." (Interviewee 10)
"Als je al eerder samengewerkt hebt met het team, dan weet je wat je kan verwachten van het team en zijn ze flexibel in meedenken, zijn ze flexibel in ruimte voor je vrij maken als dat nodig is. Als je eigenlijk nooit eerder met zo'n team hebt samengewerkt is het nog een beetje zoeken." (Interviewee 1)


Factor
Subfactor
Quote
Team autonomy
Decision making
"Het is zo'n beetje dat je al in een soort van silo werkt weet je wel, omdat we tussen de teams niet weten waar ben je met elkaar mee bezig. Waar het andere time bezig is." (Interviewee 8)
"Iedereen heeft ook weer binnen zijn eigen business unit een eigen cultuur, hun eigen werkwijze en dat zie je altijd terug in samenwerkingen. De een prefereert om te werken met Jira de ander prefereert Monday, de andere prefereert een andere tool. Dat zie je daar ook weer terug." (Interviewee 10)
"Dat zie je ook in de techniek he, hoe bepalen we welke omgeving we nodig hebben of in welke taal we iets schrijven? Ja dat dat maakt niet uit. Je mag dat zelf bepalen, nog steeds. Dus ja, de ene gaat naar Azure, de andere gaat naar Google, de andere gaat naar de interne omgeving, de ene gaat wel in de cloud de ander gaat niet in cloud... Dat maakt best wel dat t een complex speelveld wordt." (Interviewee 6)
"En ik denk dat dat ook wel te maken heeft, ongeacht dat we dat wel communiceren, is dat men echt heel erg in die silo's kijkt. En uh, ook al informeer je wel wat er in die andere silo's gebeurt. Men is niet altijd bij alle overleggen aanwezig is. He dus dan krijg je t sowieso niet mee." (Interviewee 6)
"Nu is t toch nog ieder team die beslist gewoon voor zichzelf wat ze denken dat t beste zou zijn. En er zit heel weinig overkoepelende besluitvorming bij voor mijn gevoel." (Interviewee 12)
"Ja maar echte besluitvorming. Iemand die zegt van wij gaan A doen of we gaan B doen, kan heel lang op zich wachten." (Interviewee 7)
"Ik denk dat er steeds meer stakeholders zijn en dat de belangen steeds groter zijn. Dus keuzes die we maken hebben beperkte beschikbaarheid. Dus we kunnen ook niet op elk leuk initiatief inspringen en moeten goed keuzes maken." (Interviewee 6)
"Ik denk als je geen duidelijke visie hebt als leidinggevende of als besluitvorming dan leidt dat tot frustratie en dan krijg je dat mensen eigenlijk al met één been buiten de boot staan. En daarom heel vaak de negatieve kant op gaan zoeken wat samenwerken betreft." (Interviewee 11)

