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# Information and Communication and their Impact on Productivity Determinants of XFTs in a Large-Scale Agile Environment: a Case Study

*Master of Science Thesis in Software Engineering*

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**Abstract**

Agile software development has been put forward in response to the industry's need to embrace and adjust to change quicker to be able to deliver higher business value. Even though agile's practices have been originally defined for small, single-product companies, their successful implementations have lead to it being recognised by large multi-site and product corporations. Transitioning towards agile and a new work environment embodies challenges of different natures, especially for large-scale organisations. This thesis presents a case study performed at Ericsson AB where the challenges related to information and communication flow within a large-scale agile organisation are investigated. The findings are then put into organisational context and related to the productivity determinants of Cross Functional Teams (XFTs).

Keywords: agile at scale, information, communication, XFT empowerment

## Acknowledgements

# Contents

# Acronyms & Abbreviations

**APO** Area Product Owner

**DM** Department Manager

**DSD** Distributed Software Development

**FPjM** Feature Project Manager

**OPO** Operative Product Owner

**PDU** Product Development Unit

**PDU LMR** Product Development Unit Long Term Evolution and Multistandard Radio
Base Stations

**PG** Product Guardian

**PgM** Program Manager

**PO** Product Owner

**SM** Section Manager

**STC** Socio-Technical Congruence

**TC** Team Coach

**TPO** Total Product Owner

**XFT** Cross-Functional Team

**XP** eXtreme Programming

# 1

# Introduction

Agile software development's ideas and principles go back to the early 1960s and have been laid down in 2001 with the Agile Manifesto [3]. Ever since the industry's need to adjust and respond to change quicker, in order to deliver higher business value, did not lose importance. Partially promising these results, agile is geared towards being applied within small, loosely coupled teams, all working mostly independently [66]. The general acceptance of agile grows towards 84% but it is mostly applied within companies of intermediate size [72]. This is where bigger corporations tend to be confronted with a larger set of issues brought about by more defined practices and processes and a strict and well-defined organisational structure [59].

Research has largely focused on general advice towards transformations from waterfall to agile development models. Nevertheless, it has been less concerned with belated integration difficulties that follow after the adoption of agile methods [34]. The academia paid attention to communication within Cross-Functional Teams (XFTs) [35, 52, 67] and the productivity of agile methodologies in general [1, 42]. Communication has been widely discussed in the field of Distributed Software Development (DSD) [5, 22, 38, 38] but got little focus on its relation and impacts of agile's methodologies. Furthermore, to the authors best knowledge, there is a lack of literature investigating XFTs and their communication with other units in large-scale agile organisations, its associated challenges and their impact on productivity. This area is worthy of attention as agile's popularity increases and gains attention from organisations of different context and size.

The thesis investigates and questions agile's compatibility with large organisations' structures with a focus on problematic aspects of communication, its paths and intersections and the resulting information flow with potential blockages. Hence, research questions focus on challenges associated with information and communication (RQ1) and relate their interplay to the organisation's scale. It then discovers the organisation's influence on the work of its XFTs from the perspectives of productivity determinants (RQ2). Finally, heat maps and social networks are utilised to capture and support the investigation (RQ3). To this end, the thesis reports on a case study conducted over a four month period in cooperation with one of the software development organisations at Ericsson AB — Product Development Unit Long Term Evolution and Multistandard

Radio Base Stations (PDU LMR). As performance fluctuations and discrepancies within the organisation became visible over the course of the adoption of agile methodologies, it seems that especially issues around communication and information hinder taking full advantage of agile software development.

The study employs both quantitative and qualitative methods in form of daily surveys and semi-structured interviews respectively. Week long daily surveys with two distinct groups as participants with 20 people in total highlight the paths and intensities of different types of communication. A qualitative part of the research addresses issues of communication and information by obtaining personal opinions and experiences of a subset of the survey's participants with 13 employees of different roles.

The remainder of this thesis is structured as follows: Section 2 lays a foundation regarding theoretical concepts such as communication and information, heat maps, social networks, and agile. Section 3 presents related work in the area of agile with its expectations and implications, agile at scale, agile coordination and communication, and communication in DSD. Section 4 defines the case study's context and Section 5 describes the case study's research methodology from its data collection and analysis to threats to validity. Section 6 presents findings which are discussed and interpreted in Section 7. Section 8 concludes the thesis work and gives recommendations for further research.

# 2

# Background

This chapter describes the theoretical concepts of importance for the thesis: it explains information and communication and the difference between the two, presents the notions of heat maps and social networks, and gives a brief introduction to agile software development's core values.

## 2.1  Communication & Information

Communication is the exchange of meaning between various parties. Within this exchange, the medium's specific channel type or physical nature to exchange meaning is not of interest in most theories [57]. Shannon [63], as illustrated in Figure 2.1, defines a model which envisions the role of a transmitter and receiver between which the signal is transferred while being prone to potential external noise. Internal noise, on the other hand, can emerge during the encoding or decoding process of a sender or receiver [71]. In addition, messages are exposed to an exponentially increasing amount of noise in relation to the nodes they pass through. This specially applies for large organisations with long distances between the sender and final receiver [63].

Information coheres to communication as it is perceived as the message which travels between parties [26]. Just as Savage [57] attempts to embed communication in a mathematical model, information theory formalises areas of signal processing and data compression. Signals are not independent of their context and static in how they are understood during interpretation before their transmission [73]. Whenever a single piece of information is accessed, a human processes it, which is a dynamic procedure strongly influenced by the context of the actor and its ability to understand the information's complexity [73]. Finally, whenever the meaning conveyed constitutes something previously unknown, Gleick [28] acknowledges actual information being transmitted.

In the scope of this thesis the concepts linked to information and communication are being handled separately. *Communication* is understood as a form of humans dynamically exchanging information through various channels where *information* is a single manifestation of a message's content.
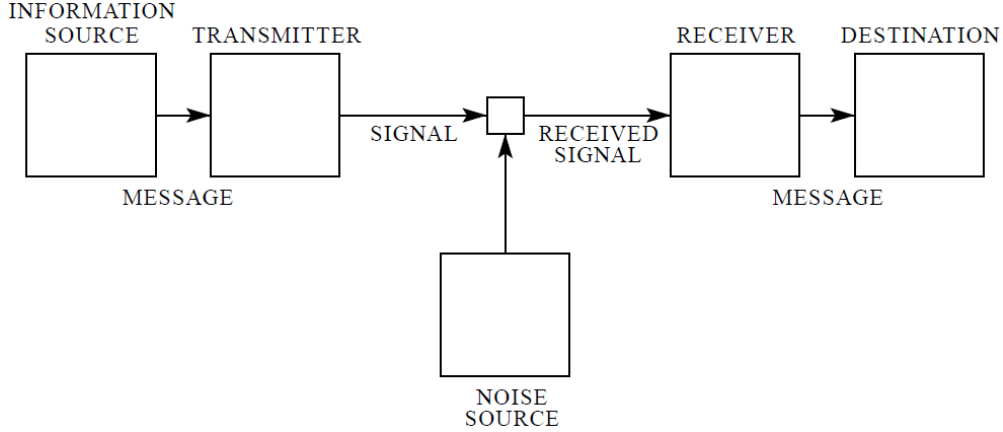
**Figure 2.1:** Schematic diagram of a general communication system [63]

## 2.2 Heat Maps

Heat maps were first used over a century ago to illustrate social statistics across various districts in France [76]. Over time statisticians have worked on different algorithms to perform various types of clusterings involving permutations of the heat maps' rows and columns [76], allowing the heat map to be more powerful visualisation tool communicating the data's statement clearly. As a result, heat maps are often used to visualise dense, three-dimensional data of a table format. Data in regards to an observation can be collected continuously over or at a discrete point in time [50]. Colour coding is then used to give structure and illustrate clusterings. All in all, it allows for an easier interpretation of the original data [50]. Their data independence allows heat maps to be applied in different fields such as social science, biology or meteorology.

In software engineering Feldt et al. [25] use heat maps to visualise code churns over time of different code elements to predict potential integration problems. Other investigations visualise the change status with a file and project view using colour coding for each line's status [74]. The aggregated project view gives a dense view of the overall status also linking progress to single developers. Harrison and Coplien [30] utilise heat maps to visualise the intensity of communication between roles within software development organisations. Their heat maps, which are called interaction grids, are sorted in descending order according to the roles' communication intensities, illustrating the epicentre of communication and the associated roles at the point of origin. By performing further analysis and data comparisons, Harrison and Coplien [30] deduct characteristics of successful corporations such as inward communication flow, even distribution of work and the distribution of communication among roles.

Heat maps are used in the context of this thesis to demonstrate the intensities of communications of different natures between the representatives of various roles in an organisation.

## 2.3 Social Networks

Social networks are a concept vastly used in sociology as a mean to represent social groups as networks of their interrelations. Their analysis has been mathematically formalised and, as outlined by Scott [61], is closely related to the methods of graph theory. Using the terminology of the latter, individuals (or groups of individuals) in a social network are represented as nodes while their interrelations are depicted by edges. Scott [61] mentions the measures of network density and centrality, examination of cliques and clusters as a few aspects of a social network that can be investigated using existing methods and theories.

Linguistics, criminology and demography are among other research areas that over time incorporated the analysis of social networks in their field of study.

In software engineering's body of knowledge, social networks have been used for instance by Cataldo and Herbsleb [12] for communication analysis in a geographically DSD to study the core of communication networks and the level of technical proficiency of those in the core.

The thesis employs social networks to complement the heat maps visualisations with a structured overview of the communication paths between the representatives of various roles in an organisation.

## 2.4 Agile's Principles & Values

Almost all agile practices and methodologies are based on a set of common values and principles. The original proclamation of agile's values in "The Agile Manifesto" states four core values [3]:

**Individuals and interactions** over processes and tools.

**Working software** over comprehensive documentation.

**Customer collaboration** over contract negotiation.

**Responding to change** over following a plan.

The values are contemplated with 12 principles which themselves are build around three main categories: delivery, communication and quality [3]. By taking both, values and principles, into account the community around them termed various agile methods, such as Scrum [65], eXtreme Programming (XP) [2] and the Crystal methodologies [15]. These extend agile's basic notion by custom foundations such as Scrum's five values in commitment, focus, openness, respect, courage [60].

The studied organisation employs agile methodologies based upon the stated values by which they impact the work environment and participants under study.

# 3

# Related Work

Prevailing research of interest for this study mainly spans across areas which cover application of agile methodologies at a large scale. First, a foundation is laid by outlining expectations and implications of agile's application which then leads to more profound explanations regarding agile at scale and the influence of agile on communication and coordination to lastly give an outline of related work in the field of DSD.

## 3.1 Expectations and Implications of Applying Agile

It is important to note that agile left alone with its mentioned core principles and values does not aim at increased productivity or alignment with business expectations. The focus is upon agility itself to move fast without imposed friction embracing change while overcoming its obstacles [41]. In that regard, the Agile manifesto has been recently scrutinised as its values are perceived as too vague for either academic research, business application or methodology development [40]. Nevertheless, the principles have frequently been used as input to set up new methods attempting to yield business benefits by increasing productivity, quality and satisfaction [42]. It has been found that developer satisfaction increases with agile methodologies and especially XP in place, also resulting in an organisation becoming more attractive and generally pleasant for employees to work at [45]. Mann and Maurer [44] add, that overtime tends to be decreased in agile projects by enabling developers to work faster and communicate workloads more appropriately towards customers. With agile's success and recent applications with large scale in mind, Cockburn [16] defined the Declaration Of Independence (DOI) linking people, project and values to emphasize the interdependent nature of a network each project team resides in. A lack of awareness and care of this network will limit the likelihood for teams to succeed with their mission.

Agile promises to yield several benefits such as reduced time-to-market, increased quality and the ability to respond to market change quicker, thus it is becoming a competitive advantage to apply agile correctly [11]. As pointed out by Cardozo et al. [10], successful development tends to have a strong correlation with agile, customer

satisfaction and team motivation. Moreover, agile positively affects different levels of organisations as stated by Ceschi et al. [14], who discovered that project management in general benefits by tighter customer collaboration and the ability to embrace changing requirements more easily. Still, adopting some of agile's methodologies is not a silver bullet and a straight route to success. As pointed out by Grenning [29], the utilization of XP embodies unexpected issues mostly caused by varying personal expectations especially on different levels of the organisation. The importance of understanding the organisation's status quo in order to improve towards a higher level of agility has been emphasized. Kettunen and Laanti [36] stress the fact that some parts of an organisation are more leaning towards agile than others. Furthermore, different parts of an organisation might be generally favouring a change trying to eagerly deploy it while other parts may evoke opposition [18]. Kettunen and Laanti [36] also identify a clear friction between larger corporations' business models and an unpredictable development process. By the same token, the agile feedback loop tends to be slown down by defined processes, complex dependencies and product life-cycles.

Taken together, the introduction of agile to previously existing organisations bears threats to its successful implementation often also relating to the context's scale.

## 3.2 Agile at Scale

Agile's growing support and appreciation leads to it being used in large contexts or even throughout multi-site organisations. Larman and Vodde [41] emphasize, that Scrum should not be evolved towards a new general methodology for a scaled context. It should rather remain a set of roles and ideas which every organisation takes into consideration and adjusts to their needs. A loose definition may leave ground for misunderstandings giving little advice for larger organisations, but has advantages as it allows for a custom application [40]. Spotify [37], for instance, embraces the notion of flexible guidelines within agile to scale it differently from suggested approaches by, for example, Larman and Vodde [41]. Scaling in itself should be aligned to the product and its expectations and leave room for design of beneficial communication flows and coordination between teams, as it mostly evolves among the multiple teams or even units [41]. In any case, dependencies between teams increase with the number of concurrently working teams, in turn causing constraints and blockages on the order of tasks carried out [47]. In this regard Sekitoleko et al. [62] investigate the challenges associated with technical dependencies and point out that these impinge each other, causing domino effects and potentially vicious circles thus blocking progress.

The adoption of agile practices within an established enterprise environment also entails issues extending solutions prescribed by the standard perception of agile at scale [41]. Moving towards a new process and leaving old, established ways of working behind brings change which is not necessarily appraised equally among the organisation [4]. Here especially educating practices and continuous coaching are perceived as vital to success to lower dysfunctional patterns, such as managerial control over teams and resources, as high level business procedures can not always be changed and have a proven right to

exist. Turk et al. [70] question agile's applicability for any context and suggest classifying processes among a spectrum of agility allowing a more context sensitive application, reasoned in the fact that any distinct mix of methods yields different outcomes for the overall development process. Eklund and Bosch [24] focus on embedded systems development and propose a model for applying agile within a plan-driven corporate environment. Their investigations put significance on interactions between the agile and plan-driven parts of the organisations. They argue that the awareness and definition of interactions regarding requirements, product project gates and validation reduces friction with non agile parts of the organisation. The border should be wisely placed as the application of Scrum solely on a team level excludes synchronisation on a product level and among development teams [39]. By the same token, management concerns and long-term planning should be combined with short-term development strategies leading to longer development cycles but improved alignment with product visions.

Boehm and Turner [7] take a broader view and categorise the potential problems to be mostly of three natures: development-, business process or people conflicts. Each of these have different root causes and means to be addressed. Mitigating and avoiding software variabilities and evolving legacy systems can be achieved by thorough planning, risk awareness and creating a customized process. Such methods, according to Boehm and Turner [7], do not necessarily align with agile's principles but are complementary to piloting projects and continuous measurements to react to business process challenges, which also embody expectations carried over from previous processes.

Kettunen and Laanti [36] continue from accepting the heterogeneous distribution of agility within an organisation by extending a model to systematically assess agility of separate units. At its current state it envisions understanding and measuring agility through understanding enablers, means and goals. Gained understanding might also reveal local optimizations and unintended accumulations of knowledge.

All in all, the application of agile within a large-scale organisation bears the potential of yielding its promised improvements. The flexibility towards its application eases the adoption, but also puts forward challenges on various levels of an organisation.

## 3.3 Agile, Coordination and Communication

Incorporating and scaling methodologies within an existing organisational culture, which comprise a redefinition of established ways of working, will affect communication and coordination.

Agile software development itself relies heavy on internal communication within a team and external communication with the customer. It embraces the high degree of tacit knowledge aiming at reducing the need for formal documentation [3]. A high degree of informal communication within XFTs however does not inevitably ensure a project's success. A potential lack of communication between different roles which do not directly fit into agile practices can entail threats to success [21]. Especially as uncertainty about ways of external communication from and towards development teams comprises potential to optimise collaboration outcomes [68].

Pikkarainen et al. [52] point out that agile methodologies increase formal and informal communication within an organisation as intended and anticipated by practitioners. Nevertheless, ways of handling the increasing amount of available information are not always in place limiting its potential advantages. For instance, information regarding long-term goals of multiple dependent features can be present in some but not communicated to all parts within the organisation [52]. Cohn and Ford [18] argue that even though agile increases communication within development units, upper management quickly loses the ability to track progress and to plan and control the underlying development process. This loss of control is to be expected by structural empowerment which aims at distributing and delegating the decision making power towards development units [46]. According to Tessem [69], agile developers are often more empowered by gaining a higher level of managerial influence and task selection possibilities leading to an increased work motivation. Still, the empowerment and shift of responsibilities often causes friction between parts of an organisation caused by scepticism and uncertainty eventually resulting in counter-productive behaviour [46].

The coordination within the development of large software systems has become one of the main managerial challenges and shows limits for empowerment [38]. Large-scale systems of high complexity entail a high level of interdependence of separate components developed by a large number of teams. According to Kraut and Streeter [38], the coordination mostly relies on informal communication which does not solve issues around the search for a consensus and information sharing. Coordination grows to become particularly challenging in software development with the rise of DSD. Distance tends to hamper communication which is the main intermediate towards engaging in collaboration and control with projects. With the great chance of communication being too sparse or single pieces being distorted, threats for the whole software development process, such as activities within requirements engineering, arise [54].

In general, areas of concern regarding coordination and communication in respect to agile tend to be manifold and span over an organisation as a whole and can be seen as an enduring challenge not to be overcome at a specific moment in time.

## 3.4 Communication in Distributed Software Development

Communication and coordination issues do not solely become apparent in large-scale agile projects and also have been of interest within DSD. The degree of distribution in software development, according to Cockburn [17], can be ranked on a scale where local co-location corresponds to the lowest values while global distribution is of highest degree of distribution.

