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ABSTRACT

Abstract

In the era where delivery speed is perceived more important than IT landscape integration, consistency and long-term planning, different architectural approaches have become important considerations of information systems management. Moreover, recent studies have shown that the need for a holistic EA is often overlooked, when organizations try to apply agile development models, which may lead to several problems, such as technical debt, redundant rework, inconsistent communication, decentralized and siloed architecture design, unsustainable architecture, and inconsistence in coding style. Hence, with the growing deployment of scaling agile methods there is a need for purpose-fit approaches to integrate EA frameworks to enable organization agility while maintaining long-term vision.

This study aims to explore how EA activities are put into practices in a company deploying large-scale agile development methods – namely EA deliverables, EA benefits, EA concerns and EA enablers. In total, 13 semi-structured interviews were conducted from a case company, and an analysis was done using the Gioia method. As a result, EA deliverables (business objective deliverables, intentional architecture deliverables, and emergent design deliverables), EA benefits (organizational agility and organizational robustness), EA concerns (immaturity, disengagement, urgency, and resistance and anti-patterns), and EA enablers (communication and collaboration, Lean EA, and EA culture) were identified.

The enterprise architecture practices used by the case company were in line with the guidelines and best practices recommended by the literature and industry experts. Moreover, a literature review provided some theoretical constructs and suggestions, namely the Lean EA development (LEAD) method and the design principles of architectural thinking for supporting organizational agility, which can be recommended to be applied by the case company or any other organization scaling agile.

Key words	lean enterprise architecture, large-scale agile development, organizational agility

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A LEAN ENTERPRISE ARCHITECTURE APPROACH AS AN ENABLER FOR ORGANIZATIONAL AGILITY

CASE: METSO OUTOTEC

Master´s Thesis
in Information Systems Science

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2.11.2021
Turku

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1. INTRODUCTION

1.1   Background

"The only thing constant is change" Heraclitus of Ephesus

Given the recent COVID-19 pandemic companies and employees are working in a highly unusual business and technology environment. Hence, there is a great demand to steer business leaders and development teams towards future-proof digital transformation regarding business and IT landscape. (Van de Wetering et al., 2021.) Furthermore, the increasing pace in digital change in 2020 to solve various concerns, namely remote working, education and new social regulations, has rebounded the global IT spending, which is predicted to total almost $4 trillion in 2021, an increase of over 6% from 2020, filling up the development backlogs for many organizations all around the world (Gartner, 2020).

Researchers often describe agile methods as a way to survive and thrive in a competitive environment and unpredictable disruptions by responding quickly and effectively with customer-centric products and service designs (Gunesekaran, 1998; Baiyere et al., 2018; Tallon et al., 2018). According to Paasivaara et al. (2018) many large organizations have also started to adapt the agile development methodologies. A study by Laanti et al. (2011) reveal that most people working in IT organizations agree with the commonly claimed benefits of Agile methods, such as higher satisfaction, a sense of efficiency, increased quality and transparency, increased autonomy and happiness, and earlier detection of defects. In addition, they say that 60 percent of them would not want to return to their former ways of working. Leffingwell (2007) notes that these scaling efforts have often several challenges, namely cross-team coordination, lack of up-front architecture and lack of requirement analysis. Furthermore, Alzoubi and Gill (2020) highlight that agile software development performance depends on active communication, which is difficult to do, especially, in geographically distributed agile teams.

Enterprise Architecture (EA) has been broadly deployed and suggested as a planning and governance approach to deal with some of the above-mentioned hurdles as it addresses the organizational viewpoint and transformation (Niemi and Pekkola, 2020). However, there is still a lack of empirical studies that show, what kind of EA approach would best fit and enable achieving and sustaining such benefits, namely organizational agility, (Espinosa, 2011, Carvalho & Sousa, 2014) in companies scaling agile. Moreover, some studies (Barlow et al., 2011; Dikert et al., 2016; Duijs et al., 2018) point out that the demand for EA is often overlooked, which may lead to several problems, when applying agile development methodologies. According to Paasivaara and Lassenius (2016) these

concerns include technical debt, redundant rework, inconsistent communication, decentralized and siloed architecture design, unsustainable architecture, and inconsistence in coding style. Hence, there is a clear demand for purpose-fit approaches to integrate EA frameworks with agile methods to enable the successful delivery of benefits, namely organizational agility.

1.2   Case: Metso Outotec

In the beginning of July 2020, the former companies Metso Minerals and Outotec merged into Metso Outotec (MO) combining the closely related expertise of both companies, namely in process technology, equipment and services, serving the minerals, metals and aggregates industries (Metso Corporation, 2019). From the business-IT perspective, the post-merger Metso Outotec has been deploying an IT and digital development model that is predominantly focused on agile development, which encompasses also more traditional waterfall projects with IT and digital components. The agile development follows the principles of Scaled Agile Framework (SAFe), developed by Leffingwell (2007), which is a widely recognized development model adopted by many large corporations. At the time of this research the ongoing waterfall development projects are being finalized as planned, and the agile approach is applied to new development initiatives.

With the newly deployed operation model, *value streams* can be identified to represent the steps the company's core business uses to implement solutions that provide value to the customer at the end of the value stream. The customer can be either an internal company or an external customer, or an end user. In the IT and digital development model, the term "value stream" is used for a specific area of development, for instance, "Standard products and parts" that covers both agile development and waterfall projects in that area.

In the agile operation model, the teams are organized into value streams in a way that they can be aligned to produce a continuous flow of value with the collaboration between IT and the business providing a systematic way to follow-up on value delivery and for a joint mitigation of issues. Moreover, the model aims to bring transparency to IT and digital costs and investments and focuses on providing a framework for structuring the development initiatives with a large-scale agile approach.

To concretize the high-level strategic plans and to support the value streams in the large-scale agile development Metso Outotec utilizes *enterprise architecture* (EA) practices setting EA guardrails for the business counterparts and development teams and steering large projects in complying to EA best practices and the high-level strategic themes. All architectural considerations in the IT organization and EA practices are executed by a semi-centralized IT architecture team, led by an IT architecture manager. The IT archi-

tecture team consists of enterprise architects nominated to take care of business, information, application, or infrastructure domains of architecture and solution architects nominated to take care of a value stream domains of architecture. In addition, the IT organization is governed at the portfolio and value stream level by various governance mechanisms, but they are excluded from the scope of this case study.

The case study part of this research aims to focus on the EA work of the IT architecture team consisting of enterprise architects and solution architects, who are the key practitioners communicating and facilitating EA practices outside the architect community, aligning and deducing long-term business objectives into short-term program increments and collaborating actively with cross-teams. In addition, a few key beneficiaries from portfolio and value stream management level are included to the scope of this case to provide a more transparent observation of the EA practices within the company.

The following Figure 1 represent the process that takes place in each value stream, when new IT solutions are developed; major changes to existing IT solutions are made; IT resources are required; or a service design for new solutions is needed.
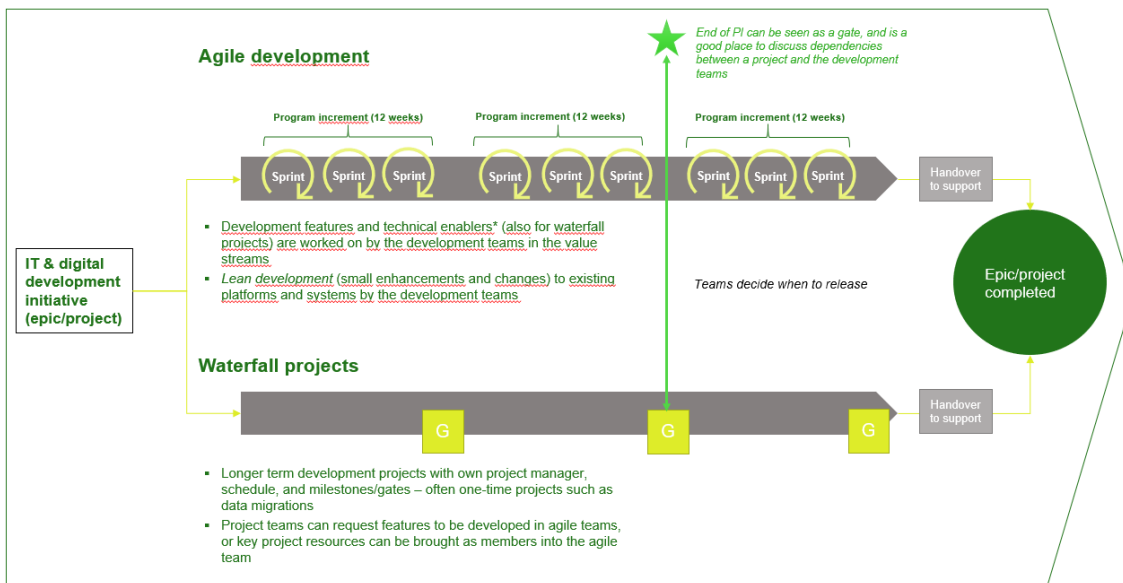
Figure 1   Development model within a value stream

The presented development model is systematically supported by the SAFe model, but based on the first impression the development does not yet operate without hiccups. Especially, the architects face a challenge of remaining in "reactive mode" and having unclear effect on long-term planning possibilities. As part of the EA practices architects are utilizing selectively various artifacts, frameworks, and components, when appropriate. At the beginning of this study, the EA function was perceived to be at the earlier stages of the maturity due to a recent merger, hence, short-term activities seem to supersede the long-term activities today.

1.3 Research Questions

Based on the presented motivation and the case study description, an outlined research objective is to develop a holistic view of enterprise architecture, with the following research questions:

RQ1 How are enterprise architecture (EA) activities put into practice in an organization deploying large-scale agile development?

> **RQ1.1** *What are the typical deliverables of enterprise architecture (EA) practices in a company deploying large-scale agile development?*
>
> **RQ1.2** *What are the typical benefits and concerns of enterprise architecture (EA) practices in a company deploying large-scale agile development?*
>
> **RQ1.3** *What are the key enablers of enterprise architecture (EA) practices in a company deploying large-scale agile development?*

2   ENTERPRISE ARCHITECTURE

In this section the appropriate literature for the research is presented. When looking at the overall Enterprise Architecture (EA) work from the standpoint of large-scale agile development, it is sensible to define, what is meant by enterprise architecture and what is the typical role of enterprise architecture in organizations scaling agile. In Section 2.1, a definition of EA is presented. In section 2.2, the common elements of EA frameworks are presented as well as common EA artifacts that are found in most organizations using EA practices. In Section 2.3, the rationale for scaling agile is presented as well as, the role of EA in large-scale agile development. Moreover, in Section 2.4, a Lean enterprise architecture is presented, which can be considered the most important part of the literature review regarding the overall research. Lastly, in Section 2.5, organizational agility and the way EA may enable it is presented.

2.1   Definition of Enterprise Architecture

In the context of information systems science (IS) architecture can be defined the as *"the fundamental organization of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution"* (ISO/IEC/IEEE Standard 42010). Furthermore, Fowler (2003) regard architecture as a social construct by defining that:

> *"In most successful software projects, the expert developers working on that project have a shared understanding of the system design. This shared understanding is called 'architecture.' This understanding includes how the system is divided into components and how the components interact through interfaces. These components are usually composed of smaller components, but the architecture only includes the components and interfaces that are understood by all the developers."*

Perhaps, the most recognized definition of Enterprise Architecture (EA) comes from Ross et al. (2006), who have defined it as: "the organizing logic for business processes and IT infrastructure, reflecting the integration and standardization requirements of the company's operating model." Moreover, they stress that EA builds capabilities by enabling a holistic view of organization processes, systems, and technologies. Similarly, Jonkers et al. (2006) have defined enterprise architecture (EA) as "a coherent whole of principles,

methods and models that are used in the design and realization of the enterprise's organizational structure, business processes, information systems, and infrastructure. EA captures the essentials of the business, IT and its evolution."

A more recent definition of architecture by Gartner (2021) states that:

"Enterprise architecture (EA) is a discipline for proactively and holistically leading enterprise responses to disruptive forces by identifying and analyzing the execution of change toward desired business vision and outcomes. EA delivers value by presenting business and IT leaders with signature-ready recommendations for adjusting policies and projects to achieve targeted business outcomes that capitalize on relevant business disruptions."

According to Jonkers et al. (2006) EA is simultaneously a *product* and a *process*. The process aspect of EA concerns the processes of creating, maintaining, redeploying, and retiring EA products. In addition, as most users, or stakeholders, of a system have often different backgrounds and are not necessarily interested in the architecture itself, but rather in the impact it has on their concerns, the EA process consists of the ways stakeholders relate to business objectives and information flow. Moreover, they emphasize that the most important role of enterprise architecture is to serve as a communicator between the various groups and facilitate ongoing discussion. Similarly, Figure 3 seen below depicts the typical process-like nature of EA vertically, from the higher-level vision to operational activities, and horizontally, moving from an *as-is* state towards a more favorable *to-be* state.
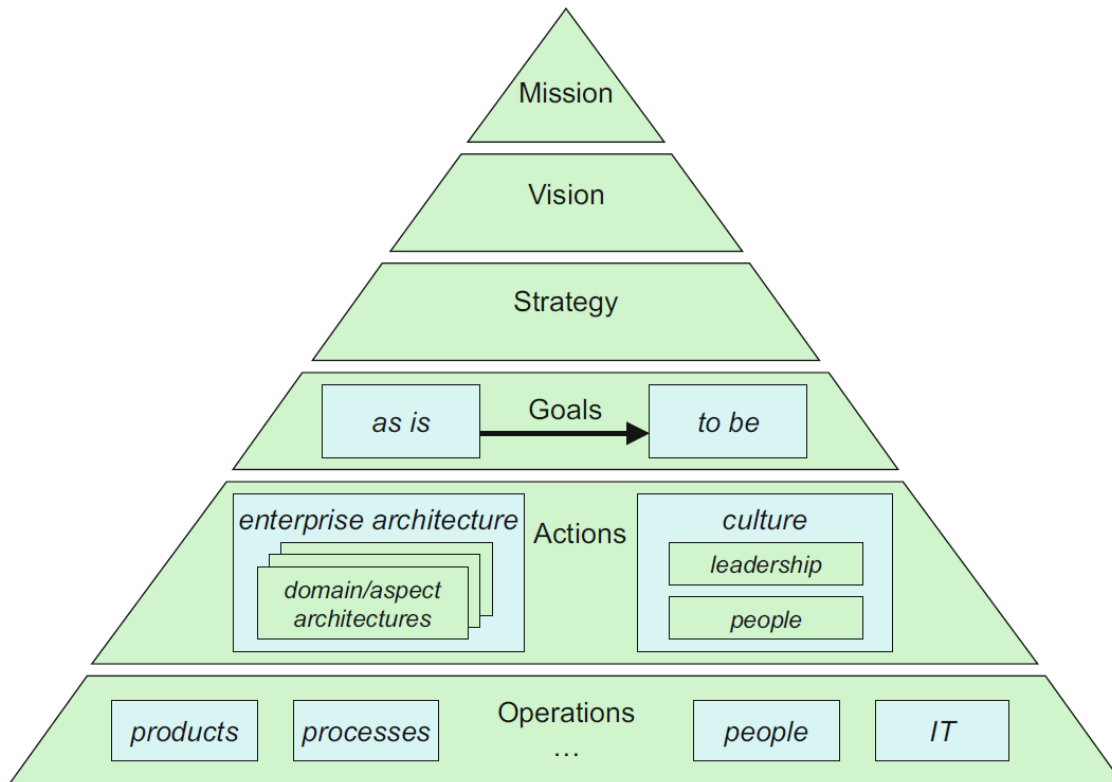
Figure 2   Enterprise architecture as a management instrument (adapted from Lankhorst, 2017)

EA as a product, guides managers in business process planning and developers in building applications according to business objectives and policies. Moreover, Kurnia et al. (2020) clarify that the EA *product* is often categorized into components, namely EA artifacts and EA deliverables. There is an exhaustive list of EA artifacts, such as architecture principles (Greefhorst & Proper, 2011), business capability models (Khosroshahi et al., 2018) and EA data models (Peels, et al., 2016) that are used in various use cases and situation in describing different domains of the enterprise architecture.

According to Lumor et al. (2021) EA deliverables can be perceived as the concrete realizations of EA artifacts, namely, business capabilities, business services, and information systems components. Furthermore, capability is defined by Lankhorst (2017) as an *"ability that an active structure element, such as an organization, person or system, possesses."* He also emphasizes that capability concerns the 'what' the business does or is able to do, not 'how' it is done or 'who' is doing it, which are questions that EA is supposed to adess.