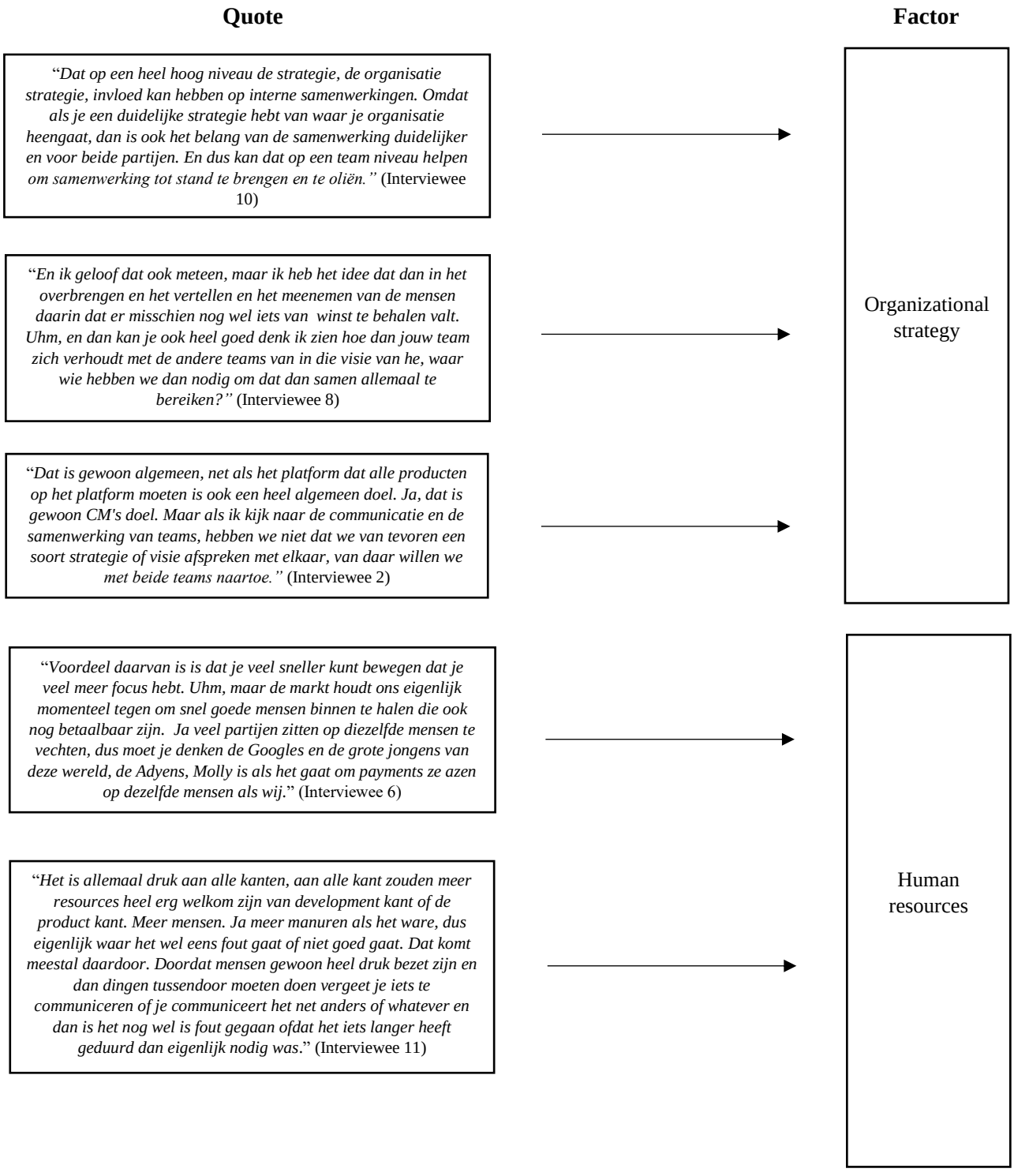

Factor
Subfactor
Quote
Personal differences
Clarity of roles and responsibilities
"Je hebt ook individuen binnen een samenwerking, het kan zijn dat de ene individu en de andere individu niet goed samengaan, de ene bijvoorbeeld een hele andere persoonlijkheid heeft, één is heel introvert en de ander heel extravert. Kan misschien geen goeie samenwerking opleveren en als ze beiden heel extravert zijn of beide introvert, het is heel persoonlijk. Dat heeft natuurlijk ook nog effect op samenwerkingen. Of je elkaar ligt of dat je elkaar kent, of dat je al eerder samen hebt gewerkt, menselijk factoren." (Interviewee 10)
"Alleen ja, je kan niet bij iedereen verwachten dat iedereen even proactief of even assertief is dus ja t is een issue wat altijd zal spelen bij iedere organisatie en iedereen moet daarin uh groeien. Dus dat is wel iets." (Interviewee 12)
"Ja persoonlijkheid. Of je elkaar ligt, culturele verschillen kun je natuurlijk ook hebben. Persoonlijkheden die elkaar wel of niet liggen, ook individuele cultuur, maar ook organisatiecultuur inderdaad. Je kan als individu een andere culturele invalshoek hebben. Dus jij verwacht dat iemand altijd op tijd is, maar de ander is altijd een kwartier te laat en dat kan frictie en inefficiëntie veroorzaken." (Interviewee 10)