Curtis et al. [22] state that a scarcity of informal communication channels negatively impacts software development in general. This problematic aspect gains even more importance as software components' growing size and complexity strictly correlates with a higher demand of informal communication for coordination [38]. At the same time Kraut and Streeter [38] acknowledge the existence of communication barriers which root in organisational, social or geographical differences and all have the possibility to restrict

the ability or will of units within the organisation to engage in communication and share information. As the frequency of communication generally drops with increasing distribution of development, Herbsleb and Mockus [33] discover a restricted flow of information caused by little interaction. This ultimately leads to employees feeling distant and less knowledgeable about the overall direction and plan of the organisation [33]. The channels and ways to address the decline of informal communication have been subject to studies with different impacts on the development's success [49, 75]. Berntsson Svensson et al. [5] evaluate different communication mechanisms categorised in three main groups claiming that some are more applicable than others in local and global site communication. Mechanisms differ according to richness, the ability to transfer volume and information on a timely manner. Global and local development in turn have different demands towards communication leading to different mechanisms being favoured and relied upon [5]. Architecture has been identified as the most applicable communication mechanism for developing reusable software components as it manages to minimise impacts of distance and cultural and language differences. Still, the importance of direct face-to-face communication is highlighted for development teams as a fast communication mechanism even when it fails at times to communicate large volumes of information [5].

DSD also spreads dependencies and increases the geographical distribution between software components. In this context Ovaska et al. [51] found a set of dependencies between components and development activities such as information diffusing between work activities not being understandable by all parties. This is mainly caused by different degrees of knowledge of a piece of information for the receiver and sender where both parties are unable to find common ground and communicate their concern adequately. Furthermore, Ovaska et al. [51] states that by responsibilities spreading with the distribution, a lack of a overall hierarchy impacts the decision making ability within development. It shall be noted that the mentioned issues do not solely arise from a geographical distribution but also arise within single-site organisations [51].

The alignment of the actual amount of communication and its relation to an expected coordination need is referred to as Socio-Technical Congruence (STC) [13]. A higher level of STC is usually attributed to increase development productivity and improve team coordination [32]. Damian et al. [23] analyse STC around requirement-based dependencies pointing out that team members often communicate with others having similar knowledge and domain experts tend to act as communication hubs spanning wider over a social network than normal actors. This relates to Conway's law which states that organisations, such as software development firms, create designs which are heavily influenced or even constrained by their communication structures [19]. This view is supported by Coplien and Harrison [20], who heavily highlight the need for an equal relationship between product parts and the organisational units to avoid later integration problems.

All in all, communication has been proven to be one of the main and costly challenges in DSD whose alleviation potentially bears productivity improvements for development.

# 4

# Case Company Description

This chapter introduces the company under study by commenting on its agile transformation, the organisational structure, and associated roles of study participants altogether providing the description of a large-scale agile application peculiarities.

## 4.1 History of the Transformation

Increasing productivity remains the main purpose towards the application of agile methodologies in industry. Nevertheless, Badampudi et al. [1] point out that most companies adapting agile do not manage to strictly follow all of its main ideas. Adjustments are made to integrate agile with the large scale and existing processes, with both positive and negative impacts upon productivity. Similarly, Ericsson has its own peculiarities of scaling agile which will be discussed in this chapter.

Dissatisfied with performance, several years ago the PDU LMR organisation at Ericsson started a transformation from the waterfall based development towards a more agile approach, following small incremental and discontinuous transformation steps. Rather than only changing the lower level coordination of development teams, it has been decided to change the organisational structure along the way. A matrix-like organisational structure was replaced with hierarchical one with XFTs at its top trying to embrace agile software development: a structure not necessarily prescribed by agile but motivated by Ericsson's scale. The strictly hierarchical structure causes a lower number of connections, clear responsibilities and delegation but embodies potential queuing delays.

This is justified by the fact that matrix structures in general and as previously employed by Ericsson, combine functional (divided by types of work) and divisional (product based division) structures, adding another horizontal line of communication [58]. Hence, each unit within the structure is being coordinated by two superior entities: a functional- and a divisional superiority. The intent is to faster distribute knowledge horizontally among functional sectors without having to move through a long chain of hierarchies [27]. Hierarchical structures on the other hand are solely an extension to functional or divisional structures adding a chain of command and show superior and

subordinate units or roles. The hierarchy does not imply horizontal communication and becomes narrower towards its top [31].

PDU LMR integrated parts of agile's methodologies into their hierarchical organisational structure while adding variations where needed. This includes partially deploying methodologies, defining custom roles and responsibilities, and adding an integration layer for the organisational structure.

## 4.2 Organisational Structure at Ericsson /acPDU LMR

The structure of the organisation under study is presented on the Figure 4.1.
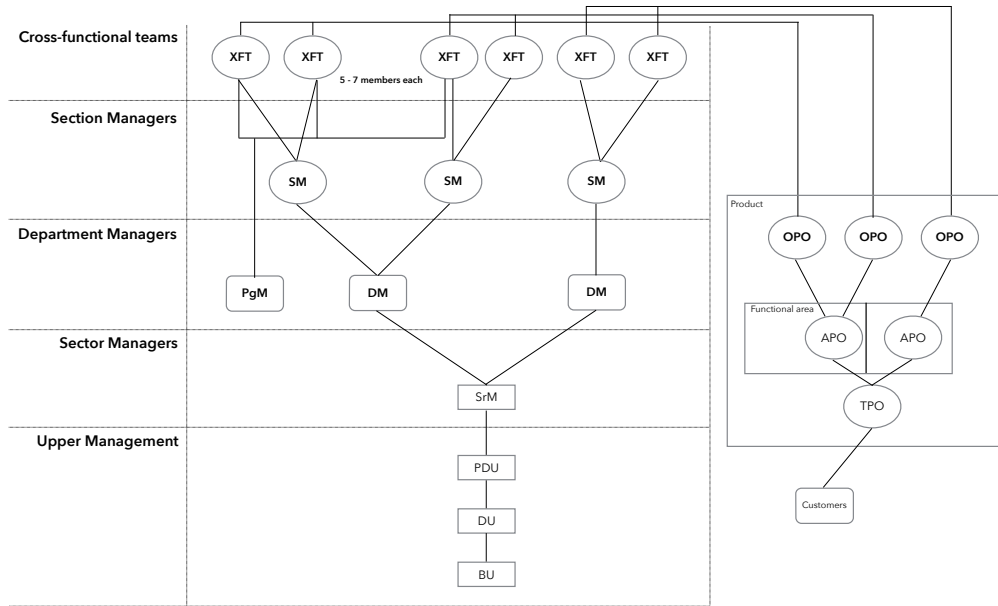


**Figure 4.1:** Organisational structure of PDU LMR

Roles with a strict relation to agile methodologies are illustrated with an ellipse and more thorough description of their responsibilities can be found in Table 3.1. Roles are grouped horizontally and the connecting lines outline the organisation's hierarchy and intended chain of commands.

In the epicentre of the development activities reside multiple XFTs — self-sufficient units which have all the necessary competencies for feature delivery at their disposal. XFTs generally consist of five to nine members. Product Guardians (PGs) are not part of an XFT but are also assigned to different products in order to oversee development and maintain a product's coherence. XFTs working on parts of a whole product in turn interact with one or several PGs which for teams also eases handling of its size and complexity.

Each team belongs to a section with a Section Manager (SM) looking over two or more XFTs. The SM also acts as a Team Coach (TC), whose responsibilities are described later in the Table 3.1. Sections themselves belong to departments, which in turn are a part of a sector, each of them having a respective manager. A structure above the sector in the hierarchy is called a Product Development Unit (PDU). Together, this part of the structure constitutes the line organisation. The line is further supervised by a Design Unit (DU) and a Business Unit (BU) which are not part of further discussions.

The start of the transformation towards an agile development process caused the addition of a new product owner community to the existing structure (depicted on the right hand side of Figure 4.1). Given the company's scale, the traditional role of a Product Owner (PO) had to be divided into the areas of responsibility. Thus, new roles of Total Product Owners (TPOs), Area Product Owners (APOs) and Operative Product Owners (OPOs) were introduced with a TPO being in direct contact with the customer and APOs, who in turn work closely together with several OPOs each. OPOs themselves work with several XFTs at a time. The exact amount depends on the nature of the product and a way of working inside a section. In case of a feature assigned to an XFT being too large and complex, a Feature Project Manager (FPjM) acts as an intermediary between the Program Manager (PgM) and OPOs, where the former is responsible for maintaining the high-level backlogs teams eventually get the stories from.



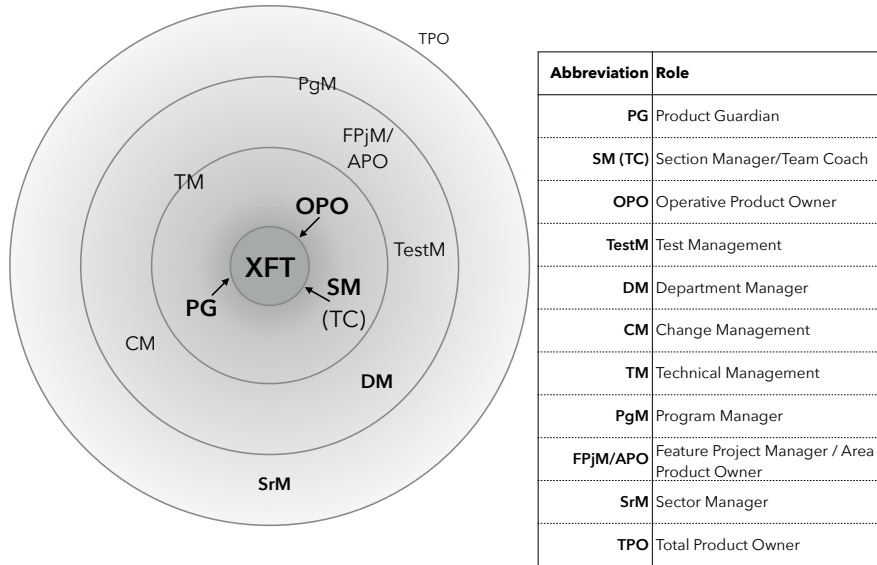| Abbreviation | Role |
|---|---|
| PG | Product Guardian |
| SM (TC) | Section Manager/Team Coach |
| OPO | Operative Product Owner |
| TestM | Test Management |
| DM | Department Manager |
| CM | Change Management |
| TM | Technical Management |
| PgM | Program Manager |
| FPjM/APO | Feature Project Manager / Area Product Owner |
| SrM | Sector Manager |
| TPO | Total Product Owner |

**Figure 4.2:** Layers of roles and their interaction

Figure 4.2 illustrates the distance and an intended amount of collaboration between the roles by outlining layers of interaction. An XFT is always in the closest and immediate contact and cooperation with the PG of the product they work on, their OPO and SM. The next layer is comprised of those roles who have a frequent contact to

the XFT and their environment while the degree of this contact is significantly lower than in the first layer. Hence, the bigger distance from the XFT to another role, the less communication is envisioned.

In the scope of the study two XFTs were investigated, where both teams have six members (including a Scrum Master) and work closely with their OPO while having a different degree of contact with their respective PgM. At the time of the study both XFTs did not have a SM and his responsibilities were temporarily taken over by respective Department Managers (DMs). Only one team had a dedicated PG while the responsibilities of this role were spread out between different persons for the other team. Summarised, these roles are referred to as *immediate environment* of an XFT further in the thesis.

## 4.3 Role Descriptions & Definitions

The more detailed description of the roles inside the organisation, including a short description of the key tasks for each, can be found in the table below.

| *Description* | *Key Tasks* |
| --- | --- |
| **Agile Coach** | |
| Coaches the organisation in the new ways of working by covering problematic and uncertain areas not handled by the existing organisational roles. Coaches the leadership team and management but also interacts with individual XFTs and other agilean roles when needed. After the settlement of new ways of working, the responsibilities are handed over to Section Managers. | Drive agile and lean improvements in the organisation. Give feedback on ways to improve working. Drive workshops and retrospectives related to agile and lean. Coach teams to improve and become high-performing. Investigate, find and propose methods to improve teams and organisation. Participate in meetings when applicable (for Leadership Team, XFT, Program, Community of Practice, etc.). Work as a bridge between organisations on items related to ways of working and agile and lean. |

| Feature Project Manager | |
| --- | --- |
| End-to-end responsible for features/other work items in case of them being too large and complex to be managed by a single OPO. Handles related coordination and progress reporting. | Support OPOs and teams with planning and coordination (e.g. between OPOs, teams, standards, projects, PDUs etc). <br><br> Provide time plans and status updates. <br><br> Report the status and escalate issues when needed. <br><br> Follow up and reporting. <br><br> Represent their part of a complex feature on a bigger scale. |
| **Operative Product Owner (OPO)** | |
| Acts as a customer on the site for 2-5 XFTs, shaping team's backlog. Follows the quality of the developed feature and makes sure its end value is understood by the XFT. Involved in technical development aspects, such as integration risks and technical dependencies. | Prioritize user stories across backlogs. <br><br> Give feedback on end to end time plan. <br><br> Handle teams' backlogs and know their status. <br><br> Provide delivery time plan and input to check-lists. <br><br> Facilitate cross XFTs learning by diversifying user stories or arranging meetings. |
| **Product Guardian (PG)** | |
| Secures product quality by ensuring unity of architecture and code structure within product/domain and alignment to software outside the domain. Knowledgeable within a specified domain of software and uses their skill to support XFTs and build up competence in the organisation. Actively cooperates with OPOs on product improvement items to be put into XFT's backlogs. | Help in technical decisions related to a product/domain that goes in line with fulfilling the product vision and quality requirements. <br><br> Have a vital few design rules for the product. <br><br> Support the creation of definition of done for features affecting the product. <br><br> Collect and prioritize product care and improvement items. <br><br> Coach less experienced people when working with the product's code, documents and test. |

| Program Manager | |
|---|---|
| Manages the program backlog, which is focused around a group of requirements from the product line. | Discuss requirements and their release with the APO. Facilitate program meetings with OPOs where they pull items from the backlog. Appoint a Feature Project Manager when main requirements are too much to handle for OPOs. |
| **Section Manager (SM)** | |
| Combines legal personnel responsibility and support of the XFTs by removing impediments that the teams cannot handle themselves and helping out with competence planning. | Participate frequently in XFT's stand-ups, demos, backlog preparations. Give feedback to XFTs and Scrum Masters. Involve Scrum Masters in discussions about team set ups, recruitments and processes. |
| **Team Coach** | |
| With application of Scrum as an area of expertise, acts as an Agile Coach on a team level typically for 2 XFTs by e.g. facilitating workshops and introducing methods. | Give feedback on ways to improve working. Drive workshops related to agile and lean questions. Coach teams to improve and become high-performing. Investigate, find and propose methods to improve teams and organisation. Participate in meetings when applicable (for Leadership Team, XFT, Program, Community of Practice, etc). Handle impediments that the teams can not handle themselves. |

| XFT Scrum Master | |
| --- | --- |
| Ensures adherence of the XFT's process to Scrum. Filters interactions from outside to their XFTs based on their helpfulness. Acts according to a traditional theory concept, encouraging the team to improve its development process. | Communicate visions, goals and product backlog items to the XFT and assure efficient backlog management techniques. Coach the XFT into self-organisation and cross-functionality. Lead and coach the team in its Scrum adoption. Work with other Scrum Masters to increase the effectiveness of the application of Scrum in the organisation. |

**Table 4.1:** Role descriptions

# 5

# Research Methodology

This section reports on research purpose and questions, elaborates on used forms of data collection and analysis and threats to validity for both qualitative and quantitative parts of the study.

## 5.1 Research Purpose

The purpose of this study is to complement the existing research on communication within XFTs, productivity of agile methodologies in general and communication in the field of DSD by investigating information and communication flow between XFTs and other units of a large-scale organisation and their effect on productivity determinants. In addition, the thesis suggests an approach for employing heat maps and social networks for studying the mentioned perspective.

## 5.2 Research Questions

The scope of the study has been shaped to investigate the issues related to information and communication flow within the organisation that undermine the application of agile methodologies. The following research questions were defined to drive the research:

1. What are the information and communication challenges associated with the adoption of large-scale agile and how does their resolution benefit the application of agile?

2. Which productivity determinants of an XFT become apparent as a result of an interplay of information and communication within a large-scale agile organisation?

3. How can heat maps and social networks be used to capture the dynamics of communication around XFTs to assist the investigation of communication and information challenges and their relation to productivity determinants?

## 5.3   Case Study Research

The thesis investigates a phenomena highly intertwined with its context, thus it follows a case study research method to be most suitable for the purpose according to Runeson and Höst [55]. Yin [78] proposes the use of case studies when the researcher has little or no control of the setting. Lethbridge et al. [43] claim the appropriateness of case studies when the focus of the study is rather broad than specific and the amount of data to be produced and analysed is small. As these characteristics apply for this thesis, it strengthens the ground for using a case study method. The findings are based on a single case mostly qualitative in its nature but are also underpinned with quantitative data. The study investigates the existing setting, points out possible problematic areas and therefore is of explanatory-descriptive nature [55].

The case of the study is PDU LMR organisation at Ericsson. Units of analysis are XFTs and their immediate environment (defined in Section 4.2) and their interactions, as summarised in Table 5.1 [55].

## 5.4   Data Collection

Data collection combines both quantitative (daily surveys) and qualitative (semi-structured interviews and observations) methods. Two main data sets were gathered using prevailingly first degree data collection techniques according to a taxonomy by Lethbridge et al. [43]. Both qualitative and quantitative perspectives are aligned to the research questions, whereas the qualitative angle sheds light on reasons for communication which are hard to identify using purely qualitative methods.

### 5.4.1   Daily Surveys

First, the patterns of communication between the different entities in the organisation were obtained by carrying out daily surveys. The surveys were designed to be cross-sectional with a focus on a single week during a sprint [53]. The data was collected from two XFTs and their immediate environment whose roles are summarised in Table 5.1. Roles and participants are complete in regards to the XFTs' development environment working towards reaching the goal of individual sprints, which makes data collection sufficient to describe the process and related research questions.

The surveys were distributed to the respondents in paper format and collected at the end of a working day. The survey queried respondents to mark their communications with co-workers during the work day and assign intensities for these interactions in relation to their usual amounts (see Figure 5.1).