2.2   EA Frameworks and Artifacts

According to Jonkers et al. (2006) the most integral objectives of EA is to create a broad view of the enterprise through different domains. Usually, these domains of expertise can be distinguished within a company, as illustrated in Figure 3, and each of the domains have some sort of architectural practices and degrees of maturity. Moreover, due to the vast number of different approaches used to document these architectures, it is not very easy to represent how each domain relate to each other.
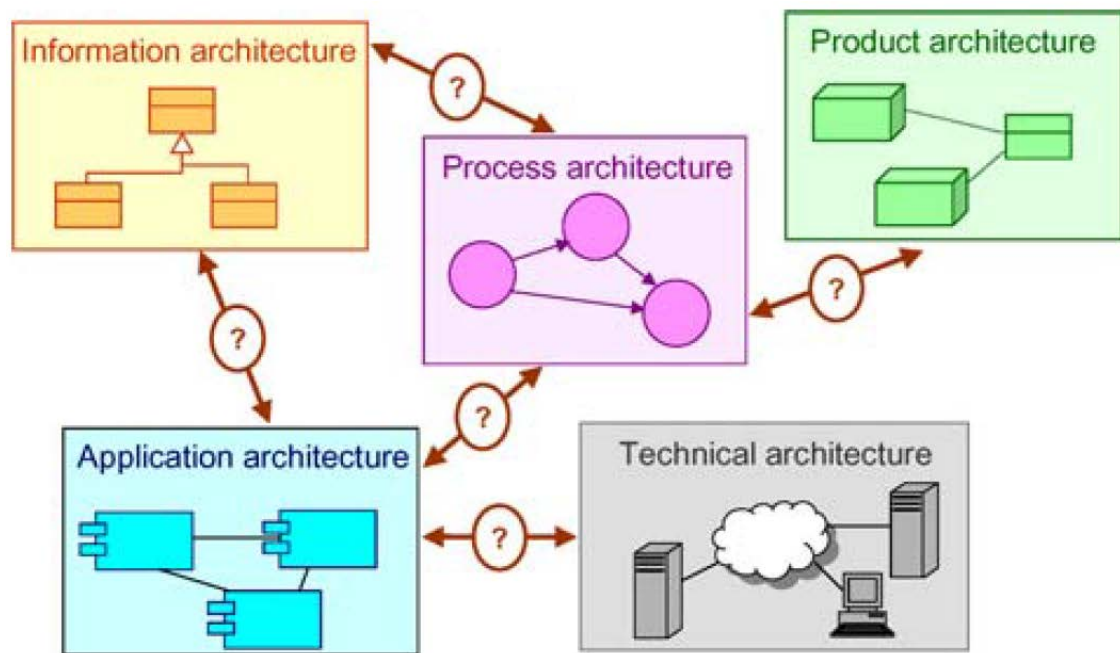
Figure 3   Enterprise architecture: Integrating architectural domains. (adapted from Jonkers, 2006)

Indeed, each architectural domain tends to do a local optimisation, which doesn't necessarily lead to the optimized outcome for the whole company. For instance, a well-thoughout technical infrastructure that can deliver optimized performance at an optimized cost may be too inflexible in times when more agile business processes are needed. Hence, it is recommended that an appropriate EA enables the necessary understanding needed to prioritize the demand and focuses on the reconciliation of strategy into day-to-day activities. (Jonkers et al. 2006.)

The literature provides common instruments for methodically develop and utilize enterprise architectures, namely, enterprise architecture frameworks (Jonkers et al., 2006). Furthermore, Winter and Fischer (2006) have identified that most EA frameworks, most notably the Zachman framework (Sowa and Zachman, 1992) and TOGAF (The Open Group, 2011), consist of the following five architecture abstraction layers:

- business architecture,
- process architecture,
- integration architecture,
- software architecture,
- technology (or infrastructure) architecture.

Moreover, DeVries (2010) has consolidated EA into two main categories of abstraction layers, namely *business and strategy*, and *information technology* (IT). She raises the alignment of business and IT as one of the integral goals of EA. Furthermore, Jonkers et al. (2006) emphasize that to utilize the enterprise architecture frameworks, business stakeholders should be able to incorporate enterprise architecture instruments with their instruments.

To reduce the overwhelming number of artifacts used in EA frameworks, such as TOGAF, Kotusev (2017) has identified eight essential artifacts that are used by most of the organizations with at least relatively mature EA practices:

- principles,
- technology reference models,
- guidelines,
- business capability models,
- roadmaps,
- landscape diagrams,
- solution overviews
- and solution designs.

Moreover, a taxonomy by Kotusev (2016) identified that these essential EA artifacts can be categorized into six common types: *considerations*, *standards*, *visions*, *landscapes*, *outlines,* and *designs*. The identified six common types of EA artifacts describe the most common features of the most used EA related artifacts. Furthermore, the six common types of EA artifacts describe what these EA artifacts represent; how they are utilized; what is their purpose; and what are the benefits they provide for organizations. Figure 4 illustrates the schematic mapping of these eight essential artifacts categorized into six common types.
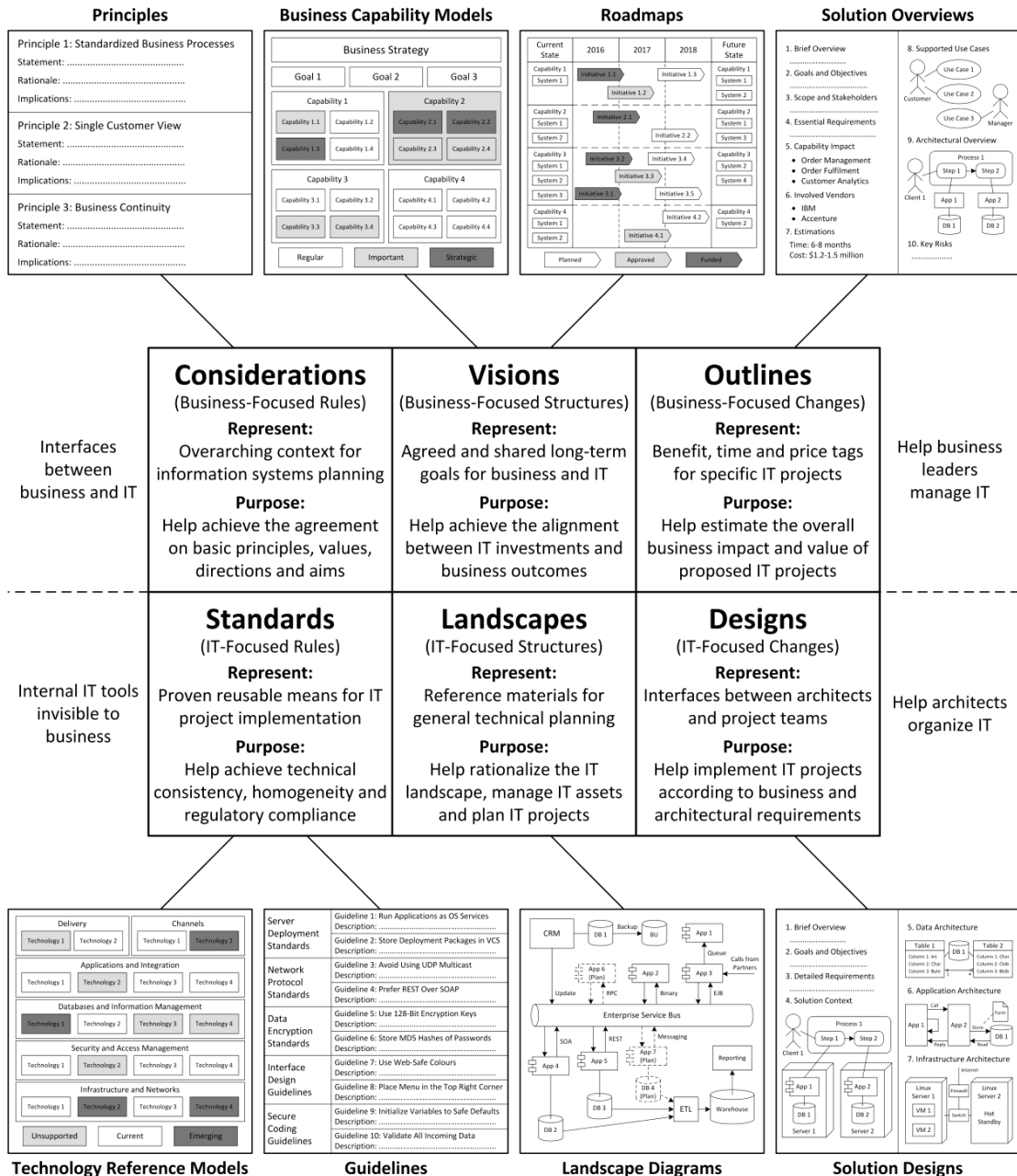
Figure 4   Eight Essential EA Artifacts (adapted from Kotusev, 2017)

2.3   EA and Large-Scale Agile

Agile development methods are often defined by the agile manifesto (2001), which places *communication and collaboration*, *responsiveness*, and *implementation* at the focus and as the core values above all else. Boehm and Turner (2005) clarify that Agile methods were originally intended to be used by a single team in small projects. Laanti et al. (2011) have concluded that the several potential benefits associated with agile methods, namely

reduced time-to-market, increased quality, reduced waste, better predictability, and *better morale* (Schwaber et al., 2007), have attracted many larger companies to change their traditional methods and start scaling agile.

Dikert et al. (2016) define large-*scale "to denote software development organizations with 50 or more people or at least six teams"*. Moreover, members of the team don't have to be merely developers, but they may include scrum masters and architects belonging to the same development organization with a collaborative effort to develop products or projects. Putta et al. (2018) notes that for companies to facilitate and manage these agile transformations Agile consultants have developed and promoted many scaled agile frameworks, namely the Scaled Agile Framework, *SAFe* (Leffingwell, 2007), Large Scale Scrum, *LeSS* (Larman & Vodde, 2010), and Disciplined Agile Delivery, *DAD* (Amber & Lines, 2012). Regardless, Leffingwell (2007) has raised that these scaling agile methods present emergent concerns, most notably cross-team collaboration, and decentralization of work, which are difficult to manage without a well-though-out architecture or properly defined requirements. Furthermore, he has emphasized that there are more dependencies between projects and teams in larger organizations, which lead to slower transformation. Similarly, Lindvall et la. (2004) have found that bigger organizations require more documentation, which in turn decreases agility.

Figure 5 depicts the role of EA in large-scale agile development (Mega International, 2021). Typically, it starts with enterprise architects, who define the business architecture and planning activities. Then the solution architects design the intentional architecture that will be used by the development teams to create the emergent design. Moreover, the intentional architecture is plan-based and high level, with the objective of aligning cross teams. Eventually, the intentional architecture is reconciled with the emergent design to follow the changes that happen during each developments cycle. (Mega International, 2021.)
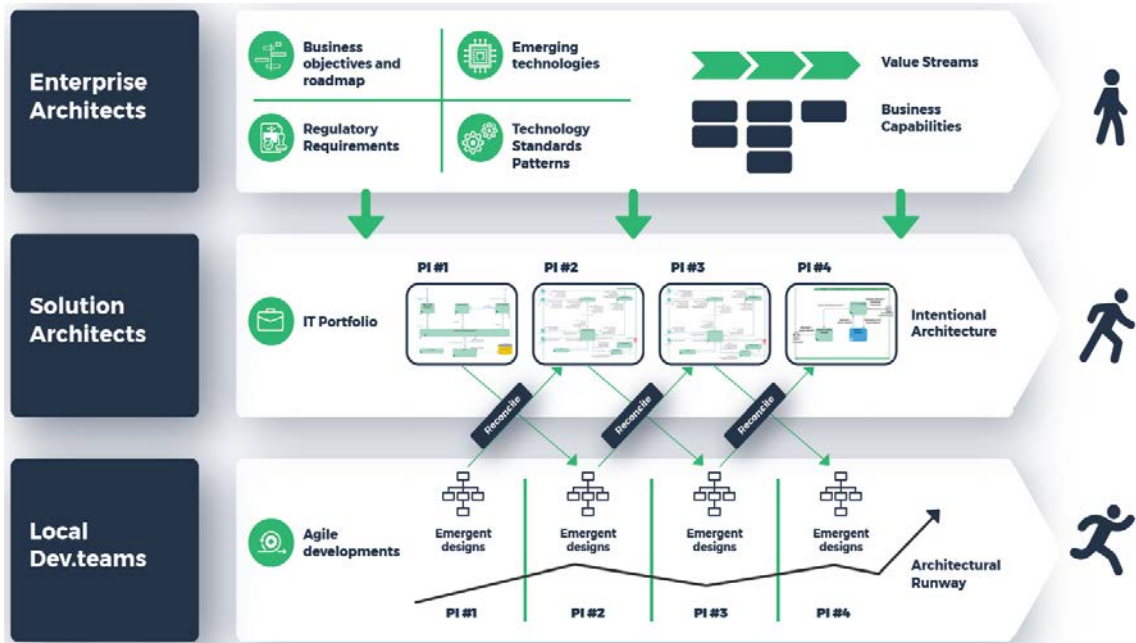
Figure 5   EA and large-scale agile development (adapted from Mega International, 2021)

Uludağ et al. (2017) describe *enterprise architect*, *solution architect*, *software architect*, and *information architect* as the predominant architect roles found in scaling agile frameworks, namely in SAFe. The typical responsibilities of each architect role are listed in the following Table 1:

Table 1   Roles and key responsibilities of architects in scaling agile (adopted from Uludağ et al., 2017)

Role	Key responsibilities
enterprise architect	- provide a top level and comprehensive picture of the enterprise solutions and development initiatives - gain knowledge and communicate strategic visions and other core business themes for system architects and non-technical stakeholders - collaborate with business counterparts and software and solution architects to enhance the holistic acceptance of software, tools, and platforms across value stream - Work with software and solution architects to make sure that individual program and product initiatives line up with enterprise objectives - Engaging in the structuring and supporting of Architectural runway; and enhancing reusability of ideas, assets, and designs.
solution	Assisting solution management with value stream Kanban

architect	- defining the enabler capabilities and epics with the solution management - qualifying the common solution architectures in Agile release trains (ARTs) - collaborating with a system architect to oversee the architecture developed by ARTs - securing technical congruence of the solution, and the related interfaces and dependencies. - attend in value stream and ART program increment planning events - Documenting and communicating advancement across goals, program increment objectives, and the dependencies between ARTs
software architect	- Qualifying of non-functional requirements (NFRs), core system elements, subsystems, and interfaces - preparing of architectural vision briefing for the program increment (PI) planning event - defining the architectural vision including descriptions of new architectural epics for common infrastructure, all large-scale refactors to be considered, and system level NFRs - and assisting the product owner by defining the team backlog.
information architect	- participating in PI planning and pre- and post- PI planning events - push requirements and taking ownership over dependent backlog initiatives - Collaborating with agile teams to resolve dependencies in PI cycles - and participating in system and solution demonstrations.

Uludağ et al. (2019) conclude that the emerging designs are sufficient in the teams, but inadequate when agile methods are deployed on a larger scale. Hence, they stress that an intentional focus on architectural design and management is needed for large-scale agile development as they secure the coordination of agile teams to achieve the desired organization-wide ambitions and link the unifying vision during each implementation of agile projects. Moreover, Nord et al. (2014) clarifies that the question of whether EA is needed in large scale agile is redundant, but the question of *when* and *how often* it should be applied become more relevant.

In choosing an appropriate approach to EA, the agile manifesto (2001) recommends early and continuous delivery of value while maintaining an attentive approach to changing requirements. Furthermore, the agile manifesto (2001) includes autonomous teams as

a key principle stating that *"the best architectures, requirements, and designs emerge from self-organizing teams"*. In the EA management context, Hauder et al. (2014) suggest that enterprise architects should aim to share their deliverables early enough, apply an incremental and iterative EA approach, and be open about changes concerning their work habits and solutions. Moreover, they state that much like their other counterparts, software developers, an EA team should aim to resolve the most essential tasks first and prioritize time over completeness and quality.

In contrast with the traditional process and documentation centric EA, *agile EA* provides an incremental and collaborative approach targeting to improve agility (Ross et al., 2006; Gill, 2015) Moreover, Gill (2013) defines enterprise to be agile,

> *"when an enterprise is responsive (scans, senses and reacts appropriately to expected and unexpected changes), flexible (adapts to expected or unexpected change at any time), speedy (accommodates expected or unexpected changes rapidly), lean (focuses on reducing waste and cost without compromising on quality), and learning (focuses on enterprise fitness, improvement and innovation)."*

A more recent study by Alzoubi and Gill (2020) define Agile enterprise architecture (AEA)

> *"as the enterprise architecture (EA) that implements agile principles and focuses on collaboratively and incrementally developing, adapting and sharing information about business and IT mode in order to effectively guide the implementation of an agile project."*

Moreover, they found that geographically distributed development and industry-strength agile practices, referred to as GDAD, are likely to deliver benefits, namely, decreased producing cost, the opportunity to hire the most competent developers, and faster time-to-market. They conclude that by employing AEA organizations may enhance communication effectiveness and efficiency and increase the overall performance of GDAD.