"Duidelijker maken welke teams waar verantwoordelijk voor zijn. Want dat hebben we ook nergens gedocumenteerd. Je moet maar weten als nieuw persoon dat je bijvoorbeeld bij ons moet zijn om dingen over orders te vragen." (Interviewee 2)
"Iemand die nieuw binnen CM kom die heeft t allemaal nog niet helemaal door waar ie precies moet zijn en iemand die hier vijf jaar zit die uh die weet de mensen natuurlijk wel weer te vinden." (Interviewee 12)
"De rollen en verantwoordelijkheid duidelijker waardoor je weet dit is waar ik voor op de rol sta en dit is mijn behapbare taak gebied. En dus als je zegt het wordt te groot, dan moeten we daarop anticiperen. Nu doen we dat niet, want we kunnen eigenlijk niet anticiperen. Dat zal iets zijn wat echt lastig blijft, ook al push je er mensen bij dan nog moet je wel de juiste mensen en de juiste visie hebben om te zorgen dat voor elkaar krijgen." (Interviewee 6)
"Soms is het af en toe een beetje puzzelen wie ik dan moet hebben. Maar goed, ik stel mezelf ook maar de vraag als ik jouw niet moet hebben, weet je dan wel welke ik moet hebben. Ja soms is dat bij mij af en toe een beetje onduidelijk. Wie nou waar verantwoordelijk voor is." (Interviewee 3)