The survey introduces the notion of a *communication nature* (illustrated in Figure 5.2) aiming at capturing the main topic of communications between roles during a working day. The natures are designed to be disjoint and to capture the most prevailing reasons for communication among the survey's participants. The nature "Other (please name)" was left for participants to give a custom nature whenever none of the

**Figure 5.1:** Communication intensities in daily survey

rest applied. Furthermore, the classification of natures of communication are based on previous research conducted at Ericsson by Sekitoleko et al. [62] and Börjesson [9]. It has been discussed and reshaped in the course of several feedback loops to integrate insights provided by available participants of the study. This was done mainly to mitigate potential misunderstandings in phrasings so as to be able to clearly distinguish between the natures.



**Figure 5.2:** Communication natures in daily survey

A complete example of a survey can be found in the Appendix on Figure B.3.

Direct administration to the respondent group allowed to control the completeness of each response and gave a 100% response rate as every participant was in personal contact with the researchers. Travelling and absence from the office caused three empty responses, resulting in 97 out of 97 possible fill-outs.

Every respondent was introduced to the survey's goals before the first day's version was handed out. The explanation included the envisioned reason and outcome of the study, data collection procedure and the outline of the main concepts of the survey, while the respondents had the possibility to ask clarifying questions.

| **XFT-1** | *Nr. of Participants in* | |
|---|---|---|
| *Role* | *Interviews* | *Surveys* |
| XFT Scrum Master | 1 | 1 |
| XFT Developer | 2 | 5 |
| XFT PG | 0 | 1 |
| OPO | 1 | 1 |
| Department Manager (acting Section Manager) | 1 | 1 |
| Program Manager | 1 | 1 |
| **XFT-2** | | |
| XFT Scrum Master | 1 | 1 |
| XFT Developer | 2 | 5 |
| XFT PG | 1 | 1 |
| OPO | 1 | 1 |
| Department Manager (acting Section Manager) | 1 | 1 |
| Program Manager | 1 | 1 |
| *Total* | *13* | *20* |

**Table 5.1:** Study participants

The survey was trialled on three volunteers of which one was the participant of the actual study to obtain general feedback on apprehension of the survey and its design. It shall be noted that rooted in the survey's nature the participant was not biased by trialling. The person only gained knowledge about the survey's concepts previous to other participants.

### 5.4.2 Interviews

After processing the data from the surveys, semi-structured face-to-face interviews ranging from 30 to 60 minutes were conducted over a three week period. The interview guide was designed to drive the conversations with respondents, whose roles can be seen in Table 5.1. The process for this data collection method was defined in accordance with the guidelines mentioned by Runeson et al. [56] and Myers and Newman [48]. The results from the surveys were used as an input for a limited amount of questions in the interview guides to put the results into context and thus ground an understanding of the reasons behind them.

Each interview session begun with an introduction to the purpose of the study and an agenda for the upcoming interview. The interviewee was then asked the permission

to record the interview and was guaranteed that the response will be kept anonymous.

The questions were structured following the pyramid model, starting with more specific questions then later on transitioning towards open-ended ones [56]. A set of questions about the employee's background was asked aiming to break the ice and establish a friendly atmosphere. The main body of questions was unified by the same underlying theme derived from the research questions. Moreover, the same general guide was used for all interviewees who were not a SM or a PgM and was extended by a brief specific guide dependent on the interviewee's role. The separate guide was used for interviews with PgMs and SMs and is a strict subset of the general guide. The complete Interview Guides can be found in the Appendix.

To finish the interview, the researchers summarized the answers allowing the interviewee to augment any part of their response if needed. The participants were asked not to discuss the interview with their colleagues until the end of the interview period to avoid a learning effect. Later on, interviewees were also provided with the transcript of their interview to correct any of the points they did not consider valid.

### 5.4.3 Additional Data Collection Methods

In addition to interviews and surveys, the internal documentation was also used to study the research's context. The information extracted from such sources mostly concerned issues such as organisational structure and process descriptions. Moreover, the researchers had access to the working area of both XFTs, which allowed for observations and possibility to ask clarifying questions about the working environment. The participants' observation [43] took place at the onset of the study to integrate with the teams and establish more firm personal contact. Summarised, this data was not directly used to address any of the research questions but rather to gain understanding of the research context and remove any ambiguities occurred during the study.

## 5.5 Data Analysis

The data analysis for both the quantitative and qualitative part of the study was performed directly after the collection. At a later stage potential relationships and correlations between data sets were pointed out to ground a deeper understanding from both data collection methods.

### 5.5.1 Daily Surveys

The data obtained from the daily surveys was digitalized manually. To assure the correctness of the input data and minimise the possibility of human errors, both researchers processed the same response forms and cross-checked for inconsistencies after.

Data was then stored in a database which was used to filter data serving as an input for following automated calculations. Further processing needed to generate data suitable for R was performed using a custom build software component. The component also allowed for selecting filter for time, communication nature and employees' roles

used as queries for the database. Filters were aimed to get a more detailed view towards specific subsets of the collected data. The functionality and calculations of the software component were tested and verified to ensure the output's correctness.

The final visualisation images were produced after the survey week using the values accumulated throughout this period. The visualisation of the data in forms of social networks was performed using Gephi — an open source graph visualisation and manipulation software[1].

### 5.5.2  Interviews

The processing of the interviews data was performed using thematic analysis — a method targeted at discovering, analysing and reporting on patterns in data of qualitative nature [8]. The studied dataset consisted of the interview recordings that all together summed up to 13 data items. To ease the processing of the data a software tool called NVivo[2], specifically designed for the analysis of qualitative data, was used.

The description of the thematic analysis method by Braun and Clarke [8] outlines 6 phases of the process, which are listed further and accompanied with a description of steps taken in the scope of this study:

1. **Familiarising with data:** review of the transcriptions while keeping a focus on possibly recurring patterns. As a first step towards the familiarisation with the data each interview was transcribed in accordance with the intelligent verbatim format: filter words and repetitions were left out aiming to capture the information content and produce a more eloquent and concise report. Each transcript was then proofread and summarised by both researchers. The summaries were not used within the thematic analysis and solely served the purpose of familiarising oneself with the contents of the interviews.

2. **Generating initial codes:** categorisation of the data set to initial codes. Each interview transcription was read through with the purpose of assigning initial codes to the individual statements. No codes were created prior to the start of this step leading to creation of a new code every time a potential finding was spotted. The same statement could have been assigned with different codes.

3. **Searching for themes:** initial combination of codes into themes. This step involved going through the initial set of codes while grouping the ones deemed similar. With the research questions in mind, the arising combinations mostly circled around existing challenges of information and communication flow, wished-for descriptions and proposed improvements while having a separate set of coded data related to the XFT workflow. No data was disregarded at this stage due to a possible refinement in the next steps.

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[1]`https://gephi.org/`
[2]`http://www.qsrinternational.com/`

4. **Reviewing themes:** critical reflection on completeness and correctness of themes by again investigating the coded data. In this step the preliminary themes were reviewed to establish whether the coded data inside them was coherent. In cases of data being too diverse the findings were separated, for instance *troublesome information gathering* transformed into two different subsets of *unknown information search* and *evaluating information*. Alternatively, groups were combined to create more generic themes. Next, the candidate themes were reviewed in a global context of the whole data set. This lead to some of the data being re-coded or coded additionally. The refinement was performed until a coherent thematic map was obtained. It should be noted, that some of the previously defined themes were dropped as not fitting the frame of findings. The group of finding on perceptions of roles and responsibilities inside the organisation was not included in the final version for this reason.

5. **Defining and naming themes:** further theme descriptions and reflections on its contribution to the studied issues. Here the themes were additionally revised to make sure they are reasonably scoped and cover a coherent set of data that individually is able to tell a story of its on. The themes of *Information* and *Communication* were slightly restructured to have a similar skeleton of challenges, improvement and benefits. Finally, the names of the themes were defined to encompass the essential nature of the findings.

6. **Producing the report:** selection of the most descriptive and compelling themes by aligning them to research questions. The results of the thematic analysis are presented in the the Section 6.

## 5.6 Threats to validity

This section discusses threats to validity of the research methodology and data collection of the study according to classification suggested by Runeson and Höst [55].

### 5.6.1 Construct Validity

Construct validity relates to the connection between operational methods and research theories investigated in the scope of the study [55].

To assure a common understanding of the concepts used in data collection instruments, each study participant went through a printed survey form together with the researchers, where the latter explained every section in detail and the former was able to ask clarifying questions. Interviewees were supplied with a study description involving goals and agendas via E-Mail before the interview and were briefly introduced this information again at the beginning of the interview session where they had the possibility to get thorough explanation on unclear parts.

To alleviate the survey's potential instrumentation flaws it was designed with the results of previous studies by Sekitoleko et al. [62] and Börjesson [9] and feedback of

trial participants as an input. The interview instrument went through a set of feedback loops with the study's supervisors to secure understandability and comprehensiveness. Trialling the survey on an actual participant of the study possesses a threat of biasing it with personal apprehension. However, the feedback was mostly aimed at the survey's design and layout and did not affect its concepts. Thus the effect of personal preferences on the instrument was minimal.

Using daily surveys to determine communication patterns is highly dependent on the respondents' answers and prone to the maturation threat. The duration of the data collection period, however, was rather short thus making motivation fluctuations and change in perceptions towards understanding of the survey's concepts rather unlikely.

Runeson and Höst [55] emphasise the role of the triangulation in empirical research, especially when dealing with data of qualitative nature. Using a variety of methods, data sources or theories allow for approaching the studied issue from different perspectives and providing a broader view thus increasing the precision of the study. For this reason, the study collected data of different nature (daily surveys and interviews) from representatives of different teams and roles therefore broadening the scope of the opinions and perspectives on studied issues. To reduce the risk of obtaining unbalanced and limited sample of study participants, they were chosen by a "gatekeeper" of the company under study [64]. The selection of participants was not in control of the researchers thus reducing bias. However, having a rather small sample of subjects from a single company remains a limitation to this study.

The evaluation apprehension threat [77], stemming from people being afraid of evaluation by their nature, was mitigated by guaranteeing anonymity to every study participant within the company and in any publications of the study.

### 5.6.2 Internal Validity

Threats to internal validity arise from the examination of casual relations between the studied concepts [55].

This study is focused on information and communication flow within the organisation and their influence on the work flow of XFTs. It is acknowledged that these factors are not the only ones affecting the productivity of the development teams but the scope of the study only investigates this perspective.

The study used representatives of different roles to ensure the triangulation of sources. This, in addition to always using two researchers when analysing the data, also alleviated the risk of inducing false findings for the whole organisation.

The participating XFTs may not be representative of the patterns within the whole organisation but have, as mentioned, been selected by a "gatekeeper" knowledge of this threat trying to minimise it.

Lastly, the studied organisation still undergoes refinements in the organisational structure related to agile transformation, thus potentially confusing the context for certain statements, for example, when referring to certain instances of immediate environment of XFTs using formal role names. This was addressed by asking follow-up questions and clarifying the context with examples.

### 5.6.3 External Validity

External validity is concerned with generalisability of the research findings [55].

This study was conducted in collaboration with a single organisation hence the setting might be biased by the culture and structure of this particular organisation and consequently its interpretation of agile software development. The results therefore may not be generalisable to a full extent. By the nature of a case study discovered problematic areas of agile's application are not necessarily valid in every context. In this regard, the characteristics of the studied company are reported with a level of detail sufficient to compare it to a context to which the results are wished to be generalised. The specifics of agile scaling and descriptions of key roles are provided with this purpose. Nevertheless, full description of the setting is restricted by confidentiality requirement and in addition, reproducing identical circumstances is often troublesome [6]. However, a subset of the discovered challenges and proposed solutions may be transferred as an input to the investigation of another case while the discussion also aims at developing a more generalisable understanding [6].

### 5.6.4 Reliability

Reliability threats arise from the influence of the researchers on the data and its analysis [55].

To enable the possibility of conducting a similar study by another researcher the steps of the data collection were documented in detail and decisions for application of research methods argued for. Furthermore, all data collected was digitalised and reviewed by the interviewees and researchers. The digitalised design artefacts can also be made available for future assessment and leave a chain of evidence [55].

The study has been performed by two researchers thus lowering the possibility of a single researcher's bias. The instruments used in the study and the results have also been discussed and reviewed with both of the study supervisors. All steps of the data analysis were performed by both researchers to increase its reliability.

The presentation of findings and their categorisation is potentially threatened by individual experiences and perceptions of the researchers. To ensure that the comprehension of suggested structure of the findings is not limited to a single perspective, the proposed suggestions were reviewed by the second researcher and further on discussed in a workshop with two study supervisors.

# 6

# Findings

This section reports on the findings of the study, first on its quantitative and then qualitative parts.

## 6.1 Heat Maps & Social Networks

The analysis of the daily surveys' data relates to the third research question, but discussed first as of the order of data collection.

*RQ3: How can heat maps and social networks be used to capture the dynamics of communication around XFTs to assist the investigation of communication and information challenges and their relation to productivity determinants?*

At the time of the data collection the sprint backlogs of both XFTs differed significantly in the nature of their work packages. The XFT-1 described their set of user stories as rather typical while the XFT-2 was said to work on internal tasks focused around documentation. This disparateness combined with a rather short duration of the data collection period makes the comparison of the findings between teams unjustifiable. Thus, the data on communication intensity is rather compared inside each team separately based on different natures of communication.

In the following visualisations of the data using heat maps the occurrence of communication between roles A and B is reflected with a table cell which is colour-coded in accordance with its intensity. The more intense a communication the darker the colour it is visualised with. For instance, a *Backlog work on planned sprint goals* heat map in the Figure 6.1 demonstrates a more intense communication between "OPOs" than between "XFT Developers". The direction to read a heat map is row to column: the rows in the table correspond to the participants of the study. In turn, roles in the columns are those the study's respondents had communication with. Thus, the amount of columns is generally greater than the amount of rows and includes roles that have not been introduced previously in this thesis. Empty cells are used to illustrate an absence of communication. Referring to the same heat map of the Figure 6.1, the "XFT PG" has a slightly less than usual communication with the "XFT Scrum Master" (colour-coded

with a shade of green that can be found on the colour key scale around the value of 2), but has no communication with the "Program Manager". In addition, the same colour codes are used across all heap maps which allows comparisons across multiple figures by solely focussing on colours.

An XFT in the scope of this study is taken up on a team level, thus the "XFT-Developer" role accumulates the responses of all of the XFT's developers. Roles in the columns are combined in the same fashion: if a participant of the study has spoken with two different developers from another XFT, it is presented in a heat map with a single "Other XFT" column aggregating both communications. The focus thereby resides on roles rather than individuals in all visualisations.

### 6.1.1 XFT-1 Heat Maps

As it can be seen from the Figure 6.1, the most communication for the developers of the XFT-1 is caused by backlog work, however they prevailingly considered it to be below the usual level of intensity. This is illustrated by the cells' colours being of varying shades of green which corresponds to the colour key's values below 3 — a designator of the usual level (as in the case of communication of "XFT Developer" to "Change Control Board"). In contrast, *Decision coordination* for developers more often involved communicating more intensively (note the red shades of colour codes corresponding to the values above 4). *Unexpected change or interruption* seems to be the least intense communication for the team and their OPO. *Resolving technical dependencies* in the majority of the cases causes communication furthest above the usual intensity. Only on one occasion, "XFT Scrum Master" to "Other XFT" members, is it slightly lower that the usual intensity level, depicted with a cell coloured in a shade of green in contrast to others being of orange or red shades.

Figure 6.1 also allows to observe how the roles present in heat maps change, depending on communication nature. The whole XFT, the PG and the OPO have presence in all communication natures while the "Department (acting Section) Manager" and the "Program Manager" only step in for the *Exchange of missing knowledge*. The survey allowed the respondents to mark "Other" as a communication nature. Although not visualised separately, it should be noted that the greatest part of communication of the "Program Manager" involved planning activities while the "Department (acting Section) Manager" to a great extent discussed the existing working set-up with his colleagues in the line organisation.