2.4   Lean Enterprise Architecture

Buckl et al. (2011) have found four challenges for traditional EA in agile development, namely *low stakeholder satisfaction*, *dissatisfied information providers*, *low acceptance for EA* and *constantly changing requirements*. Moreover, the traditional EA frameworks,

such as TOGAF, have sometimes been considered too inflexible and complex to understand, hence, Hosiaisluoma et al. (2018) have purposed a simpler approach of EA that could be integrated into organization's development process. They call this *Lean EA development* (LEAD) method, and define it as follows:

> *"it combines value chain based operating model with an agile EA practice, which focuses on operational level, linking EA directly to business demands and adding customer value. The LEAD can be adapted to any size of a target area such as to a business domain, whole organisation or wider ecosystem. In practice, the LEAD operating model organises capabilities around the value delivery chain."*

They highlight that the usage of EA visualization tool is an integral enabler as each development initiative is visualized and updated iteratively. Furthermore, the biggest divergence between LEAD and traditional EA development methods is said to be that LEAD comprise of closely linked agile activities of the entire business, not just in terms of architecture and functionality. As illustrated in Figure 6, the LEAD approach emphasizes the development of business value dictated by strategic objectives and customer-driven requirements.
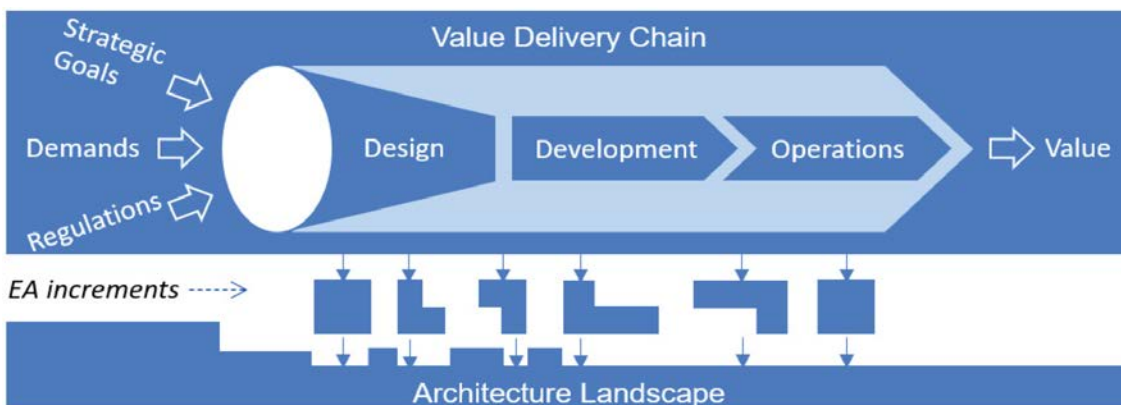
Figure 6   LEAD approach (adapted from Hosiaisluoma et al., 2018)

LEAD incrementally generates and maintains new knowledge for architecture landscape as new development projects pass through the value delivery chain. Similarly, the concept of architectural runway by Leffingwell (2011) can be linked to the LEAD approach as it also highlights the maintenance of architecture landscape in the agile development context. Furthermore, Nord et al. (2014) have found that, when operating according to agile principles, the agile community starts to acknowledge the need for architecture, namely emerging design, much like in the LEAD model.

2.5   EA Enabling Organizational Agility

Recent empirical studies have found that EA enables organizational agility (Foorthuis, 2017, Hazen et al., 2017; Pattij et al., 2019, Pattij et al., 2020). Harraf et al. (2015) regard organizational agility as a necessity that requires intentional thinking, an explorative mindset, and a constant need to be adaptable and proactive. Carvalho and Sousa (2014) define organizational agility as *"the ability to move quickly in new directions as needed without breaking the core infrastructure and without putting the organization at undue risk"*. Furthermore, agile as a feature means being highly capable in times of disruptions with agility elements, namely *cost, time, quality, and scope*. (Dove, 1994; Sambamurthy et al., 2003). Literature review by Pattij et al. (2020) conclude that *"agility comprises the ability to sense and respond to opportunities and threats."*

According to Ngai et al., (2011) organizational agility has its roots in in the manufacturing literature and it was afterwards applied to the information systems sciences. Because organizational agility depends on the context, there exist many definitions for it. In this research a consolidated definition of organizational agility by Yusuf et al. (1999) is used:

> *"The successful exploration of competitive bases (speed, flexibility, innovation proactivity, quality and profitability) through the integration of reconfigurable resources and best practices in a knowledge-rich environment to provide customer-driven products and services in a fast changing market environment".*

Alzoubi (2011) reminds that there is no single remedy for building an agile firm. Furthermore, it is noted that a firm can only become more agile and that by nature agility is not a static property that a company can acquire. Hence, defining domains of agility as a collection of constructs can help clarify the foundation and broad range of agile actions designed to address organizational agility (Harraf et al. 2015).

Horlach et al. (2020) have identified and described six design principles to increase and maintain organizational agility with architectural mindset. Table 2 depicts the design principles, underlying rationale for each principle and the proposed implementation mechanism to achieve organizational agility. Moreover, they stated that deploying these six principles would require various adjustments to the traditional EA functions. First, EA function should be broader covering stakeholders from end-users and partners to the technical solution elements. Furthermore, it is emphasized that EA should take more ownership over strategic, tactical, and operational governance from the top level down to the team level. Third, EA governance mechanism should include more roles, where "tradi-

tional" enterprise architects would have more of a supporting role. Finally, all stakeholders outside the EA team should be helped with decision-making by making the EA visible and discussable.

Table 2   Design principles of architectural thinking for supporting organizational agility (adapted from Horlach et al. 2020)

Design Principle	Rationale by Organizational Agility	Main Implications for Shaping Agile teams
DP1: Focus on the business environment	- Realize customer value & its creation - Acknowledge the role of business partners in value creation - Continuously sense environment for gaps	- Share connected information about the environment (e.g., customer)
DP2: Sense constantly internal and external opinions	- Define the role of the organization in value creation - Continuous sensing and analyzing of external demands with the value propositions and long-term strategic goals of the organization - Continuous sensing and analyzing of external needs with operational internal delivery (e.g., service features)	- Provide connected information on enterprise vision, strategy, business model(s), external needs and concerns - Incorporate architecture in portfolio management to explore the connection of business processes and capabilities
DP3: Produce value-centric support for architecture	- Ongoing coordination of internal service delivery to customer and business value - Ongoing ensuring that services fit to the desired value	- Assist portfolio management in customizing optimized delivery organization - Establish collaboration methods within the organization, e.g., shared purpose and metrics.
DP4: Allow local stakeholders to make architectural decisions early	- Allow decentralized decision-making within the appropriate constraints (aligned autonomy) - Enable quick and educated decision-making	- Enable decentralize and local architectural decision-making (e.g., skills in teams) - Enable fast support withing the organization
DP5: Give future-proof guidance for continuous architecting	- Enable constant enhancement and innovation (service, business model, process)	- Enable collaboratively built and flexible architectural vision

	- Enable flexibility to portfolio to allow locally derived innovations to emerge	- Consolidate and integrate models and data periodically, e.g., via chapters - Promote and enable collaboration of the architects
DP6: Enable approachable and visible architecture	- Map dependencies and right stakeholders early to resolve issues - Inhibit unnecessary rework based on miscommunication	- Ensure understanding of architectural models outside the architect community - Make architecturally relevant objectives visible and available

3 RESEARCH METHODOLOGY

In this chapter an overview of the methodological choices is presented. In Section 3.1, justification of the research approach is discussed. In the Section 3.2, data collection, namely the interview process is discussed. In Section 3.3, the Gioia method, data analysis process and the trustworthiness of the research are discussed. Moreover, the nature of the data collected as well as how it was analyzed is presented in more detail.

3.1 Research Approach

In this research a qualitative research method is used instead of quantitative research, because it allows the researcher to understand people in their social and cultural context (Myers, 2020). Moreover, Kaplan and Maxwell (1994) state that

> *"Qualitative methods employ data in the form of words: transcripts of open-ended interviews, written observational descriptions of activities and conversations, and documents and other artifacts of people's actions. Such data are analyzed in ways that retain their inherent textual nature. This is because the goals of qualitative research typically involve understanding a phenomenon from the points of view of the participants, and in its particular social and institutional context. These goals largely are lost when textual data are quantified and aggregated."*

Benbasat et al. (1987) suggest that case study research method fits well in the information systems research stating that *"interest has shifted to organizational rather than technical issues"*. Moreover, as the research focuses more on the socio-technical aspects of enterprise architecture the case study was perceived and chosen as the appropriate research method. According to Eriksson and Kovalainen (2008) a case study can be used to get a more accurate picture of an existing theory or, alternatively, to create a completely new theory, which in the case of this study was perceived useful.

According to Bhattacherjee, (2012) there are specific strengths in the case study method, namely that it is not necessary to know all the exact theory constructs in advance as they present themselves as the study unfolds. Second, during the research process there is a possibility to modify the research questions in case the initial research setup is found to be less relevant than anticipated. Third, a case study can help to obtain a rich, contextual, and genuine interpretation of the phenomenon. Fourth, the phenomenon can be studied from a multi-participant perspective and multi-level analysis can be used. However,

there are also some weaknesses in the case study. Because it does not include experimental restrictions, the internal reliability of the conclusions remains weak. Furthermore, the quality of the conclusions obtained from the case study also largely depends on the researcher's ability to integrate the material. In addition, because conclusions are usually drawn from context, it is usually difficult to generalize the research conclusions to other situations or other organizations.

3.2   Data Collection

For this research semi-structured interview was selected as a research method, because it gives the researcher the freedom to modify and fine-tune interview protocol based on answers given by the interviewees. It places great value in the responses and opinions of the interviewees and considers them knowledgeable members of the organization and the phenomenon at question. Moreover, additional concepts emerged from the interviews can be used to elaborate questions that arise in subsequent interviews. (Gioia et al., 2013.)

According to Eriksson and Kovalainen (2008), a common reason to use interviews in business research is that they are a sufficient and practical way to collect information that would otherwise not be found in the public domain. In addition, they aim to highlight people's experiences from their perspective or the social construction of knowledge on a chosen topic, both of which are considered very significant aspects of data in this research.

The interview questions were built around the various aspects of enterprise architecture that were formalized in the research questions in Section 1.3. Moreover, the ambition was to provide rich and insightful knowledge on, how the case company and the interviewees perceived and experienced topics at question. According to Eriksson and Kovalainen (2008) making several simple questions instead of one complex one, usually provides more better answers. Therefore, formulated question consisted of mostly *what* and *how* question. The interview questions are presented in more detail in Appendix 6. Instead of using any predefined terminology or conceptualizations, the interviewees were encouraged to discuss using as much as possible their own day-to-day vocabulary and terms to not miss any key aspects of the interviewees individual sensemaking (Gioia et al., 2013).

Most of the data used in the analysis was collected from a case company with 13 semi-structured interviews. All the interviews were conducted via Teams video calls in English. Furthermore, the interviews were recorded, transcribed, and analysed. The interviews were conducted between April and May 2021, and the duration of the interview was between 40 to 75 minutes. Details about participants, namely business field, background, EA category, job title and interview length, are presented in the Table 3. Participants were

divided into two categories, *EA creators* (e.g., "C5") and *EA users* (e.g., "U2"), based on whether the role of the interviewee was to create or use EA in the company.

Table 3   Interviewed Participants

Partic-ipant	Business field	Back-ground	Category	Job title	Interview length
C1	Information & analytics architecture	Metso	EA Creator	Enterprise architect	50 min
C2	Project business and ETO	Outotec	EA Creator	Solution architect	50 min
C3	Customer experience	Metso	EA Creator	Solution architect	50 min
C4	Services	Outotec	EA Creator	Solution architect	60 min
C5	Application architecture	Metso	EA Creator	Enterprise architect	60 min
C6	Technology architecture	Metso	EA Creator	Enterprise architect	60 min
C7	IT Architecture	Metso	EA Creator	IT architecture manager	55 min
C8	Common IT and Data Platforms	Metso	EA Creator	Solution architect	55 min
C9	Corporate functions	Metso	EA Creator	Solution architect	75 min
C10	Standard products and parts	Metso	EA Creator	Solution architect	60 min
U1	Standard products and parts	Metso	EA User	Value steam leader	55 min
U2	Applications	Metso	EA User	Value stream leader	40 min
U3	Portfolio Management	Outotec	EA User	Portfolio manager	60 min

This categorization was seen interesting as EA users bring additional "outside the box" aspect to the EA practices in the company. Furthermore, several business fields and job titles are listed to provide additional dimensions for data analysis and to point out any role specific deviations. Moreover, as the case company consisted of participants from each side of the merged company the employment history of participants is seen as having some empirical value and is therefore indicated in the field labelled as background. On average the interviews lasted approximately 60 minutes and each duration are listed in the table.

Before conducting the interviews, a formal notification was presented on the matters to keep the interviewees anonymous, which allowed an open and secure environment to exchange thoughts during the interviews. Moreover, the aim was not to promise "confidentiality", but rather "anonymity" (Gioia et al., 2013). As is suggested by The Ethical Principles of Research from the Finnish National Board on Research Integrity (2019) the participants had the right to voluntary take part and to stop the interview at any point.

3.3   Data Analysis

The interviews were recorded in Teams and later transcribed for data analysis in a Word document. A qualitative research software Nvivo was used to contain the large amount of text and the transcriptions were coded line-by-line with the features found in the software. The qualitative analysis process, based on the grounded theory by Strauss and Corbin (1998), was done following the steps described by Gioia et al. (2013).

As was instructed by Strauss and Corbin (1998) the grounded theory approach incorporates a series of systematic and structured steps, namely a comparison of small sets of data and formulation of categories that capture the essence of the observed phenomena. Moreover, they describe three coding methods for analyzing text data: *open*, *axial*, and *selective*. Eventually, the analysis should identify a small number of core categories integrating all the relevant concepts and forming a complete body of theory "grounded" in the initial proof (Langley, 1999).

Gioia et al. (2013) describe that in the 1-order analysis the number of categories can be overwhelming and the feeling of being lost is considered a natural part of the analysis process – *''You gotta get lost before you can get found''*. Like the axial coding by Strauss and Corbin (1998), Gioia et al. (2013) describe that at the second phase of the analysis the number of categories is greatly reduced, and "phrasal descriptors" are given. Moreover, at this point the researcher must be able to do parallel analysis, namely using the informants' terms and the 2nd-order theoretical level, which is the "theoretical realm". Furthermore, it is stated that at the 2nd-order level the researcher seeks any emerging theoretical concepts that could ease the define and give depth the phenomena that is being observed. According to them coding activities and theory tweaking continue until theoretical saturation is reached, namely, when further data cease to provide remarkable insight in the key concepts.

Once a clear structure of themes and concepts is established and additional data does not produce any marginal change in categorization a "theoretical saturation" has been achieved and the concepts are further consolidated into 2nd-order aggregate dimensions. Finally, as soon as 1st-order terms and 2nd-order themes and aggregate dimensions have been distinguished a data structure can be built. Moreover, the data structure provides a illustrative depiction of analysis process and they way in emerged from raw data to more elaborated terms and themes. (Gioia et al. 2013.) Table 4 describes the main data analysis steps used in this study.

Table 4   Summary of data analysis

Analysis Steps	Description
Step 1: First-order analysis (i.e., open coding)	The first step, first-order analysis, involved reading the transcribed interviews line-by-line and identifying meaningful terms. Moreover, lower-level codes were consolidated in Nvivo software. The stage resulted in a list of over 100 terms and codes.
Step 2: Second-order analysis (i.e., axial coding)	The second step, second-order analysis, identified more concrete concepts from the 1st-oder categories, namely meaningful terms that emerged from the transcripts. Furthermore, terms were categorized into 2nd-order categories. (see Figure. 9,10, 11 and 12)
Step 3: Aggregate dimension analysis (i.e., selective coding)	The third step, Aggregate dimension analysis, the 2nd-order categories were analyzed and linked to a higher level of abstraction, namely aggregate dimensions. At this stage, the relevant connections were intuitively produced. (see Figure. 9,10, 11 and 12)

According to Eriksson and Kovalainen (2008) one of the key requirements of a research is to inform the reader about its quality and trustworthiness. Moreover, justifying the evaluation criteria increases the transparency of the research, and allows a presentation its strengths and limitations. Lincoln and Guba (1985) describe the concept of 'trustworthiness' through four aspects: credibility, transferability, dependability and confirmability. From the standpoint of the four aspects, the Gioia method (Gioia et al., 2013) is designed to demonstrate rigor in qualitative research. Descriptions of qualitative evaluation criteria by Lincoln and Guba (1985) are presented in Table 5.

Table 5 Measures of Trustworthiness

Dimension of Trustworthiness	Description	Actions taken
Dependability	Informs the reader that the process of research has been logical, traceable, and documented. (Eriksson & Kovalainen, 2008)	*Auditing:* The findings were presented to an academic supervisor as well as to a contact person within the case company, who can be regarded as an expert in the research field. Moreover, the data structures (Figure 9,10, 11, and 12) and the quote samples (Appendix 1,2,3 and 4) are presented in the research.
Transferability	Informs the reader about similarities between the results found in the research and other research. (Eriksson & Kovalainen, 2008)	*Analysis method:* The Gioia method (Gioia et al., 2013) used in the research is designed to increase the rigor of qualitative research by means of systematic and transferable analysis steps.
Credibility	Informs the reader whether credible and logical links between observations and categories are made. (Eriksson & Kovalainen, 2008)	*Triangulation:* Data was gathered broadly from the case company (Interviews, company's intranet, Teams groups, internal documents.) *Member check:* Researcher made follow-up calls to the participant to checks the correctness of interpretations made during the analysis process.
Conformability	Informs the reader whether a link between the findings and interpretations can be easily made by others. (Eriksson & Kovalainen, 2008)	*Triangulation:* Data was gathered broadly from the case company (Interviews, company's intranet, Teams groups, internal documents.) *Analysis method:* The Gioia method (Gioia et al., 2013) used in the research is designed to increase the rigor of qualitative research by means of systematic and transferable analysis steps.