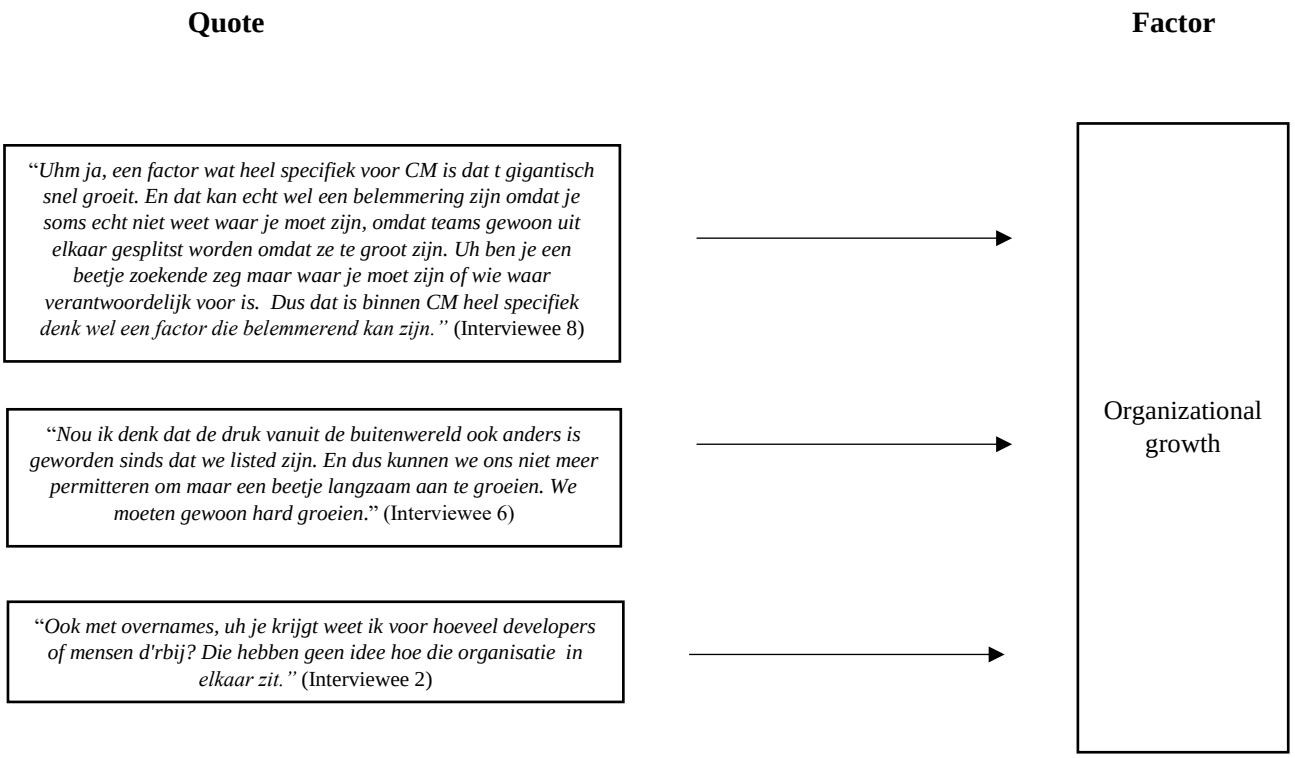

Factor
Subfactor
Quote
Collaborativeness of organizational structure
Geographical distribution
"Ik heb het idee dat het vrij plat is hier. Maar dat maakt het op zich wel makkelijk. Dat zien we niet direct als een belemmering of iets dergelijks." (Interviewee 3)
"Het is een hele platte organisatie en iedereen kan ook wel en mag ook wel ergens iets van vinden. En ik heb het idee dat iedereen het ook wel vrij goed oppakt, feedback en dat soort dingen. Dus dat zie ik hier echt als iets goeds." (Interviewee 8)
"Ik denk dat er echt een hoop projecten vertraging op zouden lopen of een stuk meer vertraging zouden oplopen op het moment dat wij verspreid zaten over verschillende kantoren. Daar ben k echt van overtuigd." (Interviewee 4)
"Wat ik wel een beetje merk, we hebben wat mensen in Nederland en Madrid zitten of remote. We zijn daar niet volledig goed op ingericht, we houden heel vaak gesprekken. Want er zijn veel mensen op kantoor en er hangen heel veel gesprekken echt op kantoor. En daar komen dan dingen uit en dan bespreek je dingen. En de mensen die dan online zitten die worden er niet zo bij betrokken." (Interviewee 9)
Collaborativeness of organizational culture
Trust
"Een andere factor wat ik bij CM heel fijn vind is als er een issue is, live issue. En d'r is echt, d'r zijn echt problemen. Dan is er volgens mij geen enkel team, ik heb het in ieder geval nooit meegemaakt, die dan zegt ja ik heb geen tijd. Iedereen helpt mee, dat vind ik ook wel heel vet bij CM." (Interviewee 2)
"Je voelt dat je niet belemmerd wordt door hiërarchie en dat je mening als die goed onderbouwd is echt wel meegenomen wordt. Ik denk dat dat ook wel heel erg voortkomt vanuit de cultuur zoals CM was met Jeroen en Gilbert. volgens mij staan die d'r ook wel zo in. Dus dat is super goed." (Interviewee 8).
"Ik heb het idee dat het vertrouwen hier wel goed zit. Want volgens mij werkt iedereen hier met 1 budget en daar moet je het een soort van mee doen. Je wordt niet per se afgerekend op de performance van het product en daardoor ben je wat meer geneigd om met elkaar samen te werken." (Interviewee 4)
"Als je elkaar niet kan vertrouwen dan ja, wat heeft samenwerking nog voor zin dan?" (Interviewee 12)