### 6.1.2 XFT-2 Heat Maps

The week under study for the XFT-2, visualised with heat maps on the Figure 6.2, was (with a few exceptions) of a rather light communication intensity. The most popular communication nature was *Backlog work on planned sprint goals* where, again, the intensity was mostly below the usual levels. As can be seen, only the cell depicting communication of the "Program Manager" with the "Department (acting Section) Manager" is colour-coded with red whereas the rest are of green colours corresponding to
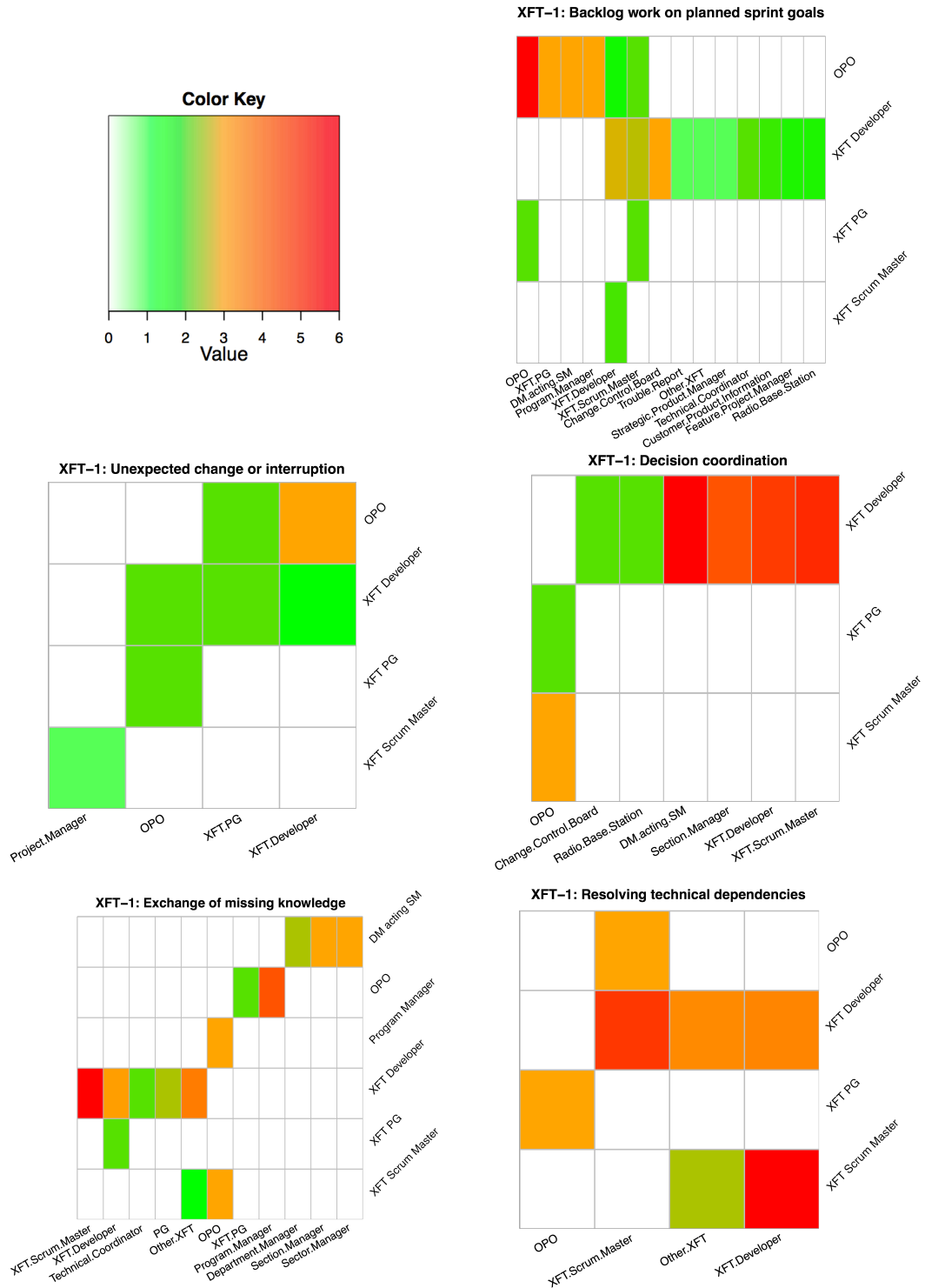
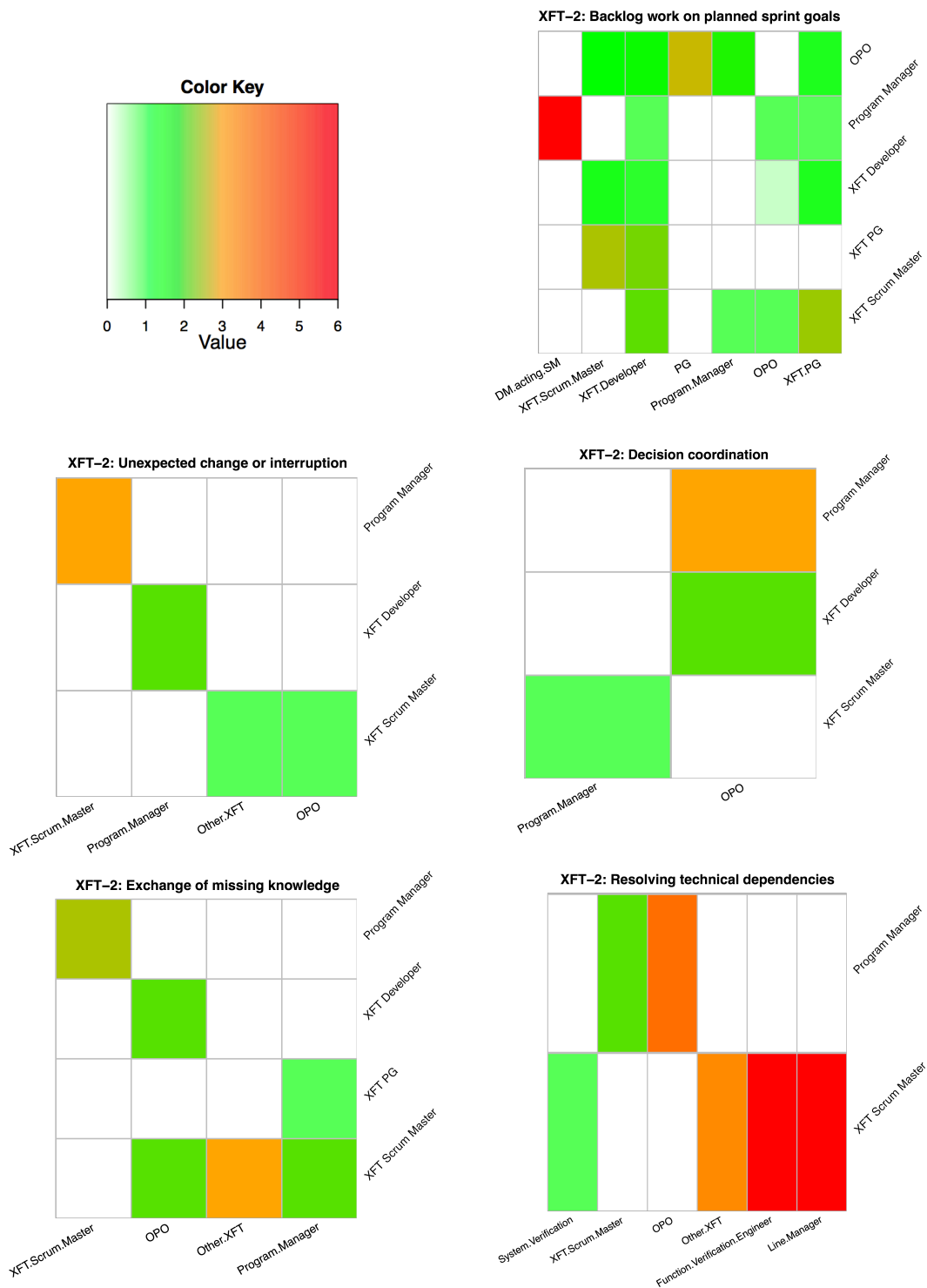**Figure 6.1:** XFT-1: Differences in intensities depending on communication nature

**Figure 6.2:** XFT-2: Differences in intensities depending on communication nature

the levels of intensity below 3 — a designator of the usual level. *Unexpected change or interruption* along with *Decision coordination* were only marked by the XFT members and the "Program Manager" and the intensity there never raised above the usual level.

Overall, a rather tight collaboration between the respondent group can be observed from all the heat maps on the Figure 6.2. The "XFT Developers" mostly stayed within their immediate communicational environment of their PG, OPO, "Program and Department (acting Section) Manager", with only the "XFT Scrum Master" reaching out in cases of *Exchange of missing knowledge* and *Resolving technical dependencies*. In addition to the "XFT Scrum Master" being the only member of the XFT involved in resolving technical dependencies, this communication nature caused the most intense interactions for him.

### 6.1.3 Social Networks

The data collected from the surveys was also used to construct social networks and thus give an overview of the interconnections between various roles in the studied groups of respondents.

The nodes in the social network graphs corresponding to the roles in the respondent group are indicated by the nodes of a bigger size. The representatives of the "XFT-D" role in the network on the Figure 6.3 participated in the study by filling out the surveys while the representatives of the "TC" role did not and were only approached by "XFT-D" over the studied period. The amount of new roles increases from the heat maps to social networks. This is explained by the fact that the respondents were able to mark "Other" as a communication nature and thereby this communication was not included in any of the heat maps, as it has been mentioned above.

The social networks characterisation of communication patterns of both teams is depicted in the Figures 6.3 and 6.4. Close collaboration between the members of the XFTs and their OPOs and PGs is attributable to both teams, which is a positive finding in the context of desired collaboration layers illustrated on the Figure 4.2. The communication between the XFTs and their "Section Manager" in both cases has been found to be less tight. Although connected in the networks, these roles seem to have rather limited collaboration based on the heat maps tables. As has been mentioned in sections 6.1.1 and 6.1.2, both have only been in contact over decision coordination in the case of XFT-1. Still, the teams communicated with their "Section Managers" during meetings.

Over the course of one week, the members of the XFT-1 had connections to ten roles who are not part of their immediate environment, as shown on the Figure 6.3. Most of them were initiated by the developers rather than the "XFT Scrum Master": nine out of ten for the former and two out of ten for the latter with a single overlap. The "Program Manager" of the XFT-1 is rather detached from the team with communication flowing via the "OPO". The "Department (acting Section) Manager", although connected with all members of the respondent group, has an equal number of communication with other roles mainly from the line organisation. Referring back to the heat maps calls for a conclusion that the latter set of communication paths is of a greater significance for the role.

| Abbreviation | Role | Abbreviation | Role |
|---:|---|---:|---|
| XFT-D | XFT Developer | CCB | Change Control Board |
| XFT-SM | XFT Scrum Master | SPM | Strategic Product Manager |
| XFT-PG | XFT Product Guardian | RBS | Radio Base Station |
| OPO | Operative Product Owner | FPjM | Feature Project Manager |
| SM-DM | Department Manager (acting Section Manager) | CIRV | Continuous Integration & Release Verification |
| PgM | Program Manager | PjM | Project Manager |
| TC | Technical Coordinator | SM | Section Manager |
| APO | Area Product Owner | DM | Department Manager |
| CA/KM | CA Kanban Master | SrM | Sector Manager |
| TR | Trouble Reports | CL | Change Leader |
| PG | Product Guardian (other) | TM | Technical Managerment |
| CPI | Customer Product Information | O-XFT | Member of other XFT |

**Figure 6.3:** XFT-1: Social Network

The social network of the XFT-2 overall has notably less connections than its counterpart, possibly due to the internal nature of the tasks at hand. Here, the team is in collaboration with their immediate environment. However, similarly to the XFT-1, the "Department (acting Section) Manager" is connected to all respondent roles but as can be tracked from the heat maps, the contacts between them are not frequent. The XFT-2 has six contacts with the roles outside their immediate environment, with the "XFT Scrum Master" contributing the most and solely having five of them. Thus, outside communication to a great extent seems to be flowing via the "XFT Scrum Master" who

acts as a communication hub.



| Abbreviation | Role |
|---:|---|
| **XFT-D** | XFT Developer |
| **XFT-SM** | XFT Scrum Master |
| **XFT-PG** | XFT Product Guardian |
| **OPO** | Operative Product Owner |
| **SM-DM** | Department Manager (acting Section Manager) |
| **PgM** | Program Manager |
| **PG** | Product Guardian (other) |
| **DM** | Department Manager |
| **CIRV** | Continious Integration & Release Verification |
| **IT-S** | IT Support |
| **SV** | System Verification |
| **FVE** | Functional Verification Engineer |
| **SSE** | Senior Software Expert |
| **LM** | Line Manager |
| **O-XFT** | Member of other XFT |

**Figure 6.4:** XFT-2: Social Network

## 6.2 Information & Communication

The analysis of the daily surveys was followed by the analysis of the interviews' data. This section focuses on the data discovered in connection to the first research question.

**RQ1:** *What are the information and communication challenges associated with the adoption of large-scale agile and how does their resolution benefit the application of agile?*

The findings are divided as pertaining to either information or communication as defined in Section 2.1. They are organised in three groups: challenges, benefits and improvements. The challenges describe the existing problematic aspects of information and communication flows while benefits picture desirable situations that could foster interviewees' work. The improvements suggest means of overcoming the challenges and thus reaping benefits, however it should be noted that these are solely the opinions of

the study's participants which might favour transitions from challenges to benefits, but are by no means complete and capable of solving all of the existing problems.

All findings are illustrated with quotes from interviews transcriptions. Naturally, the amount of quotes for each finding does not reflect their magnitude. The excerpts of opinions are rather used to describe an issue from several perspectives where applicable.

### 6.2.1 Information

The findings related to the concept of information are summarised on the Figure 6.5.
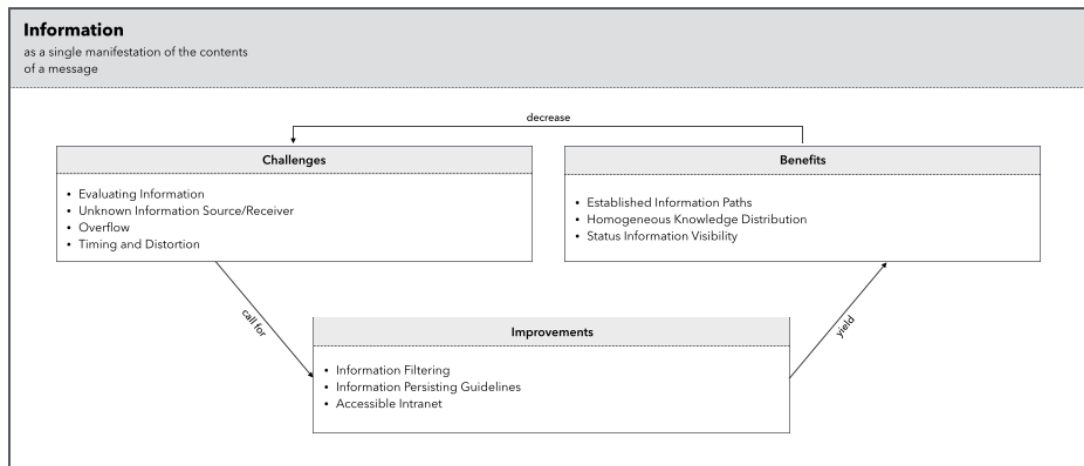


**Figure 6.5:** Information challenges, benefits and improvements

#### 6.2.1.1 Challenges

**Evaluating Information.** Each XFT in the studied organisation follows their own development process. From the interviewees' point of view it is favourable to have access to the descriptions of thereof. This can serve as a source of inspiration for own process improvements or assist in solving problems that might have been encountered previously by another team. However, the information circling around the organisation does not undergo a strict evaluation process, according to the interviewees. This leads to situations where the same issue is described in several different ways which differ significantly. For the people seeking this information it is troublesome to sort out approved pieces of it. The interviewees emphasize a need of reliance on the information that is commonly accessible by every party within the organisation.

> ... we say that "We have decided that we will do this and this and that" — that is not so easy to find, because you could find 10 "We have decided this and this and that" so which one is valid? ... It should be more clear about that kind of information, what kind of information is approved and

> *which is not. Because we really can't afford to run on information that is not valid.*

**Unknown Information Source/Receiver.** Although acknowledged as a fundamental and integral activity of each organisational unit, information sharing remains an intricate problem, which consequently adds to the problem of information gathering. Due to a not always clear separation of responsibilities, information is often being broadcast to every party that may, according to the information source, be interested thus leading to big amounts of "so that you know" information spread. At the same time, those who are genuinely in need of this intelligence and would benefit from it are potentially left unaware.

The organisation uses an internal portal to store information that is accessible by the employees. By means of this portal, teams can put up status updates or share information pertaining to their work. Still, while diligently updating their Wiki pages, the respondents mark that the information is not reaching its' seekers due to unstructured nature of the portal that makes the links hard to find.

> *Of course it's visible for more or less everyone, but I know for myself that if I enter another area, it's really tricky to find if I don't have any clues about where to start searching.*

Consequently, information gathering demands a significant effort. Whenever XFTs are being faced with an unknown domain in their work packages, they are lead to dead ends with a need for information hunting also not knowing where to begin the search.

Unclear responsibility concerns negatively affect the information gathering process as well, creating unnecessary long information search paths.

> *Many times I would like to just know "Who do I ask?". I mean I could ask one person just to get the name of the person who I really should ask to find out for a specific thing.*

These situations make XFTs reliant on their personal social networks that have been established while working at the organisation. Information discovery in these networks is accidental rather than the information flow building up the evidence.

**Overflow.** A problem of an overwhelming amount of information constantly circulating within the organisation was noticed by almost every interview participant and is one of the most prominent challenges. The interviewees mentioned numerous E-Mails reaching them on a daily basis from a vast variety of sources, which span across work-related issues, inquiries to provide competence and variety of newsletters from different parts of the organisation. In addition to this, there are numerous demo events and synchronisation meetings. The incomprehensible flow of incoming data is hard to handle without loosing the focus of one's primary work and

thus leads to either unnecessary long data acquisition engagements or ignoring the potentially relevant information.

> *... if you get a lot of emails each day, a lot of them you can't read by physical limitations — you have to throw them away. Sometimes you miss stuff. It's a lot of stuff but sometimes you miss the important.*

**Timing and Distortion.** In an environment which requires agreements from several parties to proceed on a certain task, it is not always possible to hold a common discussion at the same time. This creates the need for several coordination meetings sometimes parted by a number of days where information clutters and spreads thus disrupting the atmosphere around the XFTs.

> *... you have this distorted information and some team has heard something and some team has not. And then when it involves some kind of change then people don't really know what to trust.*

### 6.2.1.2 Benefits from Overcoming Challenges

Unimpeded and fluent access to information will smooth the working environment of XFTs by reducing the time needed for the information search, promoting knowledge sharing and shifting the focus of the developers to their primary backlog work.

**Established Information Paths.** A structured information flow within the organisation will contribute to a resolution of information overflow and consequent problems. Establishing communication paths comes with a significant cost by the need to sort out all existing information sources and declare paths to access them while at the same time saves the information that potentially could be lost due to misguiding travel paths.

**Homogeneous Knowledge Distribution.** Having a clear structure of the information flow within the organisation will help information to reach its intended audience. By removing the unclarity of intended information sources and receivers, knowledge will spread more fluently and evenly, meaning that the chances for each person to get access to the same piece of information are more or less the same. This homogeneous distribution of knowledge assists, for instance, promoting the adoption of best practices between several teams and reducing the amount of double work.

**Status Information Visibility.** Availability of information regarding the status of work in a collaborative environment is crucial to successfully determine a project's health. The benefits of having unimpeded access to status information at all times are two-fold: while the information source is shielded from being disrupted when such information is requested, information seeker is not dependant on availability of information provider. Thus various units in the organisation are allowed to follow up on each other without significant effort.

### 6.2.1.3 Potential Improvements

**Information Filtering.** An ability to filter out incoming information is desirable to overcome the information tsunami XFTs are faced with. While some interviewees suggest to mission a specific role for selecting information that is valuable for the teams, others propose the creation of seeking profiles for better customisation of heterogeneous needs of different roles with varying areas of concerns.

> *I think the teams need to do that themselves really, because its better to have information available but then everyone has a bit different needs. It's better that they do their own seeking profile than someone plans it for them.*

**Information Persisting Guidelines.** The respondents seem generally concerned about the faultiness of the existing way of spreading information. The seeming anarchy caused by the lack of a commonly agreed and followed rules regarding information persistence leads to the knowledge being lost inside the teams as they do not know a ways of sharing it or being lost in a sea of unevaluated information not easily reachable by others. The interviewees expressed the need of information persisting guidelines while marking the importance of knowledge sharing practices. To decrease the amount of unreliable data one proposal, for instance, was to include a review step prior information persistence, where the suggestions are analysed and their validity is evaluated.