4   FINDINGS

4.1   EA Deliverables

The first research question aimed to find out typical *deliverables* of enterprise architecture practices in a company deploying large-scale agile development. After the analysis, three dimensions of EA deliverables were found: 1. *business objective deliverables*, 2. *intentional architecture deliverables*, and 3. *emergent design deliverables*. Moreover, these dimensions can be linked to the three corresponding levels of EA and large-scale agile development in Section 2.3. The dimensions comprise of eight second-order categories (i.e., 1. *capability mapping*, 2. *portfolio review*, 3. *big picture visioning,* 4. *road mapping*, 5. *reference architecture*, 6. *architectural principles*, 7. *EA artifacts*, and 8. *architectural runway)*. Each EA deliverable resulted from the interviews within the organization deploying large-scale agile development. The data structure in Figure 7 shows 1st-order codes, 2nd-order categories, and aggregate dimensions and presents their connection. The data structure for EA deliverables is discussed in more detailed in Sections 4.1.1, 4.1.2, and 4.1.3.

1st Order Codes   **2nd Order Categories**   **Aggregate Dimensions**

- Modelling capabilities and product life cycles

Capability Mapping

- Epic portfolio and development portfolio guidance

Portfolio Review

- Deducing high level vision into executable parts
- Taking care of the big picture of the technical

Big Picture Visioning

- Roadmaps and user journeys

Road mapping

Business Objective Deliverables

- Reference architectures, best practices and, guidelines

Reference Architecture

- Defining and providing architectural principles

Architectural Principles

- list of applications, data models and integrations

EA Artifacts

Intentional Architecture Deliverables

- Extending and maintaining Architectural runway
- Non-business-driven architectural work

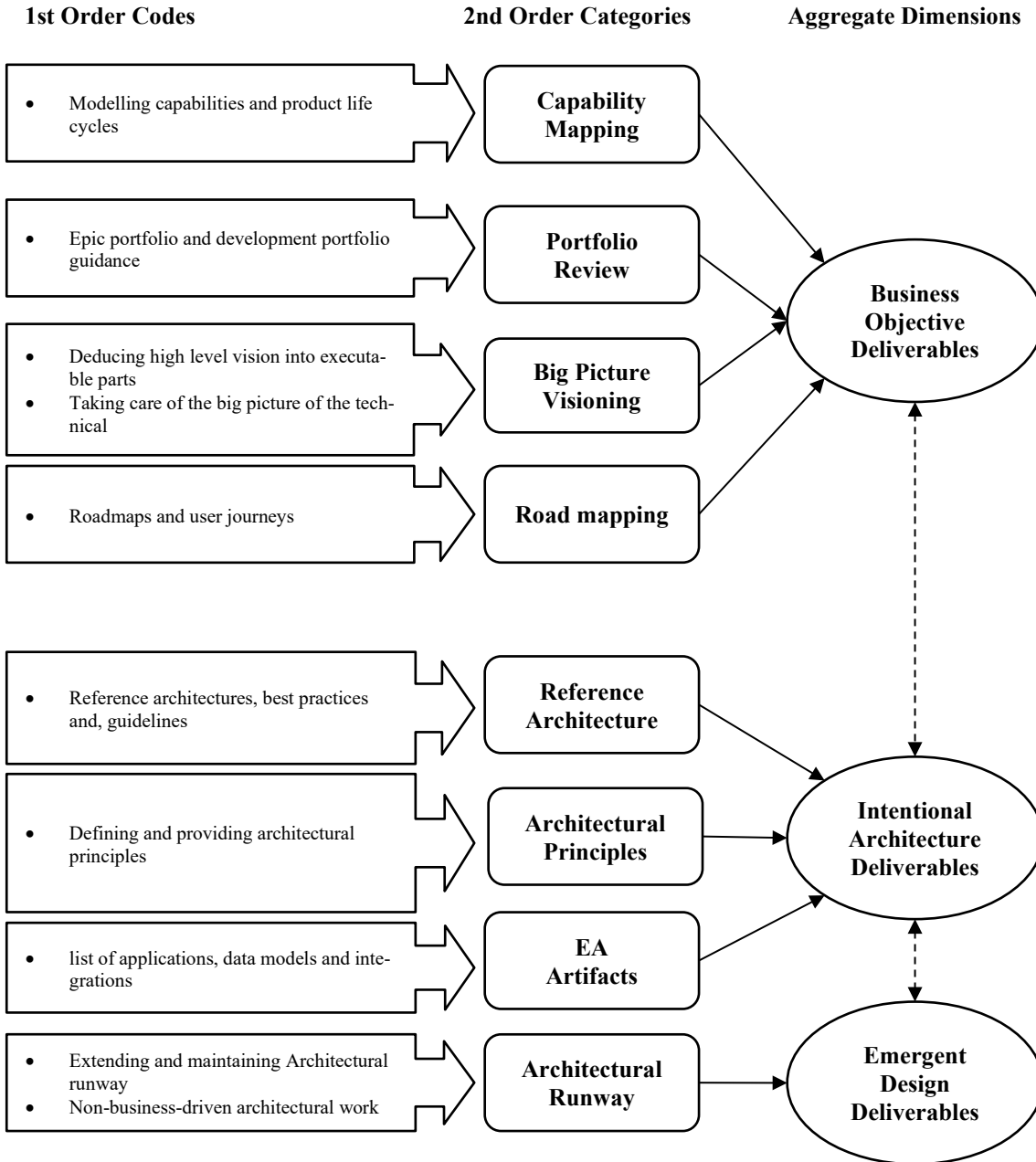**Architectural Runway**

Emergent Design Deliverables

Figure 7   Data Structure for EA Deliverables

4.1.1   Business Objective Deliverables

The first aggregate dimension, *business objective deliverables*, refers to the EA deliverables related to the common objective of deducing higher level strategic themes into more concrete building blocks for intentional architecture. Furthermore, the most frequently used deliverables relate to the ways in which EA clarifies a path from current state to future state. All the business objective clarification deliverables, and data extracts are depicted in Appendix 1. The business objective deliverables are further categorized into *capability mapping*, *portfolio review*, *big picture visioning*, and *road mapping* as they can be linked quite closely to the highest EA objective themes presented in Figure 5.

> *"I think this whole discussion has a lot of layers and we should start by look-*
> *ing at the strategy, then the vision, and then the systems." (U2)*

The category labelled as *capability mapping* consists of *modelling capabilities and product life cycles* (C1, C2, C4, C5, C7, C8, C9, C10, U2, U3), which refers to the capability work done by the architects and value stream leads. Vast majority of participants highlighted capability modelling as an important part of EA. Especially, capability work was seen helpful in converting future visions into resource and skill needs, and to the related development items. In general, capability maps were a broadly recommended approach. Especially, there was a need to transform the business approach so that the focus would be more on the capabilities and on the provided services rather than the tools themselves. In many cases the business counterparts have a very strong opinions on what they want and even a specific tool aspiration in mind, but architects are bringing the so-called capability aspects, the competence and resource fit to match the Metso Outotec aspects and architectural landscape.

> *"I like to tackle these [EA] topics basically more from a product perspective,*
> *when I look these capabilities and the product life cycles. So creating these*
> *capabilities is basically creating a product and it's not all about just taking*
> *care of the product when you build it since it needs to be taken care of while*
> *it is been build and after it has been delivered and maybe also when you want*
> *to upgrade it and you don't move it back to the garage. So I basically try to*
> *always think more from a product lifecycle management, not the PLM domain*
> *but more like IT product services." (C4)*

The second category for business objective deliverables is *portfolio review*, which refers to all the preparation and clarification practices that EA does before major projects or

epics start. Moreover, they quantify initial business requirements and ensure that all relations are considered from architectural point of view. The category consists of *epic portfolio and development portfolio guidance (C1, C3, C5, C9)*. Currently, epic portfolio or development portfolio guidance and analysis were used most of the time. Especially, the portfolio epics required to be reviewed at least on some level before approved and before started to make sure that they are taking the company towards the long-term vision. Normally, business area or market area brings a requirement to the architecture team, who have the responsibility to define the 'how' according to the enterprise architecture guidelines and way of working. Moreover, architects are responsible of setting off and initiating a project or epic that is about to starting to the right track from the beginning and ensuring that all the necessary relations are considered and that the business is asking for something the IT organization is planning for. Typically, EA review consists of qualifying whatever architects have understood and then preparing a planned solution to the initial needs of the business. In addition, now that the IT organization is following the cadence of PI-planning quarterly, it was emphasized that the architecture topics can't be limited to the one day or three session only, therefore, identifying the areas, objectives and development epics where architecture review is required was seen very important.

> "In the [SAFe] agile development, where you have an epic, where you have a business case, where you have an idea what we are doing and why we are doing and when we are handling that, it is a plan basically. We evaluate the tools, we decide the technologies and so on and there we do certain architectural work on which systems we use, which technologies we use and how the data flows basically… The as-is pictures, for example the application portfolio, are important here, because if you have a future state then with the two you can pave the path." (C5)

The third category for business objective deliverables is *big picture visioning*, which refers to the big picture representations of the enterprise architecture. Typically, they try to capture, how business processes, applications, information flows and how people work in the organization. The category consists of *deducing high level vision into executable parts* and *taking care of the big picture of the technical*.

> *"You can use it [big picture as a background when you trying to explain certain thing so you will always see the big picture and not be stuck with the silo discussion." (C2)*

Deducing high level vision into executable parts (C7, C8) was perceived as one of the ways EA gives a more holistic view of the long-term activities within the company. Although, there wasn't a fully formed way of managing this, it was informed to be an important deliverable for architects in deducing the visions within and across the different value streams in the organization. Furthermore, the EA team have some vision work ongoing at the value stream level, which provides a vision for each of the team and each of the activities, and together with the roadmap they give EA and the development quite good view for the long-term and short-term actions.

> *"It is a kind of a combination of doing that long-term vision and strategy planning and identify the future capabilities or the future enablers that we need to have… but then once identified then we of course need to turn that into executable parts and build the roadmap in a way." (C7)*

Typically, the role of EA in the company involves taking care of both the technical and business aspects of the organization. Thus, *taking care of the big picture of the technical* (C2, C6, U1, U3) was an integral part of EA in the large-scale agile development context. For example, communicating the complexity of IT landscape to the business counterparts was informed to be done with big picture deliverables as they help many times to clarify architectural dependencies. Moreover, architects are regarded as the ones who have time to think about the bigger picture in more detail and they usually can help to open any technical problems relating to big pictures.

> *"I would say that we have been doing a lot lately the big picture managed in power points, which tries to explain the world. There the idea is to show the business processes application, information flows and possibly functions and people so how the company works, how the machine works. It is kind of an ambitious way to explain the enterprise architecture in one glance." (C2)*

> *"I think the big pictures have been really valuable in just creating the sense of complexity… Sometimes developments are pretty small, sometimes big, so the guys show from the big picture that what is influenced so they communicate what is the complexity and what are the parts that need to change." (U3)*

The fourth category for business objective deliverables is *road mapping*, which refers to various roadmaps that architects use to facilitate discussion with stakeholders on EA related topics. Moreover, they are used for visualizing architecturally relevant outcomes and milestones to other parties. The category comprises *roadmaps and user journeys* (C3, C4, C8, C10, U1, U3). Roadmaps were highlighted to rationalize the ongoing and near

future smaller development. Indeed, they are used for bridging the gap between businesses demands and portfolios. Roadmaps were regarded as a comprehensive deliverable, when doing strategic planning around a specific topic as it makes it easy to discuss around with the business counterparts, and vice versa, regardless of the domain in question. Furthermore, a clear roadmap was stated to speed up discussion as it deflects some commonly recurring questions that might otherwise emerge. Similar to principles, user journeys were considered useful deliverables, when communicating about architecturally relevant topics to stakeholders outside the immediate EA community. Especially, they were seen effective in bridging the gap between IT and business by providing a more non-technical preview on architectural topics.

"Well, the roadmaps I see, when I am in discussion with the higher-level people, for example, in supply chain manager… So it is important to visualize the landscape and then like rationalize the ongoing and near future smaller development with those guys, that is something roadmaps are useful for." (C10)

"I personally like a lot the user journeys that our [project business and ETO solution architect] has been using and others as well. That is really the way to explain, what is actually the need. If you come and explain that we need this and this system, this and this component and so forth, you go to really deep waters. You sort of lose the audience immediately, because not everyone knows exactly the technical details. So you cannot approach the stakeholders through complex technical jargon. You need to somehow clarify, what the actual users are seeing and doing, and user journeys are very nice for that." (U3)

4.1.2   *Intentional Architecture Deliverables*

The second aggregate dimension, *intentional architecture deliverables*, comprise EA deliverables related to the set of intentionally planned architectural strategies and initiatives that aim to improve solution design and guidance of the different collaborations in large scale agile development. Moreover, as emergent design alone is not sufficient to manage the complexity of large-scale agile development intentional architecture deliverables are needed to build future-proof solution architecture design. All the intentional architecture deliverables, and data extracts are depicted in Appendix 1. The intentional architecture deliverables are further categorized into *reference architecture*, *architectural principles*, and *EA artifacts*, which relate to the middle-level EA objective themes presented in Figure 5.

The category labelled as *reference architecture* consists of *reference architectures, best practices, and guidelines* (C1, C3, C6, C9), which are proven methods and recommendations that help design architecturally sound foundation for operating agile development. It was emphasized that the involvement of architects in creating and sharing these deliverables withing the IT organization is very crucial as no other party would consider them nor take ownership over them. Especially, the solution architects are very much involved in early phases of the development initiatives sharing practical level guidelines with all the development teams on, how development should be done in a sustainable way and at some levels they can be quite detailed. Moreover, architects regularly educate themselves regarding the market trends, tools, and peer companies, and attend various technology seminars to keep up with the industry best practices. On the other hand, because of the post-merger situation, the best practices are still formulating, but there are identified aspects from both former companies, which can be used as a reference for future EA work.

> *"We use common guidelines on how certain things are done and try reuse certain capabilities, systems and applications and so forth." (C3)*

> *"For the infrastructure side this kind of reference architectures are very important. In general, when you are doing mass items that is the idea and in some cases I like to reference that we were at the simplest terms crushing rocks, taking a big rock and turning it into a smaller rock, so we shouldn't be redefining some of the most advanced infrastructure items on the IT side as it is not our business…. That is why I think the reference architecture and best practices in the industry are super important." (C6)*

The second category for *intentional architecture* is *architectural principles*. The category consists of *defining and providing architectural principles* (C1, C3, C5, C8, U1) Currently, EA supports development teams by providing architecture principles, helping teams in implementation, and steering them through roadmaps. As the new agile development model tends to gear towards short-term objectives principles are a good deliverable to keep development activities in line with long-term strategy and architectural themes without the need for constant monitoring. Moreover, clear principles help define, how new initiatives and requirements are addressed, and they make it easy and cost efficient for everyone to start up with new requirements. Specifically, it was emphasized that principles, such as "respect master data resources" and "mobile thinking as a default", is an effective way to communicate architectural intentions as there need for repeating them every time a new request or requirement comes in is greatly diminished. In principle,

business defines the 'what needs to be done' and the IT organization defines the 'how it should be done', and on this 'how' part the architecture principles play a key role.

> *"We have also on some level these kinds of architectural principles that we then share with all the development teams that at some levels are quite detailed." (C1)*

> *"What I often do is refer to the architectural principles. So it doesn't matter whether it's short-term or long-term objectives. Speech is cheap and it is good to talk, but I also like to have somewhere a thing [architectural principles] where I can go back and kind of anchor my thoughts into. That is one artifact I often go back to. So, if we don't have a particular long-term architectural objective, it might be that everything is micro-service based, loosely connected or everything is by default mobile free, everything is fit-for purpose and cost-effective." (U1)*

The third category for *intentional architecture deliverables* labelled as *EA artifacts*, consists of all the major IT landscape artifacts that architects utilize in EA work. Currently, many of the EA artifacts are described in an EA tool, Ardoq, which provides a pragmatic and systematic management of the IT landscape as well as a good starting point for the planning of new solutions and integrations. The category consists of *list of applications, data models and integrations (C1, C2, C8, C10),* which were seen integral artifacts in various development phases. Indeed, it was stated that detailed EA artifacts, such as information flow diagrams, enriched the discussion on all domains of EA. Especially, the landscape documentation and information flow diagrams were considered as concrete artifacts that architects are using while discussing lowest level things. Specifically, these information diagrams and information flows are used in solution architecture, when solution architects are trying to understand certain new applications; how it might affect the current landscape; and where the relevant information is located. Furthermore, to understand, what data is available, and what relationships exist the architects often need to somehow show different conceptual and logical data models, when teams are planning new integration solutions. Teams can already start data base development based on the higher-level data modelling using conceptual data models, logical data models, and application data models. In addition, architects have list of applications and list of integrations that have been created between different applications. They include what data is transferred and what is the source system and what is the target system. Lastly, business process diagrams, managed in QPR-software, emerged as a key EA artifact that some architects utilize in their work.