Appendix D. Inter-team dependency matrix

		CPaaS						Ticketing				Online payments					SaaS										POS Payments					Core Platform				R&D Ops	
		Messaging Apps	Messaging Core	Carrier Channels	Voice apps	Voice core	Channels one / texter	General Admission	YTP/GAT	Global Ticket	Seated	PSP	Payments Gateway / iDeal Acquiring	Central	Point of Sale	Card Acquiring	Sign	Mobile Marketing Cloud	CDP	Tracedock	MSC Core	MSC Channels	MSC Data	Customer Contact	Bot & Router	CAIC	Core IT	CP Gateway	Terminal	New Technology	Government	PaaS	IT	Order to Invoice	E-commerce	R&D Ops	*Total dependencies*
CPaaS	Messaging Apps		✓	✓		✓	✓											✓	✓													✓	✓	✓		9
	Messaging Core	✓		✓			✓																									✓	✓	✓		6
	Carrier Channels	✓	✓				✓																									✓	✓	✓		6
	Voice apps					✓																										✓	✓	✓		4
	Voice core				✓																	✓									✓	✓	✓			5
	Channels one / texter	✓	✓	✓														✓				✓			✓						✓	✓	✓	✓		10
Ticketing	General Admission			✓							✓	✓	✓	✓	✓			✓	✓													✓	✓	✓		11
	YTP/GAT							✓		✓	✓				✓			✓	✓								✓						✓				8
	Global Ticket	✓	✓					✓			✓	✓			✓			✓	✓								✓		✓				✓				11
	Seated							✓	✓	✓		✓	✓		✓			✓	✓														✓	✓	✓		11
Online payments	PSP												✓	✓		✓												✓	✓			✓				6
	Payments Gateway / iDeal Acquiring											✓		✓	✓	✓	✓	✓													✓	✓				8
	Central											✓	✓		✓	✓		✓									✓	✓	✓	✓	✓	✓	✓	✓		14
	Point of Sale									✓		✓	✓	✓				✓	✓								✓	✓	✓	✓			✓				11
	Card Acquiring											✓	✓	✓																		✓				4
SaaS	Sign	✓		✓								✓	✓					✓														✓	✓	✓		8
	Mobile Marketing Cloud	✓	✓	✓	✓	✓	✓					✓	✓	✓					✓													✓	✓	✓	✓	15
	CDP																			✓													✓	✓		3
	Tracedock									✓									✓		✓		✓										✓	✓		6
	MSC Core																		✓	✓													✓	✓		4
	MSC Channels				✓	✓															✓				✓	✓							✓	✓		6
	MSC Data																			✓	✓												✓	✓		4
	Customer Contact																								✓								✓	✓		4
	Bot & Router						✓														✓		✓			✓							✓	✓	✓	7
	CAIC																							✓									✓	✓		3
POS Payments	Core IT													✓														✓	✓		✓	✓				6
	CP Gateway												✓	✓	✓	✓											✓		✓	✓							7
	Terminal														✓												✓	✓									3
	New Technology																										✓	✓				✓					3
	Government																										✓										1
Core Platform	PaaS																															✓					1
	IT		✓																																		1
	Order to Invoice		✓									✓					✓	✓														✓					6
	E-commerce	✓	✓			✓												✓														✓	✓				6
R&D Ops	R&D Ops																															✓					1
	Total dependencies	7	8	6	3	5	5	3	1	4	3	11	9	8	8	4	2	12	9	0	1	4	1	1	4	2	9	6	6	3	2	7	31	20	16	1	

Appendix E. Inductive coding scheme




Quote
Factor
"Uhm ja, een factor wat heel specifiek voor CM is dat t gigantisch snel groeit. En dat kan echt wel een belemmering zijn omdat je soms echt niet weet waar je moet zijn, omdat teams gewoon uit elkaar gesplitst worden omdat ze te groot zijn. Uh ben je een beetje zoekende zeg maar waar je moet zijn of wie waar verantwoordelijk voor is. Dus dat is binnen CM heel specifiek denk wel een factor die belemmerend kan zijn." (Interviewee 8)
"Nou ik denk dat de druk vanuit de buitenwereld ook anders is geworden sinds dat we listed zijn. En dus kunnen we ons niet meer permitteren om maar een beetje langzaam aan te groeien. We moeten gewoon hard groeien." (Interviewee 6)
"Ook met overnames, uh je krijgt weet ik voor hoeveel developers of mensen d'rbij? Die hebben geen idee hoe die organisatie in elkaar zit." (Interviewee 2)
Organizational growth