**Accessible Intranet.** An Intranet is capable of providing access to all of the shared information while at the same time it lacks a comprehensible structure. The interviewees note the discouragement of using it as an information platform as it simply does not have a common entry point. Reshaping it in a way allowing for information filtering will contribute to a more thorough use and a clarification of ways of information sharing.

## 6.2.2 Communication

To recall, the thesis makes a distinction between the concepts of information and communication, where the latter is a form of humans dynamically exchanging information while the former is viewed as a single manifestation of a message content thus representing a more static concept.

The findings on the communication aspect of the first research question are summarised on the Figure 6.6

### 6.2.2.1 Challenges

**Bottlenecks.** Having a growing organisation of a large-scale comes at a cost of required extra coordination by several roles and persons exclusively holding responsibilities or information needed by a variety of units. Apart from bringing heavy load on the bottlenecks themselves it creates delays for dependant parties.
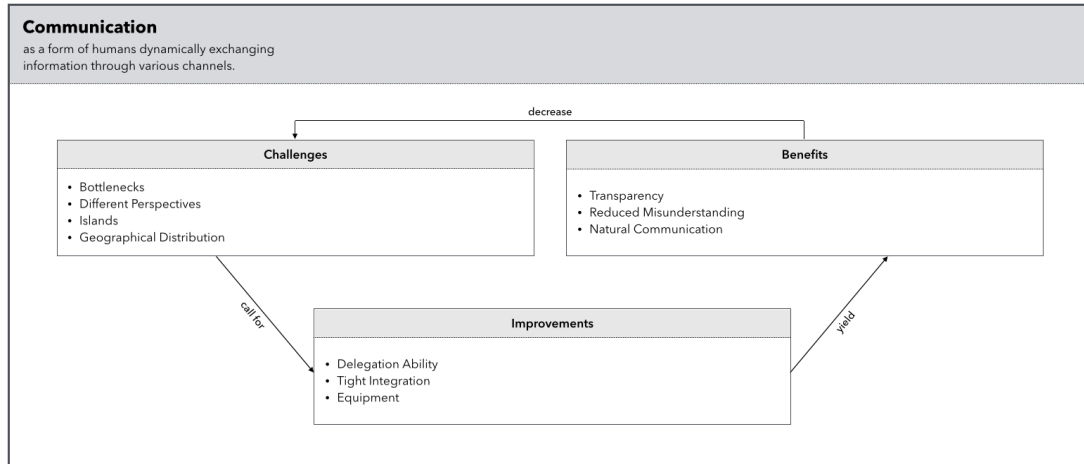
**Figure 6.6:** Communication challenges, benefits and improvements

> *They have very-very many features to keep track of, but when something arise and get very hot, they are coming back, but if it's not that hot it takes long time, because they have such a full load on that.*

**Different Perspectives.** Due to differences in day-to-day concerns interviewees are faced with in their work, it is not uncommon that communicating instances diverge in their levels of attainment with various topics. This leads to misunderstandings that can turn into hindrances for either of involved parties. Different perspectives and levels of understanding of a task may invoke confusion for one of the ends of a communication channel as it hinders assessment of impact on their work.

Some of the interviewed developers note that sometimes they are being enforced to take part in time consuming, not beneficial communications, stemming from the fact that the organiser of the meeting, likely unintentionally, misjudges its usefulness for different participants:

> *You have a different point of view form a Project Manager. When he calls that meeting he has a status from all the teams, but that team does not care at all what this team does, so the benefit is only for the Project Manager, mostly.*

**Islands.** A concern cross-cutting through several interviews is the presence of communication islands. These are shaping around certain roles who tend to have the greatest deal of the daily encounters with a limited number of other roles. This results in knowledge concentration and its' following isolation inside these emerged groups. The interviewees mentioned this phenomena as both positive and negative aspect of the existing communication set-up thus supporting the challenging nature of balancing it out.

Small numbers of teams working on the same product have been mentioned by the interviewees as a beneficial factor for XFTs due to close connections with other teams — they are contributing with a clear separation of work and provide availability of competences on other parts of the product the team is reliant on.

> *We are three teams working with [product], it's very good functioning and we are all focused in one product. We are also situated in one area, so there are good communications between those 3 teams that is no issues at all.*

On the other hand, such a separation from the rest of the organisation has the drawback of missing out on work and ways of working in other teams.

Moreover, the XFTs have been mentioned as being communication islands by their own, to a big extent tending to keep communication channels within themselves and thereby solely relying on the competence of the team members and potentially narrowing the viewpoint when taking decisions.

As it has been mentioned in the Section 6.1, Figure 6.3 illustrates a communication island around the PgM role from the XFT's point of view. Nevertheless, it is considered to be rather beneficial as the team does not need to rely on the details of work the PgM performs. On the other hand, a PgM has a direct connection to the APO role, who is in closer contact with the customer than the XFTs, which is desired for the teams in the agile context under study.

**Georgaphical Distribution.** The scale of the organisation requires coordination of multiple units that are often distributed across several geographical locations and could not be brought together as for strategic reasons. According to some of the interviewees, the environment in which such meetings are held is not well supported by the organisation and at times leads to the loss or misunderstanding of the issues that define upcoming decisions.

> *So it's 30 people ... and they are talking a lot, then we just sit there "Oh, what did he say now? Was it our problem or not?". They have minutes of meetings and we try to follow them and so on. Sometimes it's difficult to follow the meeting when you are not in the place.*

### 6.2.2.2 Benefits from Overcoming Challenges

An organisation transitioning towards an agile environment should value open communication to promote smooth collaboration and cooperation between employees of various roles. Adjusting the approach towards organisational communication will yield certain benefits which when combined will help to establish that open-minded atmosphere agile emphasises on as a mean of reaching the ultimate goals.

**Transparency.** Not being in full control of their environment, XFTs often delegate the removal of impediments or handling of inquiries. The interviewees repeatedly pointed out a wish for transparency in the progress on issue-solving.

> *... it's good for the teams so they now that there is an interest and an awareness of their work and their problem if they have any problem.*

The responsible parties being frank about the steps that have been taken to resolve a problem is a stimulating gain for the teams as they are no longer left blinded with a hope of a quick response that sometimes has to travel through another organisation.

The need for transparency was also mentioned in the context of the delegated issues disappearing without being taken care of due to either lack of willingness or competence from those who are responsible. An environment allowing for traceability of impediment handling is advantageous for a more efficient problem solving as well as for integration of the roles that are lacking competence which can be obtained by making the impediment visible and welcoming feedback on its solution.

**Reduced Misunderstanding.** Overcoming such communication challenges such as perspective differences or geographical distribution will foster collaboration for communicating parties. Naturally, this is profitable for every participant as a better understanding of problems and providing detailed input or feedback increases comprehensibility at both ends of a communication channel.

**Natural Communication.** A rather asynchronous style of communication within the organisation is more desirable by some of the interviewees over having to attend the meetings called upon for synchronisation purposes. The demanded presence in such meetings, in which only a small part concerns the attendee, is viewed as disrupting and as a direct inconsistency with the agile principles. One of the study participants, describing the desired communication style as "less of a project leader set-up with status meetings every week and synchronisation meetings every morning", notes that natural communication promotes general collaboration.

### 6.2.2.3 Potential Improvements

**Delegation Ability.** The respondents report on being overwhelmed with the required communication channels they need to be able to establish while working on different work packages. These channels need to be established prior to performing the task and may entail long waiting times for receiving feedback. Thus, to reduce the frustration and demanding effort of coming into contact with every role that needs to be coordinated for solving a task, the study participants suggested having an intermediate role or specialised group of people who would take on handling issues.

**Tight Integration.** In an ideal agile world it is desirable to have an open communication environment in which competences of others can be easily obtained. In

organisation of a large scale however this turns out to be rather troublesome. The interviewees note a loose connection between some units that are intended to have tight collaboration in Ericsson PDU LMR's interpretation of agile.

Thus, it has been noted that the collaboration between XFTs and their Section Manager is rather weak and does not correspond to the intended level mentioned in Figure 4.2. This partially touches the previous improvement, as Section Managers are supposed to take on teams' impediments thus reducing their problem load.

> *... it really should be a really close connection [with the Section Manager], but it isn't.*

On a bigger scale, the acknowledged loose connection between the line organisation and the program (agile branch), depicted on the left and right sides of the structure on the Figure 4.1 respectively, is an issue in need of paramount attention given the essential role line organisation has in the new, after-transformational, way of working. Some of the interviewees think that the line is "not really deep into the organisation", but suggest that this could be improved through education.

> *I think they need more education maybe, I think so. Because I think they have a very important role, so I think it's good if they have more, I think they should be better at this agile work than we are in the teams or in the programs, because we are thinking a lot about these technical solutions so we don't really have so much time, so we just work as they say in a way. "OK, we have set up this way of working" and we just work, but I think they need to be more involved in this agile transformation.*

To illustrate the loose collaboration, it is mentioned that the XFTs, their OPOs and Section Managers have their communication scheme in a form of a triangle, where each two nodes communicate with each other separately but the three are never discussing issues together. This leads to issues never leaving the triangle as its resolution tends to loop around the nodes with them coming back to each other for suggestions.

**Equipment.** Due to geographical distribution, it is not always possible to have face to face communication in decision making meetings. In this regard, a desire is put forward to have a setting which is as close to real physical presence as possible. The interviewees think that with the technical equipment capturing not only the voices of participants but allowing to have visual contact makes the meeting's participants feel more included in the discussion and thus promotes fruitful results.

## 6.3 Productivity Determinants

This section reports on findings related to the second research question with the summary presented on the Figure 6.7.

*RQ2:* *Which productivity determinants of an XFT become apparent as a result of an interplay of information and communication within a large-scale agile organisation?*
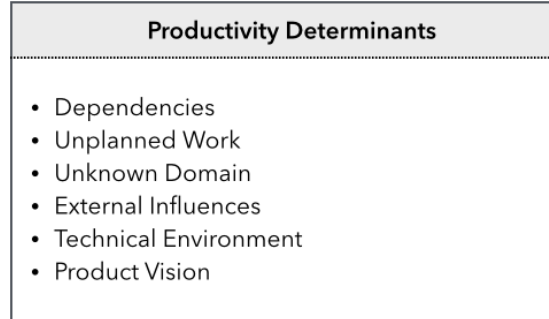


**Figure 6.7:** Productivity determinants

**Dependencies.** Providing the development teams with independent work packages, on which XFTs can focus during their sprints is desirable. However, such an isolation of work is hard to achieve in an organisation where many teams are working on several products. As noted by the interviewees, it is not uncommon to be interconnected in one way or another with other parts of the organisation. Namely, there is a need to coordinate with another unit in the organisation while working on the first step of some user stories, where a meeting should be booked and prepared for, thus demanding a noticeable amount of communication.

Another perspective on dependencies is related to more implementation level, where being dependent on progress of others can cause stalling or, if dependencies are not communicated properly and remain hidden, it can ultimately lead to complete invalidation of work effort.

> *... one team is doing work in the same area of the code and they don't know about someone else is doing a delivery and suddenly everything that you have made is not valid anymore because it doesn't align with what has just been delivered in.*

However, discovered dependencies are readily discussed and collaborated on between developers, but tend to cause more intense communication between XFTs than usual, as heat maps *Resolving technical dependencies* on Figure 6.8 depict. Both heat maps show a high communication intensity around the "XFT Developers" and "XFT Scrum Masters" indicated by the respective cells in the heat maps being of high values corresponding to the shades of red on a colour key, and at least three distinct roles being the communication's target.

In addition to this, the social networks in the Figures 6.3 and 6.4 demonstrate a quite significant amount of contacts for the XFTs with entities outside their immediate environment within a week long period.
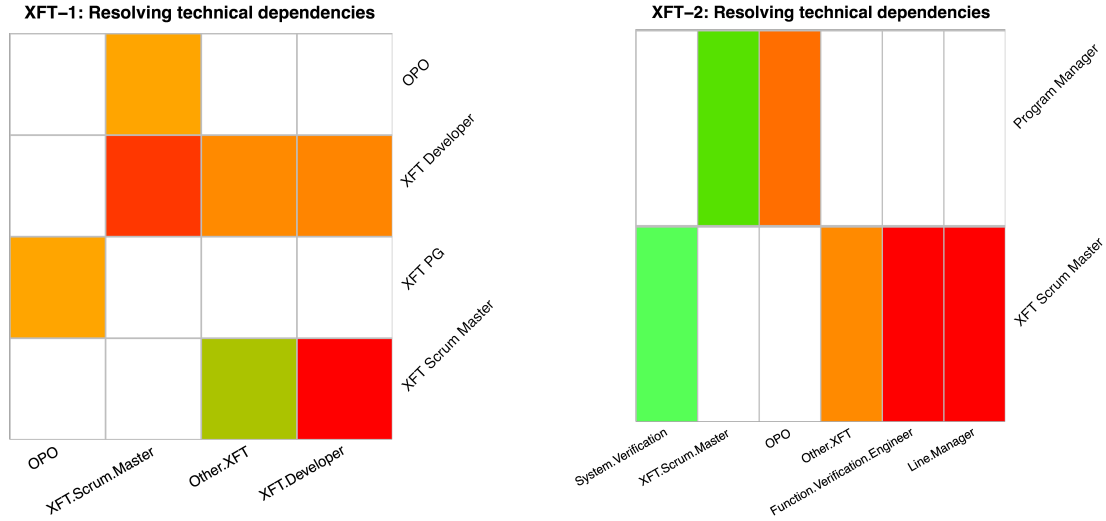
**Figure 6.8:** Heat maps: resolving technical dependencies

**Unplanned Work.** The commitment to a set of stories throughout the duration of a sprint, as considerably emphasized in Scrum, is not always strictly followed by the studied organisation. XFTs experience influences from different parts of the organisation, which do not necessarily contribute to the progress of development. In this regard, it is noted that the teams get additional stories from the line organisation, which do not contribute to the work on a product, but are intended to help the line organisation to get better integrated with the remaining elements of the structure.

Aside from additional tasks, developers are often disturbed by the trouble reports which can be put forward by customers or fellow development teams. In case of a high severity a report may force an XFT to put the ongoing stories aside to fully concentrate on the report at hand:

> ... that started up as a small TR that someone started to work on and the suddenly it got really, red alert on it, so everything within Ericsson was almost stopped because this TR must be solved. And then of course, at least two of the teams were involved at the same time and it took one week to solve it.

These items of unplanned work being pushed in to the backlog ultimately affect the teams' velocity by shifting the focus of developers. As reported, assigning a single team member to a trouble report often entails eventual involvement of additional person due to severity of a report or lack of competence. One of the interviewed XFT members recalls weeks where the work on a backlog has been completely set aside as every team member was dealing with trouble reports.

Communication intensity-wise, however, such occurrences do not seem to cause more friction than the regular backlog work, as heat maps *Backlog work on planned*

*sprint goals* and *Unexpected change or interruption* on Figure 6.9 demonstrate. *Unexpected change or interruption* heat maps show communication intensities for "XFT Developer" and "XFT Scrum Master" with shades of green colour codes indicating intensities below the usual level. This is similar to the communication nature of backlog work, where only in the case of the "XFT Developers" of the XFT-1 intensity slightly increases which is reflected with colour changing to orange.
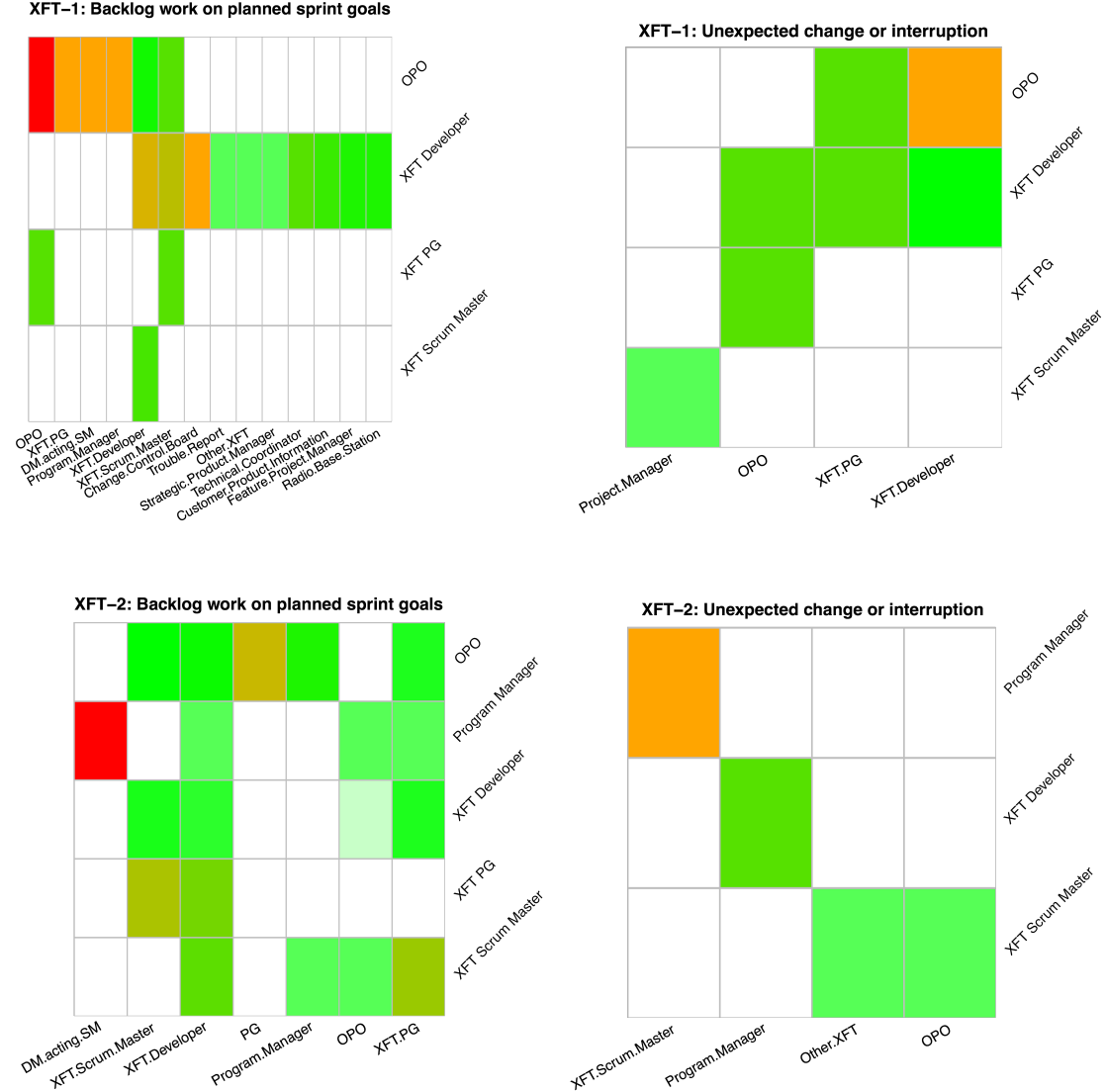


**Figure 6.9:** Heat maps: backlog work and unexpected change

**Unknown Domain.** The XFTs in the studied organisation are encouraged to take on tasks from different product areas. This sometimes causes teams to work in areas out of their expertise within an unknown domain. Familiarisation with the new

area demands tremendous effort prior to actual development.