"There [in Ardoq] we should have the full list of applications that we have in use and some sort of description on what they do and what business capabilities they support and so on. Furthermore, from data point of view the documented integration architecture was seen integral in bringing visibility to the API platform, which is a cornerstone for many of the business applications used in the company." (C1)

"Also the other one relates more on the integration architecture, so what do we have there on the API platform, and what are the connections, especially, from the data point of view. Data is usually the one thing that application and business unit need, and if they don't have it in that specific application they use, they need it from somewhere else, and that sense it is kind of a key part of my role as well." (C8)

4.1.3   *Emergent Design Deliverables*

The third aggregate dimension, *emergent design deliverables*, consists of EA deliverable called *architectural runway* that is needed to reconcile intentional architecture with emergent designs coming from the agile teams. Moreover, architectural runway (Leffingwell et al., 2016) can provide the necessary technical starting point for agile teams to develop business initiatives, new features, and capabilities without the need for excessive redesign and delay. Thus, rather than aiming for a "big design up-front" some architects and value stream leads perceived that the best architecture could emerge from decentralized agile teams. All the emergent design deliverables, and data extracts are depicted in Appendix 1.

All the emergent design deliverables are consolidated into a category labelled as *architectural runway* as it captures the holistic purpose of the lowest level EA objectives presented in Figure 5. The category labelled as *architecture runway* consist of *extending and maintaining architectural runway* and *non-business-driven architectural work,* which are important in providing architecturally sustainable building blocks that agile teams can "consume" in business related development activities both inside and outside the SAFe development model. The architects are solely responsible for considering the architectural runway, also referred to as non-business-driven architecture. Thus, it was regarded as good way to formalize the EA work in large-scale agile development. Indeed, it was stated that the concept of architectural runway could be one of the key deliverables that would bring maturity to the current way of working and help clarify the role of EA in the agile development model.

Extending and maintaining architectural runway (C1, C2, C4, C6, C7, U1, U3) was highlighted as a conceptual deliverable that helps formalize some of the EA related tasks in the SAFe development model. Indeed, the concept of architectural runway was familiar to all the interviewees, but only few were applying it in their EA related work today. Hence, the architectural runway was seen more as a future deliverable used once the EA maturity was high enough. Furthermore, it was stated that in the near future architectural runway should be defined in a more concrete manner and be instilled into SAFe development cycle. In general, the architectural runway was understood by the architects as the existing architecture that teams can "consume" as new designs requirements emerge from the development activities. Indeed, it was noted that architects already try to utilize and build the existing architectural runway instead of always proposing new solutions to keep the architecture as simple and resourceful as possible for the agile teams.

> *"So to me the that is the architectural runway that you create the reusable components by looking at the bigger picture… Another good example is CIAM [customer identity access relationship management]. Once you have the customer identity, we are able to open a lot of things to them without creating a user identity for each and every system." (C4)*

> *"So when we have this kind of architectural runway or road map that is how the teams get there. They don't need to wait for anyone to come to them and tell how things are done, but the runway is made for them, so they know what are the components and they know the big picture so they can then very efficiently focus on the development. So this applies also for the larger point of view. As teams work together of course they need this bigger picture as well and that's where the organizational agility comes into play." (U3)*

Like architectural runway, *non-business-driven architectural work* (C5, C8, C10) was highlighted as a deliverable that architects provide to business counterparts and agile teams. For example, continuous services such as APIs (application programming interfaces) were stated as a non-business driven development that architects takes substantial ownership over. Although, they may delay some development, especially in situations where data models, data objects or integrations are not in place, in a long run they were stated to provide major benefits once fully compliant and reusable for demand as applications can be built from microservices without the need to merge back-end and front-end into a monolithic system.

> *"I think the API platform is probably a good example of this kind of activity-based definition that the one we build can be used as a basis and enabler for*

the other coming activities as well. So it is kind of building on top of the foundation and start adding on that when you have a good bases there available." (C8)

"Yes, I think architectural work can be prioritized and I think it should be, but in a way there are different levels, because we need to do this non-value-adding architectural work basically and our internal work that later governs our business better creating this enterprise architecture." (C10)

4.2   EA Benefits

The second research question aimed to find out typical *benefits* and concerns of enterprise architecture practices in a company deploying large-scale agile development. This Section answers the former one. After the analysis process, two aggregate dimensions were found for EA benefits: 1. *organizational agility*, and 2. *organizational robustness*. The two aggregate dimensions form eight second-order categories (i.e., 1. *strategy agility*, 2. *scalability*, 3. *reusability*, 4. *development agility*, 5. *IT simplification*, 6. *improved visibility*, 7. *security assurance*, and 8. *competitiveness*) attained from the interviews within an organization deploying large-scale agile development. The data structure in Figure 8 shows 1st-order codes, 2nd-order categories, and aggregate dimensions. The data structure for EA benefits is discussed in more detailed in Sections 4.2.1 and 4.2.2.

1st Order Codes　　　　　　**2nd Order Categories**　　　　**Aggregate Dimensions**

- EA enables flexible connection of devel-opments to strategic themes

Strategy Agility

- EA enables scaling up

Scalability

- IT asset reusability

Reusability

- Faster time-to-value

Development Agility

- Reduction of technical debt
- Cost-effective IT landscape

IT Simplification

- Visibility to the past and the future
- Breaking down silos

Improved Visibility

- Ensuring security matters
- Future-proof development

Security Assurance

- Providing competitive edge

Competitiveness

Organizational Agility

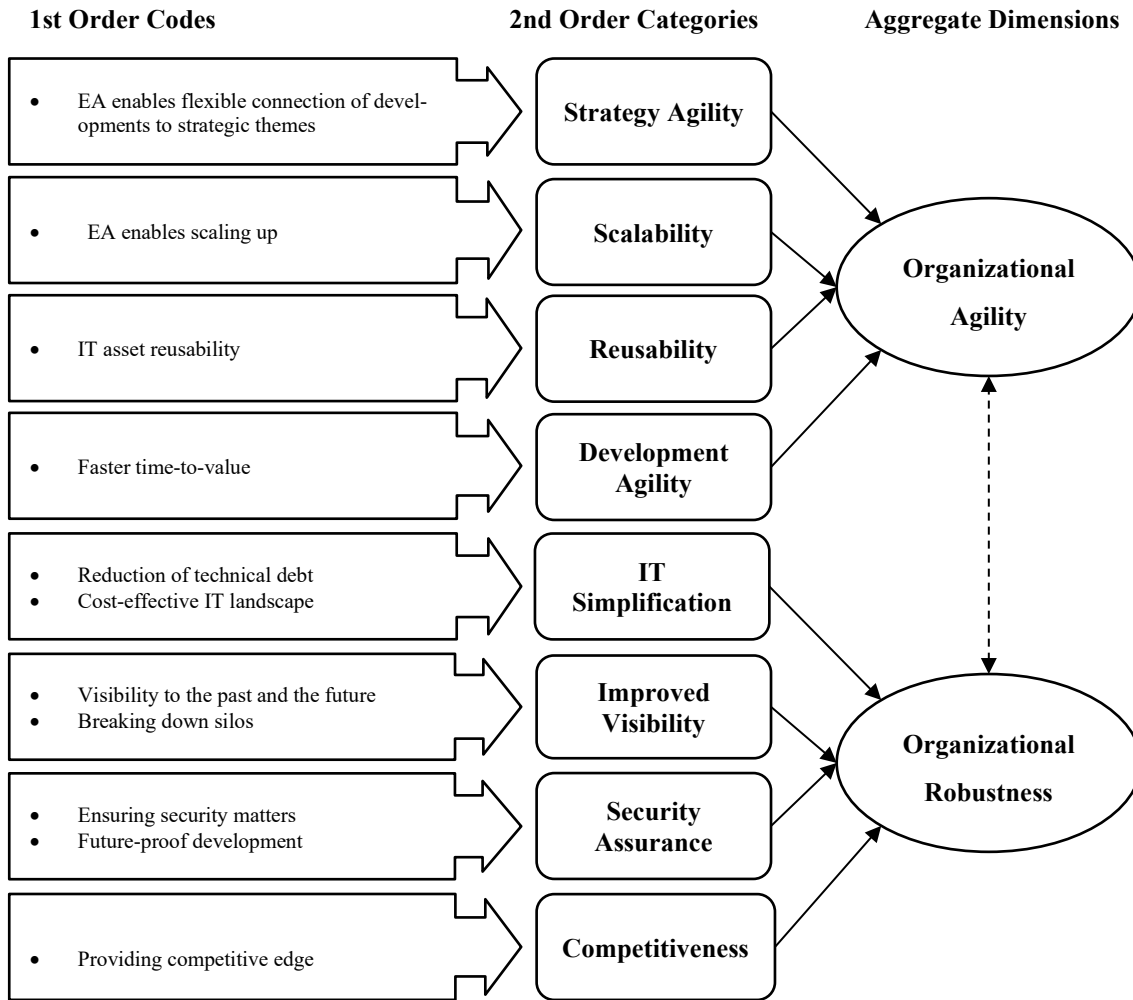**Organizational Robustness**

Figure 8　Data Structure for EA Benefits

4.2.1   Organizational Agility

The first aggregate dimension of EA benefits, *organizational agility*, describes the typical benefits that an EA can reinforce within a company deploying large-scale agile development. All the individual organizational agility benefits and data extracts are depicted in Appendix 2. The benefits for organizational agility can further be categorized into *strategy agility*, *scalability, reusability,* and *development agility* as they all form a solid basis for agility within the whole organization.

The category labelled as *strategy agility* comprises *EA enables flexible connection of developments to strategic themes* (C2, C3, C7). Not only does it relate to the strategy and vision implementation that is already in place, but also to the company's ability to react in times of major changes and disruptions in strategy and vision. Indeed, it was stated that the better the vision and the strategy goals are clarified, the easier it is for EA to deduce and connect strategy into smaller developments, and vice versa. By taking different level approaches to the requirements, however small they may be, EA provides better view of the longer ambition in the landscape linking separated objectives into a broader picture. Moreover, with this broader picture it is easier to start lower-level strategic initiatives that all work toward a vision and strategic goals.

> *"If the architecture is done well our applications and solutions are easier to integrate providing better value. Reporting capabilities should be much better, because technically then you can combine all the data So drill down to different dimensions. I think IT should be quite cost efficient with good architecture and we have flexibility to change the architecture, whenever we have major disruptions like strategy changes, acquisitions, divestments and so forth." (C2)*

> *"The architecture work basically makes sure that we are taking that long-term view in planning and take the kind of holistic view as well. So that is the key, because agile by definition should be business driven or driving towards concrete outcomes in an agile and quick way, but that means that there might be an inherent risk of silo-thinking and optimization on a smaller scale that is not actually benefiting the whole corporation in a way. Architecture work can sort of help connect to a bigger context and make sure that there is a connection to the long-term benefits and that we are going to the right direction in the long-term…So if there was a clear strategy and vision behind all the development that is done in the agile sprints or PIs then that might enough*

at it is, but I don't think our maturity is there yet so we need to have architecture to make sure that somebody considers the big plan and the long term and the connection to the strategic themes for example." (C7)

The category labelled as *scalability* comprises *EA enables scaling up* (C3, C6, C7, C8, U1, U3). Indeed. It emerged that EA plays a critical part in helping the company to scale agile as well as make the best use of the existing IT assets. Moreover, it was stated that EA makes it easier to build on top of the existing applications and that it can bring innovation to the initial business requirements. Because of the multitude of applications in the IT landscape, EA was even perceived as a mandatory practice in supporting the operational value stream. Another common response was that architects usually find relations to different areas which might be beneficial to a larger extend. This kind of integration approach was highlighted as benefit gained direct from EA. For example, an initial request from business counterparts can be scaled into a wider use within the organization many times adding value on top of the initial idea.

"If the initial proposal is too narrow or too big, architects can scale it into the right perspective." (C6)

"Enterprise architecture helps with cost efficiency, leverage synergies, benefits of the scale and how do we scale up, support the business processes better with the IT landscape. The 'how' do we make the IT landscape more scalable and efficient, 'how' do we come more agile." (C7)

The category labelled as *reusability* comprises *IT asset reusability* (C3, C4, C8, C9), which refers to architects' ability to find reusable capabilities and components between different value streams and functions. In addition, architects also bring deeper understanding and visibility to the agile teams resulting in a smarter use of inhouse assets and resources. Because architects know different technologies well in their own domains of expertise, searching and finding appropriate solutions for given needs is very sufficient. Moreover, as architects know the capabilities of current systems and the way various technologies are used, they can find easily reusable components of existing IT assets, which shortens the time-to-value.

"Very classic example in our case was the transport management solution. Someone just came to us and said 'we are going to use the oracle transports management system' without thinking that we don't have any Oracle support capability in-house which means that one FTE [full-time equivalent] needs to be hired 100 000 euros per year to the company. Of course, that is not there

in their [business's] TCO [Total cost of ownership] calculation, because to them they just buy the tool. So, then what turned out happening was that based on good architecture support to them we agreed that we will actually use transport management from another platform that already exists. So that platform already had that capability and we just plugged the switch on the transport management capability, instead of now creating a new technology expertise in house, getting new consultants from a new company that we have never work with before to develop this Oracle based solution, we can now use the existing expertise from our supplier to develop that. So that is the value we create." (C4)

"All companies go through this efficiency improvement in demand which basically means various harmonization aspects. So, one BA [Business Area] or one function has been using other kinds of application sets and the other ones have been using totally different and then we never had this kind of company level overview that what are the tools that we have in hands that can be utilized; are there commonalities at least in the demand; can we utilized something in common; is there anything that the best practice could be enlarged to in a wide extent. So, that is where EA is very helpful." (C9)

The category labelled as *development agility* comprises *faster time-to-value* (C3, C6). Contrary to the common belief that EA acts as a "showstopper", it was observed that EA can make it easier for a business initiative to be realized in the development process. Furthermore, the skillset and holistic knowledge of the IT landscape that enterprise and solution architects have was seen to speed up the development process altogether resulting in faster time-to-value. In many cases typical benefit mentioned was that business counterparts get what they want in a fast manner, resulting in a fast time-to-value, because many times architects find the ways to reuse capabilities and components from the already existing IT assets and by nature aim to minimize customization.

"You can get a bigger insight from us than when trying to figure out on your own and it is supposed to be more holistic so they save time by going through us even though it takes time to go through us at the end of the day." (C6)

4.2.2   *Organizational Robustness*

The second aggregate dimension of EA benefits, *organizational robustness*, describes the typical benefits that help to create and maintain a robust and resilient IT landscape

that supports business, especially, in times of disruptions and changes. All the individual organizational robustness benefits and data extracts are depicted in Appendix 2. The benefits for organizational robustness can further be categorized into *IT simplification*, *improved visibility*, *security assurance*, and *competitiveness* as they all play an important part in forming a resilient backbone for the organization and the IT operation model.

The category labelled as *IT simplification* comprises *reduction of technical debt* and *cost-effective IT landscape*. By design EA is not seen as a revenue generating function, therefore most of the benefits in this category describe, how the company can operate at an optimized cost level. Moreover, the beneficial role of EA in servicing business demand and supporting operational functions was frequently highlighted, especially, now that the company has started to deploy the new SAFe model.

> *"I would say from the background that part of the evolution of our IT function and IT management in the kind of modern IT team is the need to manage the architecture in a more structured and systematic way. It is a sort of common industry trend as well, but specifically for MO, I think couple of years back the need to focus on this [enterprise architecture] became more relevant and that was when we kind of started this enterprise architecture team as well."* (C7)

One of the most highlighted benefits of EA was *reduction of technical debt* (C6, C7, C8, C10, U3) that is due to various "housekeeping" activities done by enterprise and solution architects. It was mentioned that the company has a lot of technical debt, especially in the IT landscape, and that is something that the IT organization tries to put more focus into. Hence, one of the most important benefits and long-term objectives of the architecture work is to simplify and do the cleaning for the IT landscape by harmonizing, upgrading, migrating, and retiring applications and technologies that are no longer supporting the business or needed. For the architects it is a constant challenge, when business fall in love with new technologies and tools, when the reality is that there is much more architectural consideration required beside delivering the initial new feature or certain capability. Hence, without EA governance the company would likely have much more of these readymade software applications burdening the IT landscape than today.

> *"One key point here also is to minimize or reduce the technical debt so if we would keep on doing point to point integrations it would increase the amount of work and technical debt."* (C8)

Businesses are still scattered, but then all the processes and the systems in IT landscape they are very scattered and corrupted, and we put a lot of effort for those topics and the architecture is only way out of that situation. (C10)

C*ost effective IT landscape* (C2, C3, C4, C5, C9) refers to both the monetary and resource-based cost-savings that can be gained directly and indirectly from EA. Indeed, it is evident that EA plays a role in creating a cost-effective IT landscape, but also that it can maximize the value of solutions and technologies used by the company. Moreover, it was evident that with the complexity of the company it would be imposable to create and maintain a well-functioning and cost-efficient IT landscape that would support business properly without some intervention by the EA team.