> *... we spend days just on getting to know their code and so on, because it's said that we should do all development, but... Yes, we could do it, but it takes several days more than if we just ask someone who knows this from the beginning.*

In addition, variety of work packages disrupts the sense of a single purpose inside the team.

**External Influences.** Shielding XFTs from external influences and disruptions enables them to retain focus on backlog work and thereby positively affects the burn-down. Interviewees however note outside factors crawling into their daily work and distracting them from backlog items. One example is an urgent re-prioritisation of tasks that might be the result of a management decision.

Another case is forced participation in events which might not affect XFTs directly, and from the XFT members' perspective the things discussed in such meetings are not relevant for their sprints. The time spent is thus viewed as waste.

Alternatively, such events can be beneficial as they concern teams' future work, but the effect of that influence is only experienced by the teams in a number of months in the future.

> *... we have lots of other meetings that show up suddenly, some pre-study that starts and we really need to attend that one because we going to work with that in 2 months*

**Technical Environment.** One of the issues having its origins in the XFTs' empowerment is concerned with their technical environment. Empowering the XFTs means providing them with control over the great part of it. At the same time, such delegation of responsibilities is not necessarily beneficial, as the teams might not have the competence required to take care of the variety of arising issues. In this regard the interviewees repeatedly reported on being stalled by factors outside of their responsibility or competence.

> *So that has taken a lot of time and that, if you need a node and you are dependant on the nodes and you run a command and you need the traces, your work stops and that's what we have not gotten help with and we still do not know how to do that.*

**Product Vision.** The organisation's magnitude and its structure with several layers between developers and customers diminished the notion of customer collaboration. Thus, teams tend to have little participation in product discussions. At the same time, the wish of a long-term product vision being communicated to teams has been brought up. It could bring XFTs closer to customers and motivate their

work which in turn could positively affect product quality. As of now, the vision is not being communicated to the teams to a desirable extent, potentially rooted in the fact that those with more customer contact have perspective rather different from the teams'.

Moreover, those with a vision are faced with its agility and fragility and thus do not communicate it fully as it might change at any moment:

> *I think they like to know what we will go, the goals, but in this agile world, I think, it's sometimes it will just change again, even if we have this plan.*

However, in some of the respondents' opinion, the vision's carriers may sometimes be not passing it along due to lack of personal interest and involvement.

In the case of the XFT-1 the APO's role has the most customer contact among all roles present in the network in the Figure 6.10, but there is no direct link between the two. It proves how problematic the establishment of tighter collaboration between the customer or through their PO representative and the team members can be. As of now the communication has to travel via two intermediates: an OPO and a PgM. Referring back to the diagram on Figure 4.2, it does not alight with the intended collaboration.
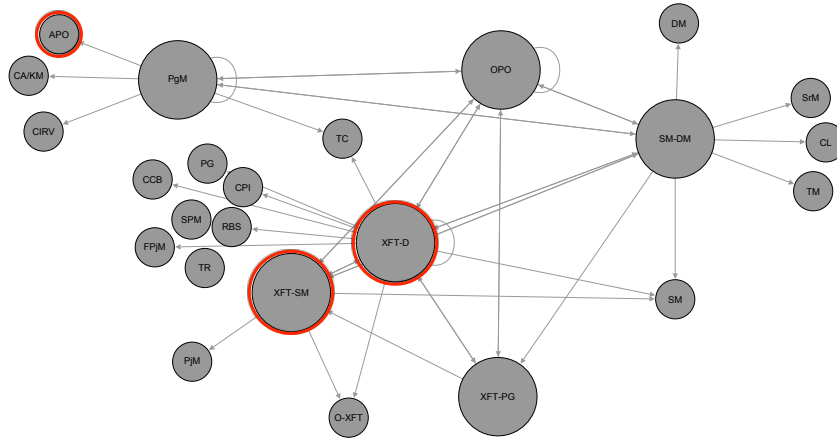


**Figure 6.10:** XFT-1: contact with APO

# 7

# Discussion

Thematically analysing the interviews revealed several common perceptions of the participants and allowed for structuring the research's findings as described in Section 6. Furthermore, it left room for interpreting and relating them on a larger scale. The following diagrams integrate all findings and generate a common view towards information and communication challenges, benefits and improvements. They lay the foundation for a set of trade-offs around XFT empowerment and their workflow and the overarching organisation. These trade-offs in turn can impact the productivity of XFTs positively or negatively.

## 7.1  Communication & Information

As outlined in the Findings, the analysis of the interviews' transcriptions revealed that respondents elaborate on information and communication by mentioning associated challenges, benefits and possible improvements.

In addition, all three elements show an equal relation among one another within the fields of information and communication. Targeted benefits can only be realised by addressing a known challenge with a tailored improvement. As outlined in Figures 6.5 and 6.6, challenges can be overcome by applying an improvement, which in turn *decreases* the challenge but might also strengthen another one as a negative side effect. Side effects are caused by the tendency of improvements to change the nature of communication and information. After all, this might just affect other existing challenges or can even create new ones. In general, challenges *call for* improvements while the improvement itself *yields* certain benefits. It is important to note that one can not overcome a challenge without addressing it with a concrete improvement.

In the context of an organisation, properties of information feed into communication and vice versa. One side of this *mutual influence* manifests itself whenever information is exchanged by communicating. Communication success depends on the present information challenges. Communication and its challenges relating to *RQ1* is likely to be efficient whenever sources are accessible without an overflow, correct information has

been evaluated, the piece of information is not distorted and appropriate receivers are known. The challenge of *communication islands* for instance, according to Kettunen and Laanti [36], often arise from the accumulation of knowledge — an issue to which this study additionally observed that islands can develop unintentionally. A later attempt to eliminate islands by publicly offering the gathered knowledge often results in an excessive demand of knowledge sharing for its members having a distractive effect on their work focus. Knowledge concentration resulting from a lack of communication has also been discovered by Herbsleb and Mockus [33] who relate a lack of interaction to a blindness regarding the overall work environment. This eventually results in elimination of shared identity which can lead to isolated group behaviour. The mentioned challenges around *RQ1* of *bottlenecks* and *islands* relate to this and have also been identified by Curtis et al. [22]. They are caused by communication paths being hard to establish and an inability to make decisions without clear responsibilities in place. Still, the importance of informal communication is highlighted. Issues arise as soon as a high level of informal communication has to integrate within various chains of command or has to take place with roles far out of the natural communication environment [22].

Still, communication can not be considered left alone as its *dynamic nature* promotes this *mutual* relationship in which information is defined as a *manifestation of the contents of a message*. Figure B.2 illustrates the overall relation with a presence of *mutual influence* between communication and information. Whenever the way in which communication is dynamically carried out is changed, it can also feedback into information and affect its challenges and possible benefits. In connection to *RQ1* Pikkarainen et al. [52], for instance, call the increasing amount of informal communication evolving into an inevitable challenge for large-scale agile organisations. The studied organisation and its XFTs also declare the rising *information overflow* as one of the main challenges which should be addressed with a variety of improvements, such as an ability for *information filtering* and an *accessible intranet*. In addition, the previously mentioned communication challenge (illustrated in Section 6.2.2.1) of having *different perspectives* towards the level of details on a certain topic or compulsory collective meetings varying in benefit for its participants is partially caused by the new and often uneven distribution of responsibilities in the process of empowering the XFTs. This growing disconnection between units within the organisation and its relation to empowerment has also been pointed out previously [46, 69]. Furthermore, Ovaska et al. [51] acknowledge spreading information in geographically distributed software organisations as one of the main challenges impacting development by knowledge distribution. Uneven distributions of knowledge and resulting *different perspectives* are one communication challenge having the same mentioned impacts on XFTs.

As discussed, the information environment's state sets the stage for challenges and benefits relating to communication. Similarly, the other way around, information challenges tend to arise by changing communication procedures and adjustments of the organisational context. A shift towards more geographical distribution, for instance, generates new communication challenges which yet again render new information demands and requirements. This is also stated by Kraut and Streeter [38], who emphasize

the geographical distance as a negative influence to communication behaviour. At the same time Berntsson Svensson et al. [5] call for applying various mechanisms of communication for different contexts to increase the communication benefits.

## 7.2 Trade-offs & Productivity Determinants

Both distinct but interdependent fields of information and communication then influence a set of trade-offs through setting up the basis of organisation's position in relation to being rather *transparent* or focussing on *islands*.

Figure 7.1 illustrates different trade-offs which are greatly influenced by the described interplay of communication and information, its challenges and benefits.

**Organisation:** Islands vs Transparent

**XFT Empowerment:** Responsibility Specialised vs. Responsibility Broadened

**XFT Workflow:** Static vs. Emergent

All three trade-offs contain the rather agile perceptions towards organisations, workflow and empowerment on their right extreme. Their left extreme outlines the more traditional perceptions towards software development processes. None of the two is to be understood as generally beneficial as their value depends on the context and its requirements.

Interviewees noted these previously mentioned concepts touching on communication and information mostly in the context of the present organisational structure as outlined in Figure 4.1. Additional to the organisational structure, interviewees interact with organisational aspects such as processes definitions and prevailing roles definitions. In an agile organisation these elements are usually aligned with the organisation's intention towards being *transparent* or favouring *islands* (see Figure 7.1). Single decisions within a given organisational framework by changing processes or just carrying out work can then change the positioning on the organisational trade-off in one of its directions, while neither one of the two extremes are wished for under all circumstances. *Transparency* may seem to always be desirable to allow for a fluent information circulation but bears issues at large scale causing confusion by overflow paralysing decision making. Forming *islands* may appear negatively connotated as it disconnects individual units but is advantageous in efficiency for isolated and specialised tasks.

The trade-off on a level of an organisation envisioning the adoption of agile methodologies influences two subordinate trade-offs: one around the XFT empowerment and the second around their workflow. The XFT empowerment bears a necessary decision on how responsibilities should be delegated towards teams. On the one hand, an XFT's responsibilities can be *specialised* according to a product or its members' competences. On the other hand, various degrees of *broadened* responsibilities can be assigned. Completely *broadened* XFTs would therefore be able to take over almost any task and solve most impediments within their environment without much external guidance. The empowerment approach tends to have negative side effects on both extremes. Assigning too
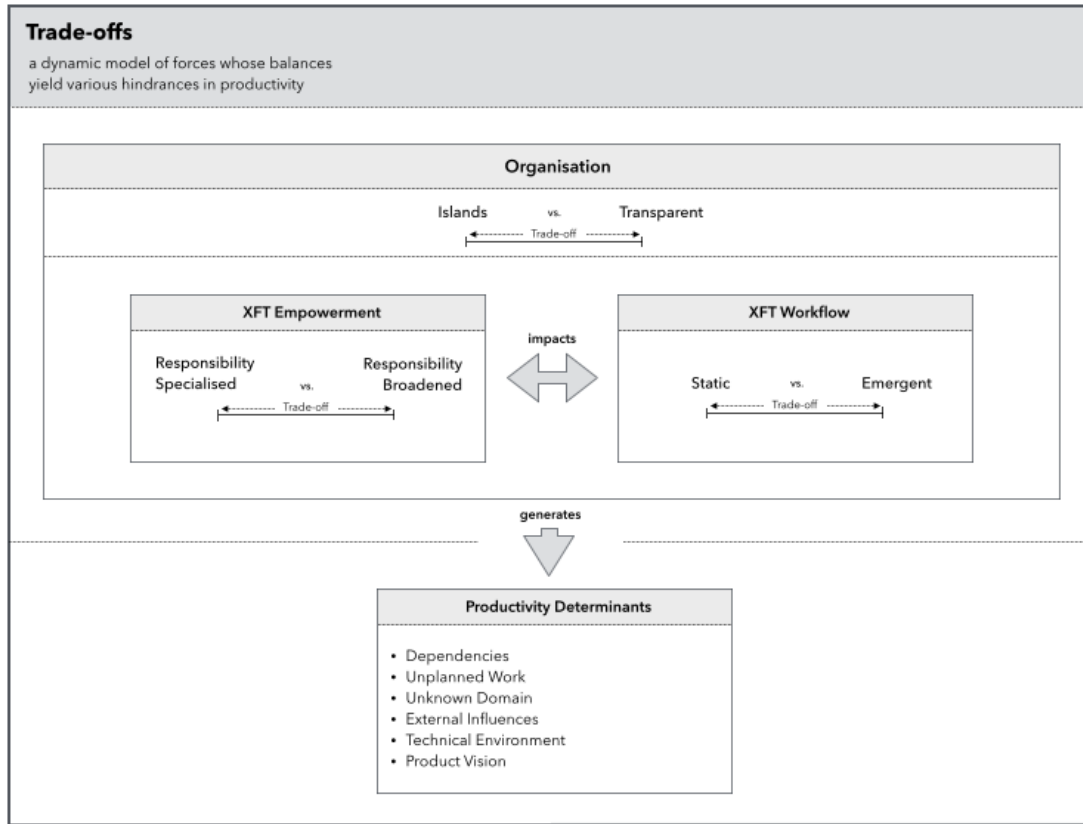
**Figure 7.1:** Trade-offs in empowerment, workflow and organisational influence

many responsibilities is a cause of XFTs being overwhelmed and loosing focus. On the contrary, highly *specialised* teams would strive in a well-defined field with a preferably narrow scope. Context changes or various external dependencies can break their focus and turn out costly for their efficiency.

Software development also entails a workflow in which a trade-off between an *emergent* and *static* nature should be made. An *emergent* workflow is composed of groups solving a task self-coordinated without dedicated supervision. Whereas groups working in a *static* fashion tend to require more oversight and are more suited for the assignment of predefined tasks. An *emergent* workflow reduces the need for pre-planning but tends to struggle with carrying out tasks of higher complexity with too many interdependencies. *Static* workflows, through their static structure, are more compatible with a vast amount of dependencies but are vulnerable by their need of coordination and supervision.

The three mentioned trade-offs around the *organisation*, *empowerment* and *workflow* mutually influence one another. The alignment within one trade-off can ease reaching a certain position on another but might be hindered by the third. The possibility to freely adjust a trade-off might thereby not always be there unless others are changed

previously. This strong attachment is also noticeable by certain incompatibilities between the trade-offs' positions. An *emergent* workflow, for instance, is difficult in an organisation favouring *islands* and a *specialised* strategy towards empowerment. *Broad* XFTs prefer some level of *transparency* with a rather *emergent* workflow to engage in solving changing tasks.

Finally, settling on all trade-offs defines a set of dependent *productivity determinants*. The existence of these concrete determinants and their severity is influenced by the mentioned trade-offs and the organisation's nature. The often negative effect of *technical dependencies* and associated challenges potentially creating domino effect or even vicious circle have previously been pointed out by Sekitoleko et al. [62]. Concerns regarding planning and maintaining a shared *product vision* have also been mentioned [1]. Still, Badampudi et al. [1] state that these are less rooted in the agile's need to flexibility but rather caused by unclear requirements, false customer collaboration and a lack of competence.

The key is to identify acceptable *productivity determinants* while moving along information and communication challenges and the adjustment of all trade-offs until the intended determinants carry into effect. The trade-offs are just means to an end and agility lies in the ability to adapt and chose the most suitable constellation under given circumstances and an intended outcome.

# 8

# Conclusions

Agile methodologies have recently been applied within companies of bigger sizes than its methodologies were originally designed for [4, 37]. Resulting from this any case study in the area of large scale agile eventually contributes to the existing body of knowledge. This thesis, through two weekly rounds of daily surveys and following semi-structured interviews, focused on the belated integration difficulties related to information and communication flow within the organisation and their implicative affect on the working environment of the XFTs.

The discovered information challenges, which are the subject of the *RQ1*, include information evaluation, problematic information sharing and gathering due to unknown sources and receivers, information overflow, and information distortion along with the timing issues of the information's travel. Through numerous improvements among which are information filtering, information persisting guidelines and accessible Intranet, established information paths, homogeneous knowledge distribution and status information visibility benefits can be obtained.

The aim of the *RQ1* was to also discover the challenges related to communication within an organisation that has transferred to agile methodologies. The most dominant findings on the topic include communication bottlenecks, communication islands, differences in perspectives of communicating parties and geographical distribution. These call for improvements in delegation abilities for the XFTs, tight integration between parts of the organisation and technical equipment support. Working on improvements yields benefits for the agile organisation, which include reduced misunderstandings, transparency, and natural communication.

The study concludes, that seemingly secondary to software development, areas of communication and information flow within the organisation are the integral aspects to consider within the adoption and emergence of a new way of working. In an organisation faced with the mentioned challenges, adjusting the level of organisational transparency and the related trade-offs of XFTs empowerment and workflow is a step to influence the productivity of development teams as subject to *RQ2*. It is characterised by various aspects, among which are dependencies, unplanned work, unknown domain, external influences, technical environment and product vision.

Finally, heat maps and social networks have been demonstrated as powerful instruments for visualising data on communication (*RQ3*). While the heat maps allow for illustrating the differences between the communications of various natures and spotting the focus points of intense collaborations, social networks give a structured overview of the communication paths. Both visualisation instruments have been used to underpin the findings connected to differences in communication intensities and their relation to productivity determinants. However, heat maps and social networks have also showed to be misleading if put out of context and analysed independently.

## 8.1 Implications for Researchers

Despite having only one case, the study opens avenues for future research. As a consequence of research on agile software development from a perspective of communication and information being sparse [52], this study intended to impart a structured understanding surrounding it. Just as Badampudi et al. [1] unfold potential productivity delays, the study attempts to integrate independently discovered determinants into a bigger picture of forces and balances.