"I think first of all to ensure that everything we do in IT is cost-effective, so that we give common guidelines on how certain things are done and try use reuse certain capabilities, systems and applications and so forth. So cost-efficiency or effectiveness is clearly one… so we do things effectively from a cost point of view but we also can then provide solutions and answers to the questions that business is looking for." (C3)

"I am a firm believer that when we buy ready-to-use platforms, let say Salesforce, dynamics, SAP, those companies have spent decades and probably billions developing what is there in the product. So business often forgets that they are paying 50 euros per user per month to use the things that are in there. So I like to remind the users and myself that if we use best of the class solutions, how do we use them to the best of our advantage based on what we are paying lets Salesforce to do… so I say we let Salesforce, Microsoft, SAP do the hard work and we should be wise enough to see how we can utilize that." (C4)

The category labelled as *improved visibility* comprises *visibility to the past and the future* and *breaking down silos*. Although *visibility* is not a tangible benefit, it is seen as one of the most useful outcomes that EA helps to provide into the organization. Moreover, the visibility that EA provides can also be an increase in information availability within the organization, which was perceived also a key success factor in the agile development cadence.

EA brings visibility to the past and the future (C8, C9, C10, U3) that was perceived to be helpful, especially, in the post-merger activities. As the company tries to migrate two legacy IT landscapes, EA is seen as an integral part in facilitating and bringing the required visibility on the legacy of the two former companies. Visibility provided by the

architects also build a good ground for future development. Moreover, after the merger architects are integral in understanding and bringing visibility on, how things have happened, done and what tools have been used on both sides of the company.

> *"I think our main goal is to make sure that we have a long-term view and that the decisions we make today regarding certain application and IT related question have long term kind of stability. We have the visibility on the long-term so that the decision we make today are sustainable and can be used and managed in a long run… On an organizational level I feel that we have been able to gain some visibility on our landscape, which in a way sounds a bit naive, but we have been able to put the visibility into place, and we have now some kind of nucleus for the future development." (C10)*

> *"It comes back to data I guess so if you want that the organization has the visibility of the things that happen and they can collaborate efficiently, this is this something that we need the enterprise architecture to support. Otherwise, it's just impossible to maintain the number of systems that need to work together." (U3)*

It emerged that business was operating within a specific silo ignoring the common big picture of the company and that EA was crucial in *breaking down silos* (C1, C2, C9). Indeed, the EA team was very aware of the fact that there are a lot of built-in legacies and silos in companies that have merged, and that architecture is needed to break down these silos to really make the company work as one. Moreover, anytime there are similar or possibly conflicting development done within the organization EA helps to connect the stakeholders across different value streams and agile teams to enable a more holistic collaboration. Typically, development initiatives are siloed and focusing on a very small piece of a given portfolio, hence the architecture work helps in painting the whole picture. For instance, whenever there is a separate development done, EA helps identify and inform overall impacts on the other relating value streams.

> *"Most important benefit is that it [EA] gives kind of a helicopter view of the whole enterprise and breaks it down into smaller manageable pieces… It also helps with prioritization and connecting the dots, which can be completely outside of certain function and which might otherwise be totally unknown… That's why we are here to bring visibility to them." (C9)*

The category labelled as *security assurance* comprises *ensuring security matters* and *future-proof development*, which both enforce the overall security and help diminish known

internal and external risks that the company has. Although, there are other parties dedicated to security and privacy matter, it was stated that architects help ensure and raise awareness of these matters. Moreover, the role of architects is emphasized, especially, during the different steps in development process as no other party would take ownership over the technical and logical aspects of business initiatives, when it comes to security matters.

Involving EA early in the planning events was seen critical in *ensuring security matters* (C3, C5, C6) in all kinds of development initiatives. Furthermore, it was emphasized that security and privacy cannot be one approval at the beginning of development, but that EA needs to follow whether the execution is made according to the plan, because business counterparts may not always have the time to consider all aspects. Hence, architects ensure that there are no shortcuts when it comes to security and dependency matters.

> *"Then of course security related risks if we think about those without like having architectural work the security related things might not be considered… I always involve our or have been fortuned enough to have this security and compliance assessment team. So I always involve them from the very early stage, when we initiate the new requirement and ideas so they are part of the planning and thinking from the very beginning." (C3)*

> *"If you involve us in the planning events it should be the quick cart that there is somebody who is thinking about, who is involved, and do we have everybody who need to be involved. If the event is not planned holistically enough then architects probably will say something by doing x and changing an office in y and that kind of stuff and that is why you should involve architects early on… Architecture work is sort of same as security." (C6)*

Agile development aims to deliver at a fast phase, which can result in complex and scattered IT environment without a systematic interference. Hence, in was noted that EA helps to steer agile release trains (ARTs) towards a *future-proof development* (C5, C6, C8). Moreover, architects take responsibility over some of the non-functional requirements and system qualities such as security and scalability, that ensure that the development is sustainable in a long-term. It was noted that EA helps ensure that the company doesn't paint itself into a corner regarding the choices made regarding technologies, tools, licenses, or data and that the stakeholders are provided with a holistic picture before starting to implement.

> *"For infrastructure side I think architects are used to validate the designs so even though the decisions are not made by architects the decision makers*

want some reassurance for projects and I think that is fairly important to en-
sure that there are people who have a little bit of more time to reflect it from
distance." (C6)

"EA gives us a good basis for developing things and ensuring they become
future-proof. If there is no architectural consideration the app integration
would be kind of whatever and it would only create more mess." (C8)

The category labelled as *competitiveness* comprises *providing competitive edge* (C3, C4, U3). Indeed, it was emphasized that architects also act as a window to the outside world bringing in new technologies and ways to compete in the market. Although, architects were sometimes seen as a disruptive force in the agile environment they provide vital insights on the best practices and industry trends that help to build, for example, a tier 1 company. It was emphasized that the helicopter view that architects have in their jobs enable innovation and to expand initial ideas, which is why business areas and market areas often ask for their expertise. Indeed, as the architect are familiar with a lot of different requirements and activities in different business areas, market areas and even in some competitors they bring valuable knowledge to the company. Furthermore, architects attend a lot of webinars and conferences to stay up to date with the technologies, which enable them to create inhouse innovation and competitive edge.

"In our business it is very profitable to actually deliver services, because first
of all you have the product knowledge, then you have the actual margin rate
quite good as well, so it is very beneficial then in my area to bring in the
broader view." (C4)

"From my standpoint enterprise architecture is part of being a modern com-
pany providing the capabilities that modern business needs and to really com-
pete in the market...It is also a cost matter. We would easily come up with
much more systems than we actually need so it is a dialogue between the
architecture and the rest, but it is essential part in becoming competitive."
(U3)

4.3   EA Concerns

The second research question aimed to find out typical benefits and *concerns* of enterprise architecture practices in a company deploying large-scale agile development. This Section answers the latter one. After the analysis process, four dimensions were found for

EA concerns: 1. *immaturity*, 2. *disengagement*, 3. *urgency*, and 4. *resistance and anti-patterns*. The dimensions found form seven second-order categories (i.e., 1. *EA immaturity*, 2. *development model confusion*, 3. *structural silos*, 4. *EA disengagement*, 5. *reactive mode*, 6. *EA resistance,* and 7. *common anti-patterns*) attained from the interviews within an organization deploying large-scale agile development. The data structure in Figure 9 shows 1st-order codes, 2nd-order categories, and aggregate dimensions. The data structure for EA concerns is discussed in more detailed in Sections 4.3.1, 4.3.2, 4.3.3, and 4.3.4.

1st Order Codes   **2nd Order Categories**   **Aggregate Dimensions**

- Immature formalization of EA work

EA Immaturity

- EA and agile incompatibility

Development Model Confusion

Immaturity

- Structural silo persistence

Structural Silos

- Unclear stakeholder engagement
- Insufficient EA compliance follow-up

EA Disengagement

Disengagement

- EA in a reactive mode

Reactive Mode

Urgency

- EA seen as the bad police

EA Resistance

- Negligence of integration architecture and master data management

Common Anti-patterns

Resistance and Anti-patterns

Figure 9   Data Structure for EA Concerns

4.3.1   *Immaturity*

The first aggregate dimension of EA concerns, *immaturity*, describes first set of typical concerns that emerged standing in the way of practicing EA in the company deploying large-scale agile development. All the individual immaturity concerns data extracts are depicted in Appendix 3. The concerns for *immaturity* can further be categorized into *EA immaturity* and *development model confusion* as they both capture the current concerns relating to the maturation of EA in the agile development model.

The category labelled as *EA immaturity* comprises *immature formalization of EA work* (C2, C6, C7, C9, U1), which refers to a sense of ambiguity that architects may experience, when trying to formulate objectives in the agile cadence. It emerged that architects find it difficult to balance between, actively monitoring and guiding the teams and acting more

on demand basis. Moreover, the long-term EA objectives were not clear for the EA team as they were still quite abstract and indirect, but there was a consensus that they should be clarified in more detail.

> *"It's not clear whether architects should be more proactive so clarifying everything with all the teams so that you know everything that they are doing or should we be more like service organizations that whenever they need us they call us… Also, when you are involved with a multiple open case, they eat up your time and energy. Architecture thinking takes time and iterations and when you are interrupted you might have to start over." (C2)*

> *"A lot of people have asked me what it is that the architects do and sometimes even the architects themselves have asked me what it is. So for example when architects review of an epic is required what exactly does that entail, what exactly like with big E? Is it review of which aspects of the proposed development or security? Obviously that it matches or follows the architectural principles. Well, that makes sense, but what else? It is fairly grey area what the architectural work is and, in my opinion, the best architectural work would be to established by providing those guardrails for the teams. So that would breed the best benefits." (U1)*

The second category labelled as *development model confusion* consists of *EA and agile incompatibility* (C1, C2, C3, C5, C6, C7, C9, U2), which refers to the difficulties in fitting EA and agile development model together. The incremental approach in large-scale agile development was perceived as the right way to help deduce architectural developments into smaller parts without the need to develop all the different platforms and tools directly into full solutions, but it has some architectural challenges, namely, that the EA team still needs to see way ahead for a solution to be able to fulfil the things that are not yet developed but will be developed in the future. Indeed, it was noted that EA as it is today is not without hiccups when it comes to adapting the agile cadence and ambitions. Hence, EA requires deliberate adjustments and practice before running smoothly in the agile cadence. Moreover, the new SAFe model and tools like Jira were integral in helping to cope with the harmonization, but the maturity is still missing in many areas, especially, from architecture review point of view. For instance, the architectural governance was regarded as important part of large-scale agile development, but the role of it and how it should be practically implemented in a good way in agile environment was still largely missing.

> *"Somehow my expectation was when we moved to the SAFe that it would remove these silos. I mean we had those silo effects also in Metso side doing*

the projects, but the SAFe kind of promise was that it would remove the silos and that there would be clear visibility into each other, but we still run each value stream as its own show… and I feel the pain of many of my colleges when I look at their portfolio boards that are so filled up because of the structuring we have in place. It is very unbalanced." (C3)

"The only concern in coordinating development in cross-team meetings is that it takes time from the calendar, so it eats up resources. So there needs to be some sort of balance how much we do it. Regardless of how much we do it is super important." (C7)

4.3.2   Disengagement

The second aggregate dimension of EA concerns, *disengagement*, describes emerged blind spots and disconnection found that can prevent or slow down the successful facilitation of EA practices. All the individual disengagement concerns and data extracts are depicted in Appendix 3. The concerns for *disengagement* can be divided into *structural silos* and *EA disengagement* as they clarify the root causes for disengagement, namely between EA and immediate stakeholders, but also within the EA team.

The category labelled as *structural silos* comprises *structural silo persistence* (C2, C3, C4, C6, U1), which refers to the formation of silos that tends to occur within the company. Indeed, it was observed that, when there were less stakeholders and decision makers involved, it was much easier to go into value stream, business area or even architecture silos that make execution of common enterprise objectives more difficult or out of reach. Moreover, the way the value streams are currently structured may play a role in, why some EA areas are perceived more overloaded than others. Indeed, to some extent EA is disconnected from the value streams, especially, when defining architecture related topics across value streams.

"I would say that whenever you are creating the organization and operating model there are silos." (C2)

"The reality is that we have far more operational value streams than we present, because the product portfolio that the entire group has, the 5 businesses, there is a vast amount of different types of products and services, and value streams for those are all different. So, we probably have tens or probably close to hundred different types of value streams and only a bundle of these archetypes, like standard product and parts. That is oversimplification, if you

really want to understand. That is why the job, for example, of our value stream architect is almost impossible and I am also close on the borderline of impossible, because the scope of this one area that we call standard products and parts is so large with tens of different value streams." (U1)

The category labelled as *EA disengagement* comprises *unclear stakeholder engagement* and *insufficient EA compliance follow-up*, which refer to architectural touch points, where EA still lacks visibility or the right stakeholders in order steer and oversee architecturally relevant activities sufficiently.

Unclear stakeholder engagement (C2, C4, C6, C10, U1, U2) refers to, how the company struggles to find the right stakeholders to take part in the EA work. Before the company started deploying large-scale agile development model much of the discussion was focused on the agile teams, which overshadowed the role and demand for project managers (also referred to as product owners). Therefore, the company must currently acquire project managers from the external market as there are no in-house personnel to lead the teams. Another emerged concern related to disengagement was that there isn't consensus on, who should be involved in the various meetings concerning architecturally relevant topics. Indeed, many times unclear stakeholder engagement leads to a situation, where architecturally relevant subject matter enter the discussion too late further delaying the development flow. Occasionally, when implementation decisions in value stream and steering meetings are done, it was highlighted that some of the nominated steering members from the business side don't understand their roles and responsibilities, which was a concern for EA.

"Even though the CoE [Central of Excellence] meeting is customer focused, this is now stretching a little bit, I think it isn't directly coming from the customer. We always have somebody interpreting the customers… and I don't think we truly get all the way back to the customer. So we have quite a good circle of critical people to produce the value, but some of the critical pieces on the demand side are still missing." (C6)

"The main concern here let's admit when we are now running our development and business in agile way on a SAFe model is that we have huge missing peace there. We have the architects there in place, value stream engineers and business product owners and so forth, but what we are now missing from the IT side is the product owners." (C10)

"We still have these review boards and even the CoE (Central of Excellence) that we run, if you have noticed, it is mostly consisting of architects and value

stream leads, but where are the product owners and the development team members?" (U1)

One common view was that EA is not always able to see whether the EA related long-term objectives are realized within the company. Moreover, feedback loop on, how well agile teams comply to architecture related activities in a long-term was missing altogether. Indeed, one significant blind spot for EA in agile environment was an *insufficient EA compliance follow-up* (C1, C2, C3, C5, C6, C7, C8, C9, C10, U1, U2). Development activities outside the SAFe umbrella, such as regional IT and continuous services, emerged as a concern for EA. Furthermore, one of the EA concerns identified outside the EA team was the lack of EA guardrails. It was stated there are situation where either those guardrails don't exist; they are not known by the teams the team itself or the solution that is being proposed is already noncompliant with the wanted state. On the other hand, it was stated that for EA it is important to be able to work proactively and raise the issues before they become time critical to avoid the need to stop everything just before imple-mentation, but the concern is that EA is not always invited in the first discussion leaving some development activities in the shadows.

> *"These qualitative measurers on architecture, like how good designs we make and how well we do, these are really challenging… First of all, architectural governance must not only relate to SAFe, but it must also relate to all the development which are outside SAFe" (C5)*

> *"Unfortunately, we don't have the time to maybe allocate the amount of time to participate in the so-called execution or roll out of the solution and to see how it all works and whether the benefits have been realized." (C9)*

4.3.3　*Urgency*

The third aggregate dimension of EA concerns, *urgency*, refers to the lack of time and firefighting that EA team needs to endure in the agile cadence. All the individual urgency concerns and data extracts are depicted in Appendix 3. The concerns for *urgency* can further be categorized into *reactive mode* as it captures the hectic state of EA work today.

The category labelled as reactive mode comprises *EA in a reactive mode* (C1, C2, C4, C5, C6, C9), which refers to the prevalent mayhem underlining EA work midst the agile cadence and post-merger migration activities. Indeed, it was noted that the reasons, why EA team is periodically in standby mode was due to seme external factors, namely the ongoing post-merger migrations and the relatively new deployment of SAFe development

model. Especially, it was highlighted that the agile cadence did not leave room for in depth architectural consideration. Indeed, a common concern was to figure out, how much time would be appropriate to allocate into different facets of architectural work. Moreover, the development process used by the IT organization is geared towards fast delivery, which substantially decreases the time architects have for long-term EA consideration.

> *"I think the challenge is that the long-term vision is missing as we are very hurried to take the next step without actually realizing if it is in the right direction. We just take the next step, and we are self-correcting ourselves later." (C4)*

> *"Maybe first is the speed. Everybody is pushing for the new thing instead of doing things properly, so that it would be scalable or serve as the foundation for the next step and you just put something together fast and off you go to the next thing. And that kind of leads to a high maintenance cost and technical debt." (C5)*

> *I have to admit that at the moment we are really focusing on burning topics and the definition done is coming very quickly for us. (C9)*

4.3.4 Resistance and Anti-patterns

The third aggregate dimension of emerged EA concerns, *resistance and anti-patterns*, refers to specific internal forces that complicate EA work, namely unfavourable attitudes towards EA kept by some business counterparts, and recurring harmful customs that are instilled in the way EA is conducted today. All the individual concerns of resistance and anti-patterns, and data extracts are depicted in Appendix 3. The concerns for *resistance and anti-patterns* are divided into categories *resistance* and *common anti-patterns*.