This comprehension calls for: *(i)* relating causes of productivity determinants with different trade-off positioning. One approach would entail performing a two-time study with a single organisation changing a single trade-off positioning before and after a transformation while looking at resulting productivity determinants. In another approach a multi-site study could be conducted with different organisations, which are positioned on different areas of the trade-offs, to compare the productivity determinants; *(ii)* conducting surveys for constructing heat maps and social networks over a longer time-span with more XFTs using an automated data collection instrument to reduce the required effort. Such investigation holds potential to bring forth profound and more diverse findings around the teams' communication behaviours.

The study demonstrated the application of heat maps and social networks for visualisation of data of quantitative nature with a special focus on communication intensities. The instrument could be applied to investigate the issues of the similar nature, identify the flaws of its design and refine it with a purpose or generalisation for future studies.

## 8.2 Implications for Practitioners

Scaling agile within a large context entails various difficulties for practitioners. Even though agile's methodologies tend to have the general ability to scale or can be extended, emerging challenges of information and communication shall not be forgotten when trying to optimise adoption of agile.

The outlined findings emphasize the importance of reflecting on trade-offs around the organisation, XFT empowerment and the XFT's workflow. A then deeper analysis of existing communication and information challenges yields benefits through specific improvements. This eventually leads to an understood environment with specific pro-

ductivity determinants which themselves can be influenced by adjusting the mentioned trade-offs and improving on information and communication's challenges.

It is important to note that qualitative investigations by capturing needed knowledge around the communication's and information's status quo are vital to lay a foundation. The proposed analysis should be applied in practice, reflected upon and eventually extended. The utilisation would give insights on how productivity determinants are affected by mitigated communication and information challenges within an environment defined by the mentioned trade-offs. Lastly, using heat maps and social networks for continuous real-time feedback within an organisation may reveal promising insights into an organisation's dynamics and associated issues.

The ability to incorporate qualities specific to any organisation's own nature allows the discussed framework to be applied outside the analysed case, ultimately contributing to a more successful application of agile without suggesting or prescribing concrete methods or practices.

# Bibliography

[1] Badampudi, D., Fricker, B. and Moreno, A. M. [2013], Perspectives on productivity and delays in large-scale agile projects, *in* 'Proceedings of the 14th International Conference Agile Processes in Software Engineering and Extreme Programming', Vienna, Austria, pp. 180–194.

[2] Beck, K. and Andres, C. [2004], *Extreme Programming Explained: Embrace Change, 2nd Edition (The XP Series)*, Addison-Wesley.

[3] Beck, K., Beedle, M., van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., Grenning, J., Highsmith, J., Hunt, A., Jeffries, R., Kern, J., Marick, B., Martin, R. C., Mellor, S., Schwaber, K., Sutherland, J. and Thomas, D. [2001], 'Manifesto for agile software development'.
**URL:** *http://www.agilemanifesto.org/*

[4] Benefield, G. [2008], Rolling out agile in a large enterprise, *in* 'Proceedings of the Proceedings of the 41st Annual Hawaii International Conference on System Sciences', Waikoloa, USA, pp. 461–470.

[5] Berntsson Svensson, R., Aurum, A., Paech, B., Gorschek, T. and Sharma, D. [2012], Software architecture as a means of communication in a globally distributed software development context, *in* 'Proceedings of the 13th International Conference on Product-Focused Software Development and Process Improvements (PROFES'12)', Madrid, Spain, pp. 175–189.

[6] Berntsson Svensson, R., Gorschek, T., Regnell, B., Torkar, R., Shahrokni, A., Feldt, R. and Aurum, A. [2011], Prioritization of quality requirements: State of practice in eleven companies, *in* 'Proceedings of the 19th IEEE International Requirements Engineering Conference (RE'11)', Trento, Italy, pp. 69–78.

[7] Boehm, B. and Turner, R. [2005], 'Management challenges to implementing agile processes in traditional development organizations', *IEEE Software* **22**(5), 30–39.

[8] Braun, V. and Clarke, V. [2006], 'Using thematic analysis in psychology', *Qualitative research in psychology* **3**(2), 77–101.

[9] Börjesson, B. P. [2013], Challenges of product owner in distributed large-scale scrum, bachelor thesis, Software Engineering and Management University of Gothenburg, Göteborg, Sweden.

[10] Cardozo, E. S. F., Neto, J. B. F. A., Barza, A., França, A. C. C. and da Silva, F. Q. B. [2010], Scrum and productivity in software projects: A systematic literature review, *in* 'Proceedings of the 14th International Conference on Evaluation and Assessment in Software Engineering', Keele University, UK, pp. 131–134.

[11] Carey Schwaber, G. L. and D'Silva, D. [2007], 'The truth about agile processes', *Forrester Research* .

[12] Cataldo, M. and Herbsleb, J. D. [2008], Communication networks in geographically distributed software development, *in* 'Proceedings of the 2008 ACM Conference on Computer Supported Cooperative Work', San Diego, USA, pp. 579–588.

[13] Cataldo, M., Wagstrom, P. A., Herbsleb, J. D. and Carley, K. M. [2006], Identification of coordination requirements: Implications for the design of collaboration and awareness tools, *in* 'Proceedings of the 2006 20th Anniversary Conference on Computer Supported Cooperative Work (CSCW'06)', Banff, Alberta, Canada, pp. 353–362.

[14] Ceschi, M., Sillitti, A., Succi, G. and Panfilis, S. D. [2005], 'Project management in plan-based and agile companies.', *IEEE Software* **22**(3), 21–27.

[15] Cockburn, A. [2004], *Crystal Clear: A Human-Powered Methodology for Small Teams: A Human-Powered Methodology for Small Teams*, Addison-Wesley Professional.

[16] Cockburn, A. [2005], 'Doi, declaration of interdependence'.
**URL:** *http://www.pmdoi.org/*

[17] Cockburn, A. [2007], *Agile software development : the cooperative game*, Addison-Wesley, Upper Saddle River, NJ.

[18] Cohn, M. and Ford, D. [2003], 'Introducing an agile process to an organization', *Computer* **36**(6), 74–78.

[19] Conway, M. [1968], 'How do committees invent', *Datamation* **14**(4), 28–31.

[20] Coplien, J. O. and Harrison, N. B. [2004], *Organizational Patterns of Agile Software Development*, Prentice Hall.

[21] Coram, M. and Bohner, S. A. [2005], The impact of agile methods on software project management, *in* 'ECBS '05 Proceedings of the 12th IEEE International Conference and Workshops on Engineering of Computer-Based Systems', Greenbelt, USA, pp. 363–370.

[22] Curtis, B., Krasner, H. and Iscoe, N. [1988], 'A field study of the software design process for large systems', *Communications of the ACM* **31**(11), 1268–1287.

[23] Damian, D., Helms, R., Kwan, I., Marczak, S. and Koelewijn, B. [2013], The role of domain knowledge and cross-functional communication in socio-technical coordination, *in* 'Proceedings of the 2013 International Conference on Software Engineering (ICSE '13)', San Francisco, CA, USA, pp. 442–451.

[24] Eklund, U. and Bosch, J. [2012], Applying agile development in mass-produced embedded systems, *in* 'Proceedings of Agile Processes in Software Engineering and Extreme Programming — 13th International Conference, XP 2012', Vol. 111 of *Lecture Notes in Business Information Processing*, Springer, Malmö, Sweden, pp. 31–46.

[25] Feldt, R., Staron, M., Hult, E. and Liljegren, T. [2013], Supporting software decision meetings: Heatmaps for visualising test and code measurements, *in* 'Proceedings of the Software Engineering and Applications (SEAA) conference', Santander, Spain, pp. 62–69.

[26] Floridi, L. [2010], *Information: A Very Short Introduction*, Oxford University Press.

[27] Galbraith, J. R. [2008], *Designing Matrix Organizations that Actually Work: How IBM, Procter & Gamble and Others Design for Success (Jossey-Bass Business & Management)*, Jossey-Bass.

[28] Gleick, J. [2012], *The Information: A History, A Theory, A Flood*, Vintage.

[29] Grenning, J. [2001], 'Launching extreme programming at a process-intensive company.', *IEEE Software* **18**(6), 27–33.

[30] Harrison, N. B. and Coplien, J. O. [1996], 'Patterns of productive software organizations', *Bell Labs Technical Journal* **1**(1), 138—-145.

[31] Healey, P. [1998], *Project Management*, Routledge.

[32] Herbsleb, J. D. [2007], Global software engineering: The future of socio-technical coordination, *in* 'Future of Software Engineering (FOSE '07)', Minneapolis, USA, pp. 188–198.

[33] Herbsleb, J. D. and Mockus, A. [2003], 'An empirical study of speed and communication in globally distributed software development', *IEEE Transactions on Software Engineering* **29**(6), 481–494.

[34] Iivari, J. and Iivari, N. [2011], 'The relationship between organizational culture and the deployment of agile methods', *Information and Software Technology* **53**(5), 509–520.

[35] Kauffeld, S. and Lehmann-Willenbrock, N. [2011], 'Meetings matter: Effects of team meetings on team and organizational success', *Small Group Research* **43**(2), 130–158.

[36] Kettunen, P. and Laanti, M. [2008], 'Combining agile software projects and large-scale organizational agility.', *Software Process: Improvement and Practice* **13**(2), 183–193.

[37] Kniberg, H. and Ivarsson, A. [2012], 'Scaling agile @ spotify with tribes, squads, chapters & guilds'.
**URL:** *https://ucvox.files.wordpress.com/2012/11/113617905-scaling-agile-spotify-11.pdf*

[38] Kraut, R. and Streeter, L. [1995], 'Coordination in software development', *Communications of the ACM* **38**(3), 69–81.

[39] Laanti, M. [2008], Implementing program model with agile principles in a large software development organization, *in* 'Proceedings of the 32nd Annual IEEE International Computer Software and Applications Conference, COMPSAC 2008', Turku, Finlad, pp. 1383–1391.

[40] Laanti, M., Similä, J. and Abrahamsson, P. [2013], Definitions of agile software development and agility, *in* 'Proceedings of the 20th European Conference Systems, Software and Services Process Improvement (EuroSPI)', Dundalk, Ireland, pp. 247–258.

[41] Larman, C. and Vodde, B. [2008], *Scaling Lean & Agile Development: Thinking and Organizational Tools for Large-Scale Scrum*, Addison-Wesley Professional.

[42] Leffingwell, D. [2007], *Scaling Software Agility: Best Practices for Large Enterprises (The Agile Software Development Series)*, Addison-Wesley Professional.

[43] Lethbridge, T. C., Sim, S. E. and Singer, J. [2005], 'Studying software engineers: Data collection techniques for software field studies', *Empirical Software Engineering* **10**(3), 311–341.

[44] Mann, C. and Maurer, F. [2005], A case study on the impact of scrum on overtime and customer satisfaction, *in* 'Proceedings of Agile Conference 2005 (AGILE 2005)', Denver, USA, pp. 70–79.

[45] Mannaro, K., Melis, M. and Marchesi, M. [2004], Empirical analysis on the satisfaction of it employees comparing xp practices with other software development methodologies., *in* J. Eckstein and H. Baumeister, eds, 'XP', Vol. 3092 of *Lecture Notes in Computer Science*, Springer, pp. 166–174.

[46] Mills, P. K. [2003], 'Reassessing the limits of structural empowerment: Organizational constitution and trust as controls', *The Academy of Management Review* **28**(1), 143–153.

[47] Moore, E. and Spens, J. [2008], Scaling agile: Finding your agile tribe, *in* 'Proceedings of the Agile 2008', Toronto, Canada, pp. 121–124.

[48] Myers, M. D. and Newman, M. [2007], 'The qualitative interview in is research: Examining the craft', *Information and Organization* **17**(1), 2–26.

[49] Niinimäki, T. and Lassenius, C. [2008], Experiences of instant messaging in global software development projects: A multiple case study, *in* 'IEEE International Conference on Global Software Engineering (ICGSE '2008)', Bangalore, India, pp. 55–64.

[50] Nils, G. and Bang, W. [2012], 'Points of view: Heat maps', *Nature Methods* **9**(3), 213.

[51] Ovaska, P., Rossi, M. and Marttiin, P. [2003], 'Architecture as a coordination tool in multi-site software development', *Software Process: Improvement and Practice* **8**(4), 233–247.

[52] Pikkarainen, M., Haikara, J., Salo, O., Abrahamsson, P. and Still, J. [2008], 'The impact of agile practices on communication in software development', *Empirical Software Engineering* **13**(3), 303–337.

[53] Pinsonneault, A. and Kraemer, K. L. [1993], 'Survey research methodology in management information systems: An assessment', *Journal of Management Information Systems* **10**(2), 75–105.

[54] Prikladnicki, R., Audy, J. L. N. and Evaristo, R. [2003], 'Global software development in practice lessons learned', *Software Process: Improvement and Practice* **8**(4), 267–281.

[55] Runeson, P. and Höst, M. [2009], 'Guidelines for conducting and reporting case study research in software engineering', *Empirical Software Engineering* **14**(2), 131–164.

[56] Runeson, P., Host, M., Rainer, A. and Regnell, B. [2012], *Case Study Research in Software Engineering: Guidelines and Examples*, Wiley.

[57] Savage, N. [2011], 'Information theory after shannon', *Communications of the ACM* **54**(2), 16–18.

[58] Schiel, J. [2007], *Human Resource Management in a Business Context*, Cengage Learning Emea.

[59] Schiel, J. [2009], *Enterprise-Scale Agile Software Development (Applied Software Engineering Series)*, CRC Press.

[60] Schwaber, K. and Beedle, M. [2001], *Agile Software Development with Scrum (Series in Agile Software Development)*, Prentice Hall.

[61] Scott, J. [2011], 'Social network analysis: developments, advances, and prospects', *Social Network Analysis and Mining* **1**(1), 21–26.

[62] Sekitoleko, N., Evbota, F., Knauss, E., Sandberg, A., Chaudron, M. and Olsson, H. [2014], Technical dependency challenges in large-scale agile software development, *in* 'Proceedings of International Conference on Agile Software Development (XP'14)', Rome, Italy, pp. 46–61.

[63] Shannon, C. [1948], 'A mathematical theory of communication', *Bell System Technical Journal* **27**, 379–423, 623–656.

[64] Shenton, A. K. and Hayter, S. [2004], 'Strategies for gaining access to organisations and informants in qualitative studies', *Education for Information* **22**(3-4), 223–231.

[65] Sims, C. and Johnson, H. L. [2012], *Scrum: a Breathtakingly Brief and Agile Introduction*, Dymaxicon.

[66] Stober, T. and Hansmann, U. [2009], *Agile Software Development: Best Practices for Large Software Development Projects*, Springer.

[67] Stray, V. G., Moe, N. B. and Aurum, A. [2012], Investigating daily team meetings in agile software projects, *in* 'Proceedings of the 38th Euromicro Conference on Software Engineering and Advanced Applications (SEAA)', Cesme, Izmir, pp. 274–281.

[68] Svensson, H. and Höst, M. [2005], Views from an organization on how agile development affects its collaboration with a software development team., Vol. 3547 of *Lecture Notes in Computer Science*, Springer, Oulo, Finland, pp. 487–501.

[69] Tessem, B. [2014], 'Individual empowerment of agile and non-agile software developers in small teams', *Information & Software Technology* **56**(8), 873–889.

[70] Turk, D., France, R. and Rumpe, B. [2000], Limitations of agile software processes, *in* 'Proceedings of the 3rd International Conference on Extreme Programming and Flexible Processes in Software Engineering (XP2002)', Alghero, Italy, pp. 43–46.

[71] Verdú, S. [1998], 'Fifty years of shannon theory.', *IEEE Transactions on Information Theory* **44**(6), 2057–2078.

[72] VersionOne [2013], '7th annual state of agile development survey'.
**URL:** *http://www.versionone.com/pdf/7th-Annual-State-of-Agile-Development-Survey.pdf*

[73] Vigo, R. [2011], 'Representational information: a new general notion and measure of information', *Information Sciences* **181**(21), 4847–4859.

[74] Voinea, L., Lukkien, J. and Telea, A. [2007], 'Visual assessment of software evolution', *Science of Computer Programming* **65**(3), 222–248.

[75] Šmite, D. [2006], 'Global software development projects in one of the biggest companies in latvia: Is geographical distribution a problem?', *Software Process Improvement and Practice* **11**(1), 61–76.

[76] Wilkinson, L. and Friendly, M. [2009], 'The history of the cluster heat map', *The American Statistician* **63**(2), 179–184.

[77] Wohlin, C., Ohlsson, M. C., Wesslén, A., Höst, M., Runeson, P. and Regnell, B. [2012], *Experimentation in Software Engineering*, Springer Berlin Heidelberg.

[78] Yin, R. K. [2009], *Case Study Research: Design and Methods*, Applied Social Research Methods, 4th edn, SAGE Publications, Inc.

# A

# Interview Guides

## General Guide: All Roles (except: SM/DM & PgM)

### Background Information

1. What is your role in the organization and with regards to the XFT [NAME]?

2. What are your key responsibilities?

3. Have you been working here before the transition towards agile?

   (a) What was your role during that time?

### Agile Transformation & Ways of Working

1. How did company's transition towards agile change your responsibilities?

   (a) What is the purpose of your role in the agile context?
   (b) How clear are the responsibilities within the agile context?

2. What are the aspects regarding the organisational structure which might stand in the way of working in an agile manner?

   (a) What are major mismatches between the XFT's way of working and its related organisational structure?
   (b) How compatible are various parts of the organization with agile and why?
   (c) What characteristics of ways of working makes them more or less compatible?

### Information Flow & Organisational Structure

1. Which roles are part of your communication environment and what are your responsibilities towards them?

(a) Name 3-5 roles you communicate most frequently and intense with?

(b) What are the topics you communicate about with these roles?

(c) Which events tend to cause high levels of communication between roles?

    i. Which communication patterns tend to impact your workflow negatively?

    ii. What are the main occasions for this?

    iii. How often do they occur?

(d) Do you see any role as being too central and aggregate too many responsibilities?

    i. How can this cause communication bottlenecks and affect progress?

2. How well is information circulating within the organisation and around you?

(a) Can you describe how the information sharing and receiving is performed?

    i. How do you decide on what information to share?

    ii. What kind of information do you share or receive from upwards?

    iii. What kind of information do you share or receive from downwards?

    iv. What kind of information do you share between co-workers of the same role?

(b) In what direction is communication insufficient or inefficient?

    i. What is problematic with information transfer?

    ii. How could impactful improvements be made?

(c) When information is needed, how do you find a relevant source?

    i. What can be an obstacle in this process?

(d) What countermeasures could improve information sharing in general?

    i. How could information be made more accessible?

(e) How well does the collaboration between teams work?

    i. What are the problems that affect a team negatively?

3. To what extent are you involved in decision coordination regarding backlog related issues?

(a) How could involvement of different parties be changed?

(b) Which problematic areas could be mitigated?

(c) What type of decision making can impact the XFT's progress?

    i. What are reasons and impacts of blockages?

4. How sufficiently integrated do you think the agile branch is with the line management?

(a) What information is shared and how often?

(b) What are your expectations toward this collaboration?

   i. How well and fast is feedback considered?

(c) How do you think interaction could be improved?

(d) How do different interests from a DMs/SMs, POs and PgMs influence the work of XFTs?

   i. How clearly separated do their responsibilities appear to be?

   ii. How can it build tension towards the XFTs and what effects can this have?

   iii. How well is agile development aligned with long term planning?

   iv. What problems does this create in regards to decision making and coordination?

5. How tight is the collaboration and communication between XFTs and POs?

(a) How could feedback and information sharing be improved?

(b) How can the team in turn affect decisions made from their PO chain?

   i. To what extent are decisions made collaboratively?

   ii. How can feedback be given and how well is it considered?

(c) What are the problematic areas within this chain of communication?

   i. What are the main issues regarding information reaching the XFTs?

   ii. How can it be improved?

**Workflow & Interruptions**

1. How can the normal workflow during a sprint be interrupted from its planned direction?

(a) *(If not interrupted)* How do you manage external influences?

(b) *(If interrupted)* Can you elaborate on different effects they have on your workflow?

   i. How frequent are they?

(c) What are the external influences that might cause these interruptions, where are their roots within the organisation?

(d) How are interruptions addressed?

   i. Which roles have more responsibilities than others in such a case?

(e) When taking action, are there any blockages in the communication path which slow down resolution?

    (f) Can you give an example for an exceptionally *unproductive* sprint?

        i. What were the characteristics, communication patterns and causes?

    (g) Can you give an example for an exceptionally *productive* sprint?

        i. What were the characteristics, communication patterns and causes?

    (h) Can you give any concrete example of how the way of working or environment for the team could be improved?

2. How does the XFT's empowerment influence your work both positively and negatively?

    (a) How comfortable are you with the amount of responsibilities?

    (b) How do increasing responsibilities affect your communication?

    (c) How could responsibilities be shared better with different roles?

## Extended Guide: XFT-Developer

### Agile & The Organisational Structure

1. Your XFT has no team coach at the moment, how does it relate to your workflow?

    (a) How are responsibilities of a coach implemented in practice?

        i. How are the responsibilities of a team coach shared?

    (b) What parts of your regular workflow are affected by this absence?

    (c) What challenges does it create for the team?

## Extended Guide: XFT-PG

### Agile & The Organisational Structure

1. How does the PO (OPO, APO, TPO) chain affect the work of an XFT?

    (a) What are problematic areas relating to communication with POs?

        i. What are the main issues regarding information reaching the XFTs?

       ii. How can it be improved?

## Extended Guide: XFT-SM

### Agile & The Organisational Structure

1. To what extent are you involved in solving impediments the team is facing?

    (a) How well is your intended involvement defined?

    (b) Are you able to resolve most impactful impediments?

        i. What communication is involved in resolving them?

    (c) Which other roles should take greater action in solving them?

    (d) What consequences may unresolved impediments have on a team?

## Extended Guide: OPO

### Agile & The Organisational Structure

1. How does the PO (OPO, APO, TPO) chain affect the work of an XFT?

    (a) How big is the distance between OPO, to APO and TPO?

        i. How in turn can this affect decision coordination?

        ii. How can this affect XFTs?

    (b) How can the PO chain affect responsiveness in regards to adjusting to change?

        i. How could this be optimized?

## Specific Guide: PgM & DM/SM

### Background Information

1. What is your role in the organization and with regards to the XFT [NAME]?

2. What are your key responsibilities?

3. Have you been working here before the transition towards agile?

    (a) What was your role during that time?

## Agile Transformation & Ways of Working

1. How did company's transition towards agile change your responsibilities?

    (a) What is the purpose of your role in the agile context?

    (b) How clear are the responsibilities within the agile context?

2. What are the aspects regarding the organisational structure which might stand in the way of working in an agile manner?

    (a) What are major mismatches between the XFT's way of working and its related organisational structure?

    (b) How compatible are various parts of the organization with agile and why?

    (c) What characteristics of ways of working makes them more or less compatible?

**Information Flow & Organisational Structure**

1. Which roles are part of your communication environment and what are your responsibilities towards them?

   (a) Which events tend to cause high levels of communication between roles?

      i. Which communication patterns tend to impact your workflow negatively?
      ii. What are the main occasions for this?
      iii. How often do they occur?

   (b) Do you see any role as being too central and aggregate too many responsibilities?

      i. How can this cause communication bottlenecks and affect progress?

2. How well is information circulating within the organisation and around you?

   (a) Can you describe how the information sharing and receiving is performed?

      i. How do you decide on what information to share?
      ii. What kind of information do you share or receive from upwards?
      iii. What kind of information do you share or receive from downwards?
      iv. What kind of information do you share between co-workers of the same role?

   (b) In what direction is communication insufficient or inefficient?

      i. What is problematic with information transfer?
      ii. How could impactful improvements be made?

   (c) When information is needed, how do you find a relevant source?

      i. What can be an obstacle in this process?

   (d) What countermeasures could improve information sharing in general?

      i. How could information be made more accessible?

   (e) How well does the collaboration between teams work?

      i. What are the problems that affect a team negatively?

3. How sufficiently integrated do you think the agile branch is with the line management?

   (a) What information is shared and how often?

   (b) What are your expectations toward this collaboration?

      i. How well and fast is feedback considered?

   (c) How do you think interaction could be improved?

    (d) How do different interests from a DMs/SMs, POs and PgMs influence the work of XFTs?

        i. How clearly separated do their responsibilities appear to be?

        ii. How can it build tension towards the XFTs and what effects can this have?

        iii. How well is agile development aligned with long term planning?

        iv. What problems does this create in regards to decision making and coordination?

4. To what extent are you involved in decision coordination regarding backlog related issues?

    (a) How could involvement of different parties be changed?

    (b) Which problematic areas could be mitigated?

    (c) What type of decision making can impact the XFT's progress?

        i. What are reasons and impacts of blockages?

## Workflow & Interruptions

1. How does the XFT's empowerment influence your work both positively and negatively?

    (a) How comfortable are you with the amount of responsibilities?

    (b) How do increasing responsibilities affect your communication?

    (c) How could responsibilities be shared better with different roles?
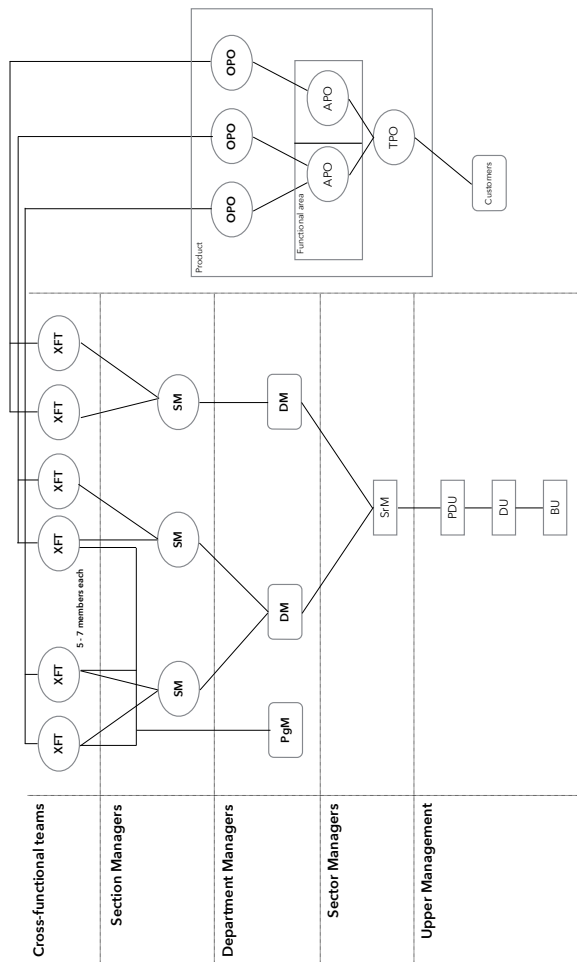
# B

# Figures



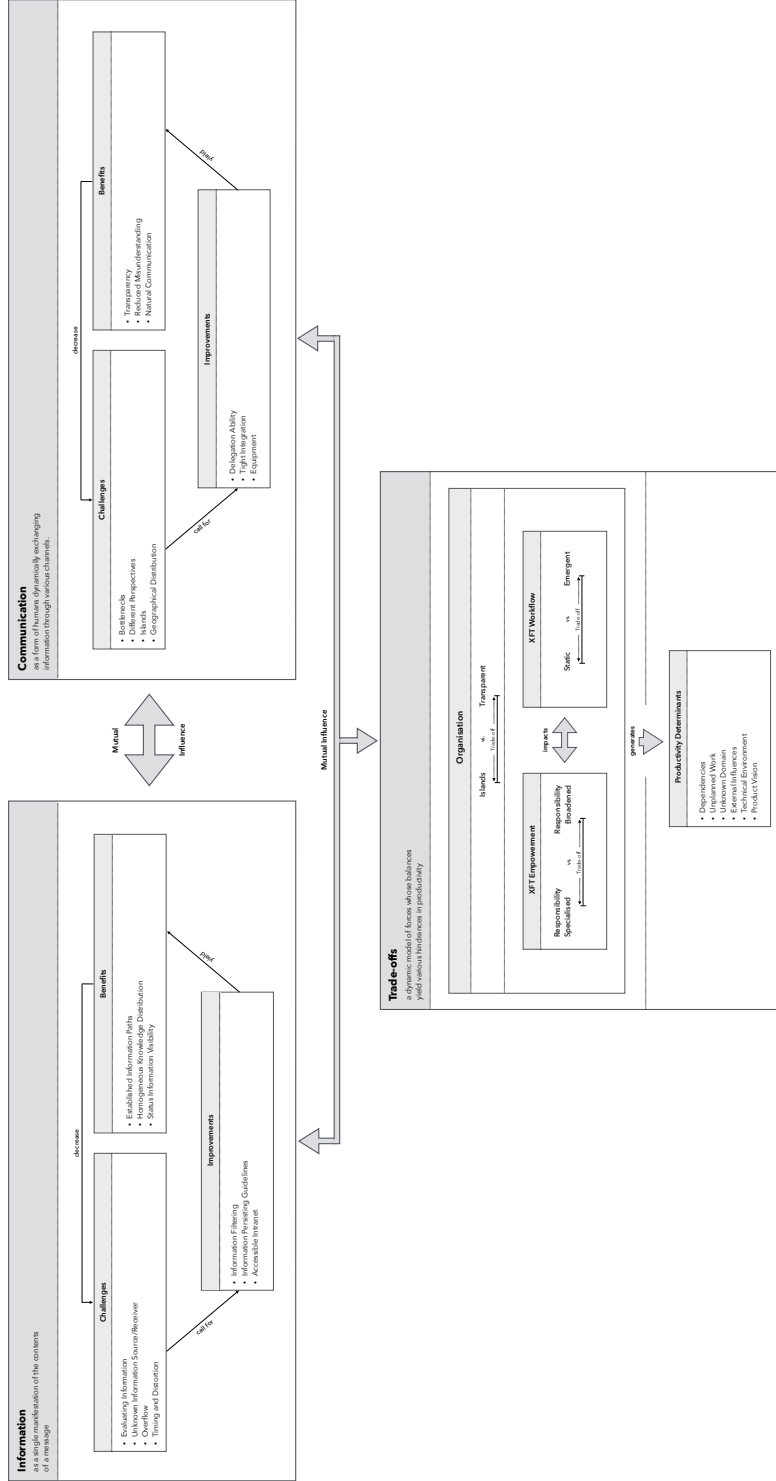**Figure B.1:** Organisational Structure of PDU LMR

**Figure B.2:** Information, communication and trade-offs

# Daily survey

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Day 5 - X23

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**Introduction**

Filling out this survey should not take longer than *five minutes*. Please take some time to consider the ideas and guidelines.

Your data will be coded thus your *response is anonymous*. Data gathered will be used to generate a *communication heatmap,* visualizing roles and their interaction by color coding their relative intensity of communicating.

The heatmaps will be *hanged out* on whiteboards around *on daily basis.* One heatmap will try to visualize the last days interaction and another one will show aggregated data gathered over time.

**Explanations**

This survey tries to investigate *communication and collaboration intensity*, their *initiation* and *nature or reason*.

Intensity: Relate such aspects of communication as duration, information density, significance to your job tasks to their usual levels when in contact with a given role. Communication implies any kind of daily **work related** collaboration or interaction.

Initiated: Whether or not the communication was **mostly initiated** by you.

Nature: The **main reason** or type of communication. If several communications of different nature – **pick the one** with the most influence of your work throughout the day.

**Legend**

◯ A *scale* from low to high - please mark only one box.

☐ A *checkbox* representing a yes-no answer ticked being yes.

⬦B Backlog work on planned sprint goals
   Regarding daily work on the sprint backlog (excludes unplanned interruptions)

⬦U Unexpected change or interruption
   External or internal, technical or social, not intended by planned sprint content

⬦D Decision coordination
   Progress towards sprint goal hindered by uncertainty or coordination need caused by unclear responsibilities

⬦E Exchange of missing knowledge
   About task clarification or to optimize its execution and result

⬦R Resolving technical dependencies
   Solely technical and blocking progress

⬦O Other (please name)
   Anything particular but unnamed above

} A radio group - please mark one.

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**Team (XFT)** — Please *do not* fill the *rows* for co-workers with who you did not collaborate

| Name | Communication intensity | | Initiated by me | Dominant nature of communication | |
|---|---|---|---|---|---|
| | *Minimal* ... *Usual* ... *Extraordinary* | | *Mark if yes!* | *Please mark only one!* | *Other (please name)* |
| John Doe | ◯ ◯ ◯ ◯ ◯ ◯ | | ☐ | B U D E R O | ............... |
| Sven Svensson | ◯ ◯ ◯ ◯ ◯ ◯ | | ☐ | B U D E R O | ............... |
| Max Mustermann | ◯ ◯ ◯ ◯ ◯ ◯ | | ☐ | B U D E R O | ............... |
| Vasya Pupkin | ◯ ◯ ◯ ◯ ◯ ◯ | | ☐ | B U D E R O | ............... |
| Michael Smith | ◯ ◯ ◯ ◯ ◯ ◯ | | ☐ | B U D E R O | ............... |
| Jane Doe | ◯ ◯ ◯ ◯ ◯ ◯ | | ☐ | B U D E R O | ............... |
| Pietje Puk | ◯ ◯ ◯ ◯ ◯ ◯ | | ☐ | B U D E R O | ............... |

**OPOs** — Please *do not* fill the *rows* for co-workers with who you did not collaborate

| Name | Communication intensity | | Initiated by me | Dominant nature of communication | |
|---|---|---|---|---|---|
| | *Minimal* ... *Usual* ... *Extraordinary* | | *Mark if yes!* | *Please mark only one!* | *Other (please name)* |
| Richard Roe | ◯ ◯ ◯ ◯ ◯ ◯ | | ☐ | B U D E R O | ............... |

**Section Managers** — Please *do not* fill the *rows* for co-workers with who you did not collaborate

| Name | Communication intensity | | Initiated by me | Dominant nature of communication | |
|---|---|---|---|---|---|
| | *Minimal* ... *Usual* ... *Extraordinary* | | *Mark if yes!* | *Please mark only one!* | *Other (please name)* |
| Juan Pérez | ◯ ◯ ◯ ◯ ◯ ◯ | | ☐ | B U D E R O | ............... |

**Figure B.3:** Example survey page 1

**Department Managers**                          Please *do not* fill the *rows* for co-workers with who you did not collaborate

| Name | Communication intensity | | | Initiated by me | Dominant nature of communication | |
|---|---|---|---|---|---|---|
| | *Minimal* | *Usual* | *Extraordinary* | *Mark if yes!* | *Please mark only one!* | *Other (please name)* |
| Ashok Kumar | ○ ○ ○ ○ ○ ○ | | | ☐ | B U D E R O | |

**Program Managers**                          Please *do not* fill the *rows* for co-workers with who you did not collaborate

| Name | Communication intensity | | | Initiated by me | Dominant nature of communication | |
|---|---|---|---|---|---|---|
| | *Minimal* | *Usual* | *Extraordinary* | *Mark if yes!* | *Please mark only one!* | *Other (please name)* |
| Josefine Josefsson | ○ ○ ○ ○ ○ ○ | | | ☐ | B U D E R O | |
| Zhang Sang | ○ ○ ○ ○ ○ ○ | | | ☐ | B U D E R O | |

**Personal additions**                          Please *do not* fill the *rows* for co-workers with who you did not collaborate

| Person & role | Communication intensity | | | Initiated by me | Dominant nature of communication | |
|---|---|---|---|---|---|---|
| | *Minimal* | *Usual* | *Extraordinary* | *Mark if yes!* | *Please mark only one!* | *Other (please name)* |
| Jean Dupont<br>Designer | ○ ○ ○ ○ ○ ○ | | | ☐ | B U D E R O | |
| Mehmet Mehmetcik<br>Section Manager | ○ ○ ○ ○ ○ ○ | | | ☐ | B U D E R O | |
| Pinco Pallino<br>PG | ○ ○ ○ ○ ○ ○ | | | ☐ | B U D E R O | |

**Others**                          Please *do not* fill the *rows* for co-workers with who you did not collaborate

| Person & role | Communication intensity | | | Initiated by me | Dominant nature of communication | |
|---|---|---|---|---|---|---|
| Name:<br>Role: | *Minimal* *Usual* *Extraordinary*<br>○ ○ ○ ○ ○ ○ | | | *Mark if yes!*<br>☐ | *Please mark only one!* *Other (please name)*<br>B U D E R O | |
| Name:<br>Role: | ○ ○ ○ ○ ○ ○ | | | ☐ | B U D E R O | |
| Name:<br>Role: | ○ ○ ○ ○ ○ ○ | | | ☐ | B U D E R O | |
| Name:<br>Role: | ○ ○ ○ ○ ○ ○ | | | ☐ | B U D E R O | |
| Name:<br>Role: | ○ ○ ○ ○ ○ ○ | | | ☐ | B U D E R O | |

**Figure B.4:** Example survey page 2