The category labelled as *EA resistance* comprises *EA seen as the bad police* (C2, C4, C7, C9), which refers to the notion that EA is sometimes perceived as a bottleneck in the agile development model. Indeed, it was highlighted that business counterparts and IT, or EA, have conflicting views on how to approach certain decisions regarding solutions and technologies. Moreover, it was observed that, where EA community is often opting for a cost-efficient and preferably in-house solution with minimal changes to the IT landscape, many times their business counterparts tend to introduce a new application from the market, which causes friction between the two parties. Indeed, external perception of EA is one concern facing architects occasionally in the company. Hence, architects are required to pay more attention to managing audience's expectations and to ensure that business

counterparts understand, why things might be more complicated than they thought initially.

> *"I'm sure that business feels that architects are always slowing down things when well-thought-out development proposals are stopped, because architects want, let's say, re-evaluate everything… so business things that things would move faster without the architects." (C2)*

> *"So often IT and architecture are seen as the bad police by business, because they see us disruptive… and why do they see us disrupting? Because we focus too much on making things right now while thinking of the future roadmap but not actually explaining to the business why we are doing that." (C4)*

> *"What I have been having challenges with is to kind of explain this capability and the link to the capability model to our business counterparts… most of the time they understand but they say, 'hey it is very nice kind of sales or marketing speech, but how will you solve my problem?', and that takes a little longer to explain." (C9)*

The category labelled as common anti-patterns comprises *negligence of integration architecture and master data management* (C3, C7, C8) refers to some of the identified weak points of architecture, that hinder the IT organization and enterprise to function at an optimal capacity. Indeed, it was highlighted that some of the data related areas, such as integration architecture and master data management, have been given less attention that would have maybe been optimal. Moreover, it was observed that there is a constant demand for point-to-point connections, which would add unnecessary technical debt for the architects, if left unnoticed.

> *"I mean from year to year, month to month and day to day the master data issue comes up. I mean that's probably not only MO [Metso Outotec], but clearly one of these anti-patterns I see reoccurring every time… We have this data but the quality is really poor or it is very scattered in several places. Many times the solutions that we like to use are limited by the fact that there is not enough data or it is not high quality or it's unreachable." (C3)*

> *"The other anti-pattern that should have more emphasize is to think more about the data architecture and the data flows and focusing a little bit more on building this kind of integration architecture… and on the importance of data." (C7)*

"I think one of the things we have seen in the past and somewhat still hap-pening is that there is too much demand for point-to-point connections… and the same kind of applies for the application development as well. For exam-ple, when the business demands solution or functionalities it should be given more the business process point of view or business demand point of view instead of getting too far in the details on the actual solution itself." (C8)

4.4   EA Enablers

The third research question aimed to find out key *enablers* of enterprise architecture prac-tices in a company deploying large-scale agile development. After the analysis process, three dimensions for EA enablers were found: 1. *communication and collaboration*, 2. *Lean EA*, and 3. *EA culture*. The dimensions found consist of seven second-order catego-ries (i.e., 1. *communication*, 2. *collaboration*, 3. *coordination platform*, 4. *EA visualiza-tion and tools*, 5. *Lean approach*, 6. *EA education,* and 7. *extended EA community*) at-tained from the interviews within an organization deploying large-scale agile develop-ment. The data structure in Figure 10 shows 1st-order codes, 2nd-order categories, and aggregate dimensions. The data structure for EA enablers is discussed in more detailed in Sections 4.4.1, 4.4.2, and 4.4.3.
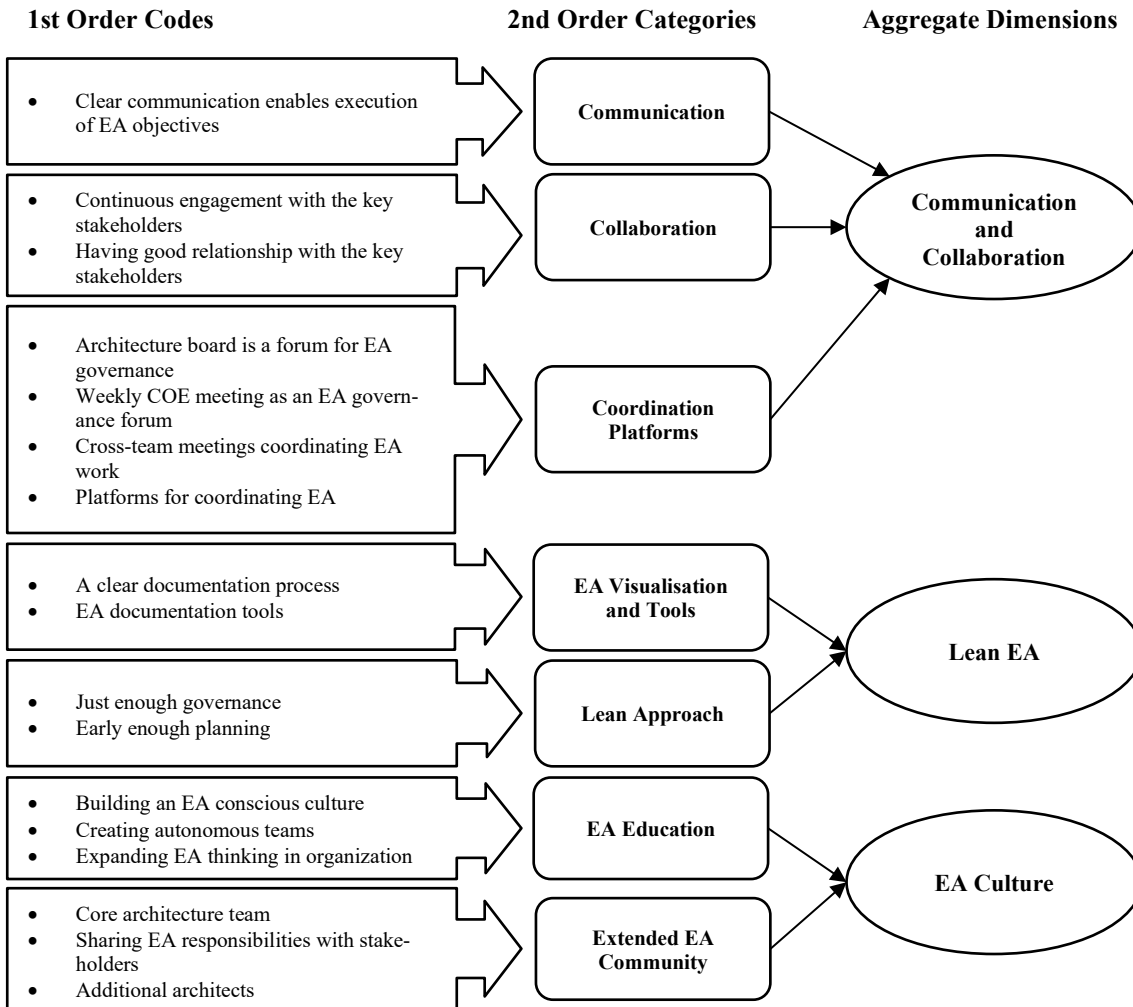
Figure 10   Data Structure for EA Enablers

4.4.1   *Communication and Collaboration*

The first aggregate dimension of EA enablers, *communication and collaboration*, describes the emerged enablers that are integral in facilitating EA practices in the company deploying large-scale agile development. All the individual communication and collaboration related enablers and data extracts are depicted in Appendix 4. The enablers for communication and collaboration are divided into *communication, collaboration,* and *coordination platforms.*

The category labelled as *communication* comprises *clear communication enables execution of EA objectives* (C1, C2, C4, C5, C7, U1). A general statement was that communication was a key enabler in bringing visibility to the various stakeholders relating to architecturally relevant topics. Moreover, without informal and formal communication much of EA information, such as best practices, principles, and EA compliance follow-up, would be out of reach and not able spread within the organisation. For example, it

emerged that communication is the only way to get a sense if the agile teams conform to EA principles. Moreover, EA team put emphasize on transparency and sharing information as it is was perceived as one of the most effective ways to connect all the different development teams and align them towards common EA goals.

> *"Each and every role is important. You can have that person in that role but unless they communicate and coordinate it is as useless as not having that person. So, the biggest thing that people don't understand at SAFe is that they feel that if they implement the model, follow the model, everything is going to work. No, it is them who need to open their mouth and keep their ears and eyes open as well. So in my opinion all the roles are important, but what is more important is that communication and collaboration there, because otherwise if you don't do that you might as well do your own development."* (C4)

> *"Well obviously the business feedback is important, which I don't usually receive directly but trough the value streams."* (C5)

> *"So it doesn't matter whether it's short-term or long-term objective, speech is cheap, and it is good to talk."* (U1)

The category labelled as *collaboration* comprises *continuous engagement with the key stakeholders* and *having good relationship with the key stakeholders*. Indeed, it was stressed that EA couldn't be practiced only by architects, but rather that it requires active collaboration of all the stakeholders. Especially, collaboration was perceived one of the key enablers in managing the cadence of change in the large-scale agile development.

Continuous engagement with the key stakeholders (C4, C7, C9) refers the common notion that the current EA work can't be a one-time judgement or task at a certain point in the development process, but rather that it should be a collaborative effort and a constant engagement with the immediate stakeholders. Moreover, collaboration with the "lower level" operational people was highlighted to be important as they often are very close to the project and usually know the burning areas giving valuable insights, for example, on what are the functions or the capabilities that they would like to fulfil. Hence, for EA it is important to engage with the operative people as well. In addition, it was noted that active collaboration helps raise awareness of architecturally relevant development topics that might come outside the PI-planning or the SAFe model altogether.

"Architecture is not one time judgement; it is a continuous engagement with the teams… I am not a big fan of that every week you should have a meeting. It is about more like a common constant pulse, where you press the gas when you need to, you press the brake when you have to but the point is to move at the right pace. So, I would say that it is more like a continuous engagement to ensure that things don't go out of let say the groove in the sense." (C4)

"It is important that the solution architects work in close collaboration with the development teams, at least the product owners, the scrum masters or some sort of lead developer or architect working withing those teams. I think that is the first and most important thing." (C7)

Having good relationship with the key stakeholders (C3, C2, U2) enables more elaborative and receptive discussion of EA topics with the business counterparts and agile teams. In fact, it was stated that it could be even ideal for the architects to receive a kind of trusted advisor status in the in the eyes of the business owners and agile teams. Once a good relationship has been established with the immediate stakeholders the need for EA governance or processes around it would decrease as business counterparts would contact architects by default whenever they wanted to change IT landscape. It was emphasized that collaborative process is many times the best remedy for business and IT counterparts to harmonize their efforts. Typically, the better participation from both the business and IT, the lesser there are big surprises at the later stages of the development and the lesser the two parties need to argue on objectives.

"I think the most efficient one would be to build actual relationships with the people so getting a good relationship with the key stakeholders in your domain or an area as a person. That way when they hear about something, they know that I wanna contact this familiar architects." (C3)

"In practical terms, I don't know how persons really come together, but we do have a very good connections to each other and we know each other. That is one of the essential points as well that we know who we should contact. So for example if a value stream architect would have a requirement, he would know that OK this lands to our value stream area and he would need to discuss it with value stream lead, but he should also be able to give a heads up to supply chain manager, and to also review it with her." (U2)

While the previous two enablers, communication and collaboration, referred to the more interactive and social aspects of EA work, the third category, *coordination platforms*,

refers to the various mechanisms and forums, where the actual architectural discussion and realization can take place in the organization. Indeed, since agile development in the company today relies heavily on informal and remote communication, sufficient coordination platforms are seen integral in coordinating the EA work.

The category comprise *architecture board is forum for EA governance*, *weekly CoE call as an EA governance forum*, *cross-team meetings coordinating EA work*, and *platforms for coordinating EA,* which are all regular communication channels known and attended by everyone in the EA community.

Architecture board is a forum for EA governance (C2, C5, C7, C8, C9, C10, U2) refers to the monthly meetings, where architects and immediate architecture stakeholders discuss about architecturally relevant new technologies and other IT landscape related topics. It was seen as one of the main EA governance forums utilized by the EA community. Currently, the meetings are kept in a Lean way enabling a sufficient allocation of time to the review topics and discussions on case-by-case basis. Moreover, whenever there is a need to introduce new tools, making decisions on continuing and discontinuing existing tools the board meeting helps to go through the topics on a high level in a way that the whole architecture team and all architecture stakeholders are behind the decision. This practice was decrease surprises and ensure to maintain the architecture flexible, cost efficient and up to date.

> *"For architecture governance we have the architecture board and then the weekly meetings, but then we have other meetings as well like following-up the cost savings and other things." (C5)*

> *"At least if we take a look at our company's as-is, the way we have been addressing EA governance is that we have this architecture board, which is kind of formulating. It is a very good forum to discuss various initiatives and then see how that fits to our current landscape and also from capability perspective what are we going to address and what are we going to solve or improve. So the governance model is good." (C9)*

> *"Yes, I have been participating both the Center of Excellence and the architectural board meetings in a way or trying to participate whenever I can. Those are good mechanisms in place." (U2)*

Weekly CoE call as an EA governance forum (C2, C7, C9) refers to the weekly Central of Excellence call, in which architects and immediate architecture stakeholders can consider and discuss about architecturally relevant topics much like in the architectural board

meeting mentioned earlier. Moreover, it enables a constant alignment and further coordination of any EA related topic within the EA community. Typically, the participant list consists of the core EA team and most of the architecturally relevant stakeholders.

> *"We have these weekly CoE [Central of Excellence] meetings where we discuss and share ideas, get comments from the rest of the [IT organization] teams." (C7)*

> *"We have these weekly architectural Central of Excellence calls where people outside of our team are also invited. It gives also then an opportunity to kind of hear what is cooking from architecture's perspective. Also we are the kind of forerunners that whenever a new thing comes we are the first filter and the first who are involved and then of course if something has been done or something concluded or decision made, we also use the opportunity to share that." (C9)*

Cross-team meetings coordinating EA work (C1, C2, C7, C9, C10, U3) refers to intentional meetings, where nominated stakeholders from different teams take part and work together on EA related topics. On many occasions, it was stated that this is exactly what the enterprise architects and all the different architecture team meetings are trying to facilitate. For example, solution architects are working in their own value streams, but then they also need to understand the big pictures to make sure whether there are overlapping or similar type of activities done in multiple value streams. Thereby, cross-team meetings help provide the big picture. In addition, even the more informal cross-team meetings, such as the 15-minute architecture morning coffee -call, was seen very important in bringing sense of clarity, unity and reassurance in EA related issues, but also in general.

> *"Coordination of developments in cross-team meetings is definitely very important unless we want to go into silos again. Even in an architectural level it is easy to get siloed in your own value stream." (C2)*

> *"I think architect morning coffee meetings are excellent in my view as lot of things are popping up here and there and it is a very good format not to deeply discuss but just to raise awareness like drop something into to the common knowledge that I am dealing with this and I feel the pain, or I have challenges, or I need your input or support so let's come back to it at a certain point to discuss it deeper." (C9)*

"I would say that one of the reasons why cross team meetings are important is that people are pretty busy and people in development many times are bit maybe introverted so their primary instinct is not to connect with someone else to start solving a problem. They probably would try to solve that by themselves first and therefore it's good that the organization helps them." (U3)

Platforms for coordinating EA (C2, C3, C7, U3) entails the currently used platforms, where EA work can be broken down into manageable parts. Indeed, it was stated that the development visualization tool, Jira, was integral in facilitating not only the entire large-scale agile development model, but also the EA related work, such as non-business-driven architectural work. In addition, it was noted that the Yammer group created by the architects could be a good way to promote and raise awareness of EA related topics within the whole organization in the future.

"For example, what we have done in Jira basically is listed all the developments we are doing so even though you were not involved in there directly you can at least see what is happening there. Then if you need to know more you can contact the persons responsible and ask for clarification unless they already contacted you." (C2)

"We also have the yammer group kind of lowering the barrier to engage with us the architecture team and it could be used more in the future." (C3)

4.4.2   Lean EA

The second aggregate dimension of EA enablers, *Lean EA*, entails a conceptualization of EA approach that would currently be most fitting in supporting the large-scale agile development model. Moreover, a Lean EA can be seen as a key enabler to steer the enterprise in times of major disruptions, such as the ones mentioned in the section 5.3, but more importantly to gain the benefits mentioned in section 5.2, such as organizational agility. All the Lean EA enablers and data extracts are depicted in Appendix 4. The Lean EA enablers are divided *into EA visualization and tools* and *Lean approach* as they are key factors enabling EA benefits.

The category labelled as EA *visualization and tools* comprises *a clear documentation process* and *EA documentation tools*. Indeed, it was observed that a clear documentation process supported by common documentation tools enable and ensure a more systematic management of EA related objectives, such as capability mapping.

Lack of documentation and application inventory caused by people changing their job roles, leaving the company and lack of time were seen as major impediments of EA. Therefore, *a clear documentation process* (C2, C4, C5, C8, U2) emerged as an enabler to secure sufficient documentation and knowledge transfer. Moreover, instilling documentation into the agile development process was seen improving information availability for stakeholders regarding EA related objectives, principles and guidelines as well as providing visibility on system dependencies and relations. In addition, it was highlighted that the only way to manage, for example, these system dependencies is to do the architecture work properly. More concretely, this means that there is a clear documentation processes in place to capture the EA related activities and to share the EA related documents – namely principles, EA artifacts – to the EA stakeholders.

> *"The better the sales and the handover is documented and handled from a process perspective the easier it is to sell something." (C4)*

> *"How it ideally should go is that we wouldn't have some separate bookkeeping process but once we operate in the process the books are kept up immediately. So the processes are made such that the information documentation is updated automatically… If documenting is not part of the normal way of operating, someone is always coming with a new request and people immediately delete the email because they are already 110% occupied with the new case." (C5)*

> *"No matter how many times we repeat, inform, and tell and we wink, someone is still not knowing anything, because there is no time to read or listen or they are thinking that 'OK, it is not for me at all'. So having the principles, having those documented and having them also repeated in every now and then, because I assume that it is something we still need to keep active in the forums in order to increase the EA awareness." (U2)*

Like documentation process, *EA documentation tools* (C1, C2, C3, C5, C7) enable a better visualization of the IT landscape. Most prominently, with EA tools like Ardog and QPR architects can approach EA related topics from value stream, capability, technology or market area perspective and shuffle around the whole IT landscape. Indeed, it emerged that EA tools help formalize and concretize the way architecture work is done today.

> *Ardog tries to list all the different aspects of architecture applications, application platforms, integrations and basically also information, conceptual*

term definitions and capabilities. In addition of modelling these separate en-
tities it also depicts the different relationship between these… Business pro-
cess diagrams, conceptual models and logical data models can also be man-
aged in QPR [a process modelling software] and that can be debated whether
it is an architecture deliverable or not, but at least architects need to be in
involved so that we can make sure it is aligned with the applications and data
flows. (C2)

"A good concrete example is the Ardog, which is a good practical way to
ensure that we are aligned in this EA landscape overall very well because it
is documented there from many different point of views… In addition, in in-
tranet, this architecture website, we have also guidelines and principles visi-
ble for everyone." (C3)

The category labelled as *Lean approach* comprise *just enough governance* and *early*
enough planning, which both refer to a emerged mindset and way of working, where the
role of EA is to focused on supporting the agile development by not becoming a burden
to the agile work flow, but rather enabling it. Moreover, a more progressive view on the
EA governance in agile environment was that EA should seek ways to enable local and
lighter decision making rather than pushing a heavy governance mechanism that would
cause EA to be a bottle neck in the development process. Indeed, it was viewed that EA
governance actions should be in proportion to the risk or benefit expected from a given
development initiative.

It was discussed that, if the agile teams would run every decision through a governance
board higher up in the chain of command, the development wouldn't be agile. Therefore,
it was highlighted that having *just enough governance (C2, C5, C6, C9, C10, U1, U2,*
U3) and placing trust in the agile teams enable agility the best way. Moreover, a well-
proportioned governance, which put emphasize on urgency, scheduling and resource mat-
ters was seen as an enabler for speeding-up the development process and prioritizing EA
work. Moreover, it was suggested that mandatory checks to agile development would be
a way to formalize the currently informal governance touchpoints.

"We operate with agile teams cross-functionally and they need to be able to
make the decisions day-to-day in their own work so they need to have the
freedom as much as possible to do decisions, but they need some guardrails.
So you have to have some guardrails to sort of direct what kind of choices the
development teams can make. Of course, the development makes the deci-
sions, because we can't even talk about agile and boards and committees
making the decision on the same day. The decisions need to be decentralized

to where the information is and where the work is done. This is just lean and agile 101.” (U1)

“I think that enterprise architecture is one of the key enablers in defining the way forward… we have the mechanism there, because on the other hand we cannot have too heavy governance and too heavy meetings, but the board one, I think that resonates quite well and it's very structured.” (U2)

Similar to just enough governance, *early enough planning* (C1, C2, C3, C4, C5, C7, U2) emerged as one of the EA approaches that streamlines EA work in the agile development model decreasing the need for EA involvement in the latter stages of a development. Indeed, a general view was that architecture work should be ongoing at the backlog level and that architects' involvement in new initiatives should start as early as possible. A common statement “the earlier, the better” was highlighted as the most fitting approach to EA planning. Moreover, mast participants concluded that in the SAFe program increment (SAFe, 2021) the most critical time for architects is the pre-planning phase, when architects make sure that the most important designs and guidelines are already established and that the teams can start working on the developments without interruptions.

More than the PI-planning I have found value in the pre-planning, because planning is chaotic and it is chaotic for a reason. It is time constrained for the fact that you don’t over-plan or you don’t actually create a waterfall project out the agility that you are supposed to have. I have seen that you may have very beautiful Jira boards and all this and that and all participating but without proper pre-planning you spent 3-4 days explaining the fundamentals and working with the fundamentals and not getting beyond anything. (C4)

“I think from the MO [Metso Outotec] point of view the month before PI-planning is the critical time, because then we are preparing the epics, Lean business cases and we have the value stream steering meetings. So one month before the actual planning for the big things for the next three months.” (C5)

4.4.3   EA Culture

The third aggregate dimension of EA enablers, *EA culture*, entails emerged ways that help raise EA awareness and speed-up the evolution of EA maturity within the organization. Moreover, development of EA culture, enables shared ways of operating the SAFe development model as well as a sufficient way to incorporate EA related responsibilities

and knowledge into the daily way of working. All the EA culture enablers and the data extracts are depicted in Appendix 4. The EA culture enablers are divided into *EA education* and *extended EA community* as they contribute to the building of EA conscious culture.

The category labelled as EA *education* comprises *building an EA conscious culture* and *creating autonomous teams.* Indeed, it was noted that education and active promotion on EA related topics would remove some common pitfalls that the core EA team faces on the large-scale agile model, but also outside of it. Moreover, once the organization becomes more aware of the benefits and importance of EA discipline, EA can be then scaled and fine-tuned to further support the development model and most importantly better support the future business visions.

Building an EA conscious culture (C1, C2, C6, C7, C10, U3) emerged as an important enabler to raise EA awareness, especially among the business counterparts. Currently, there is no clear intention to promote or educate EA benefits as most of the communication between EA and other stakeholders is very subject matter and development focused, namely, providing EA guidelines and principles to the teams. On the other hand, it was stated that education about the importance of EA could be established by being active in SAFe ceremonies, which consist most of the EA relevant stakeholders, and making use of the "15 minutes of fame" time slots allowed to each architect there. Moreover, it was concluded that most architecture communication is changing the mindset of stakeholders, namely business counterparts and teams, towards a more future-proof thinking.

> *"It is important to build the culture and change the culture to kind of have a more architectural mindset among everyone who is involved in development initiatives and having that kind of mindset of look at thing from different point of views." (C1)*

> *"We cannot ensure EA compliance and it should be architects' that are ensuring it in a long run... EA should be non-authoritative and softer in a sense, otherwise it is not organizational capability, but it is just individual capability of that single architect and it doesn't scale and the same applies to any maturity right. So if we are solving the same problems all the time, then we are all in away screwed." (C6)*

> *"This architectural communication is maybe to educate the decision makers and the stakeholders that these are the fundaments in our architecture and this kind of capabilities are being built… so to instill this kind of more product mindset instead of always them coming up with a new piece of software that solves this sub-problem, but it doesn't solve me anything else." (U3)*

It was highlighted that once the agile teams are informed about the architectural guidelines and principles, architects should give trust and freedom to the agile teams to carry out the execution by themselves. Moreover, it was stated in this way the team members would comply with the EA principles more easily. Moreover, this would also save time from the architects enabling them to put more focus and time on the future development initiatives. Hence, *creating autonomous teams* (C1, C4, C8, U1, U3) emerged as an important enabler facilitating EA work, especially in hectic and time restricted periods. Indeed, in an ideal situation it is not the architects reaching out to the agile teams, but the agile teams reaching out to the architects, whenever there is a need for architectural considerations.

> *"Focus on creating successful teams and most of the work is done." (C4)*

> *"If you were to have the teams do something and then submit their work to some architecture board then rate their work and send it back well I might think that might be slowing us down. Instead, establish those guardrails, continually sprint by sprint coach those teams, communicate to the teams what the architectural guardrails and principles are and you get much better result. Maybe you don't even need the board after that… In addition, then the development would be faster too." (U1)*

> *"The autonomy comes from that we really trust that the teams know what they are doing and they get the freedom to operate how they see best." (U3)*

The category labelled as *extended EA community* comprise *core architecture team, sharing EA responsibilities with stakeholders*, and *additional business architects*. Indeed, it emerged that the core architecture team shouldn't be the only one waving the EA flag in the company, but rather that architecture related objectives and responsibilities should concern everyone from the business counterparts to the lower agile team members.

   Core architecture team (C1, C2, C8, U3) refers to the IT architecture team, led by the IT architecture manager, which is responsible for most of the EA related work in the IT organization. A general opinion was that the existing team line-up of 3 enterprise architects working horizontally cross value stream and the 6 solution architects working vertically in a value stream specific domain is sufficient and capable of operating the EA activities in the large-scale agile development cycle, regardless of the periodical rush hours. Moreover, the diverse skillset and knowledge of the individual architects were regarded as one of the key enablers supporting, for example, the activities needed to extend the architectural runway mentioned in Section 4.1.3.

"I would more or less rely on the existing team spread-ups. We have few enterprise architects that are cross value stream architects working on specific layers of EA like applications, information or processes so they are the horizontal layer in the architecture and then we have the value stream specific solution architects which is the vertical element in the architecture. Solution architects basically convert business requirements and capabilities into architecturally sound solutions, which these agile teams can implement, and architects are making sure that its according to our architecture principles and hopefully aligned with a vision." (C2)

"I think we are getting there and the good thing is that we have the nominations now done for the solution architects like in each value stream so it helps that everyone knows that if they need architectural support they always know who to contact and of course we solution architects also utilize the support from enterprise architects whenever that is needed." (C8)

Currently, there are 10 nominated architects, who are supposed to take care of more than 200 active development initiatives and an estimated 600 applications and systems in the IT landscape. Hence, a sensible notion was made that the architects alone shouldn't take full responsibility of each solution and development initiative coming through the development backlog. Hence, *Sharing EA responsibilities with stakeholders* (C2, C3, C5, C6, C9, U1, U2, U3) was seen vital, especially, in enabling Lean EA approach mentioned in Section 5.4.3

"At least I am trying to involve as many SMEs [subject matter experts] as possible in early day or early levels, because I can't be and none of our architects can be an expert on all the tools and all the aspects that we are kind of responsible for." (C9)

"In the future we shall also invite to those calls [architecture board meetings], for example, the applications team leads to share the information, and then trying to really involve them when their area of topics is discussed, because they really need to understand and be following there. (U2)

I think it's always business that is important in facilitating EA work as they bring in their needs and then there is most likely also the development teams that again look at the ways we can implement certain things and subject matter experts participating. Of course, there is a lot of subject matter expertise in the architecture team, but no one can manage it all. (U3)

Architects are confined in the IT side too often, while they can create a bigger impact on business transformation initiatives. Therefore, it was stated that in the future there could be more nominated architects within or across a value stream, such as an aggregate value stream architect, who would be focusing solely on the domain in the business and the architectural requirements they have. Indeed, *additional business architects* (C3, U1) were suggested to be the first responders at a very early stages in the business organization making sure that any major development idea preparations would not go unnoticed by the EA umbrella. Moreover, this would also help with the case of architects' seen as the party-stoppers and the typical disconnection of business and IT as EA preparation would start already at the idealization phase of any business requirement.

> *"In this agile way of working to better manage the architectural governance would be to almost have kind of cross value stream chief architect looking at the different things, because currently we have only solution architects within the value streams and they work in their own lanes. So if we want to look at the overall, I think our IT architecture manager is kind of doing it now in his role in these architectural meetings… but that still doesn't take into account all the other things we are not involved in like local IT or businesses, because they do their own decisions without having us involved." (C3)*

> *"Maybe we should have real business architects, because now we have this interface between the business and IT so there are things that the business does and there are things that the IT does. The business requests things from IT and IT delivers things to the business. Why should it have to be this client–vendor-relationship? We all know that nothing would happen in the company if there were no digital IT solutions. Why do we still have to have a separate IT organization? So maybe we should left-shift our understanding of architectural competence also to the business well before they bring us these ideas so that they can already start the architecting themselves." (U1)*

5   DISCUSSION

5.1   Key Findings

The enterprise architecture function utilized by the case company were more or less in line with the guidelines and best practices recommended by the literature and industry experts (Leffingwell, 2007; Hosiaisluoma et al., 2018; Mega International, 2021). Regardless, a relatively recent merger and an adaptation of a new development model was seen as a major hinderance in the organizational transformation. Hence, the maturity of EA was observed to be at the earlier stages of the evolution.

Enterprise architects and solution architects don't have a fully formalized way of using EA deliverables in architectural work nor are they defined in the large-scale agile context. On the other hand, there is a clear consensus on the deliverables that the EA team are and should be providing to the stakeholders in the SAFe model. For example, the concept of architectural runway was not used by all architects, but it was perceived important in the future as the maturity of the EA evolves.

Key finding 1:   *Typical EA deliverables used in the company are business objective deliverables, intentional architecture deliverables, and emergent design deliverables.*

The current literature on the benefits of EA in scaling agile was perceived unreliable and too vague. Therefore, an emphasize was given to the participant, who were considered experts on their fields and knowledgeable sources of information. Furthermore, as cultural and social factors usually play a role in the daily operations of the organization, participants as active members of the organization were considered reliable observers of the benefits and concerns related to EA.

Key finding 2:   *Typical EA benefits identified in the company are organizational agility and organizational robustness.*

Key finding 3:   *Typical EA concerns identified in the company are immaturity, disengagement, urgency, and resistance and anti-patterns.*

Applying the Lean EA approach in the SAFe development model, and outside of it, was found to be major enabler on many facets of EA. Not only does it address directly the various concerns related to EA today, such as urgency and reactive mode, but is also enhances the benefits in the company, namely organizational agility and organizational

robustness. By incorporating the thinking and principles of Lean EA, based on the Lean EA development (LEAD) by Hosiaisluoma et al. (2018), EA is no longer seen as "bad police" in the agile cadence, on the contrary, an enabling force that can speed up the development process while maintaining a long-term strategic mindset.

Key finding 4:   *Key EA enablers identified in the company are communication and collaboration, Lean EA, and EA culture.*

5.2   Limitations and Future Research

The presented study has several inherent concerns, although they are not uncommon in other studies. During the research it was observed that some of the topics related to EA, namely benefits, might be observable only after a certain amount of time has passed. Much like in the literature, it is difficult to firmly prove whether a particular observed phenomenon is a direct result of EA, and not an occurrence of some other external influences or actions made in the past. Moreover, architecture is not a one-time judgement, but a continuous practice. Similarly, it should be considered that this interpretative research is mere one-time pictures capturing EA related practices from a specific time and unique situation.

Secondly, the fact that the company had merged relatively recently meant that most of the experiences that the participants had about EA was from either side of the company. Furthermore, as the former companies, Metso and Outotec, had somewhat different EA functions previously it is not possible to generalize the emerged views on EA into one, but rather it has many standpoints. Nevertheless, as the company, EA team, value streams and agile teams move now in one direction the result provide important insight on the concerns and opportunities that await ahead.

A literature review by Kotusev (2017) has concluded all the topical EA related research themes according to their lifecycle in the EA domain. Although some essential themes in this research, such as *EA benefits* and *maturity,* have emerged relatively long ago and interest to them seems to be declining, other themes are still relatively new and interesting for future research. For example, themes related to this research, such as *EA culture*, *virtual enterprise*, and *EA in different industries,* have either emerged relatively recently or research on these topics is currently missing altogether.

6   CONCLUSION

This research presented a case study carried out in an organization applying EA practices in scaling agile. The goal of this research was to explore the way EA practices are used in a company scaling agile with the following questions:

RQ1 How are enterprise architecture (EA) activities put into practice in organizations deploying large-scale agile development?

> **RQ1.1** *What are the typical deliverables of enterprise architecture (EA) practices in a company deploying large-scale agile development?*
> **RQ1.2** *What are the typical benefits and concerns of enterprise architecture (EA) practices in a company deploying large-scale agile development?*
> **RQ1.3** *What are the key enablers of enterprise architecture (EA) practices in a company deploying large-scale development?*

Furthermore, the goal was to confirm that Lean EA can enable organizational agility in a company like was suggested by the literature (e.g., Foorthuis, 2017; Hazen et al., 2017; Pattij et al., 2019; Pattij et al., 2020). In total, 13 semi-structured interviews were carried out within a case company deploying large scale agile development (SAFe). In addition, the Gioia method (Gioia et al., 2013) was used, data was transcribed and analyzed. As a result, knowledge about EA deliverables (business objective deliverables, intentional architecture deliverables, and emergent design deliverables), EA benefits (organizational agility and organizational robustness), EA concerns (immaturity, disengagement, urgency, and EA rejection and anti-patterns), and, EA enablers (communication and collaboration, Lean EA, and EA culture) were identified, all of which can be utilized by the case company in their efforts to improve EA practice in the future.

In addition, literature review provided some theoretical constructs and ideas, namely Lean EA development (LEAD) method proposed by Hosiaisluoma et al. (2018) and design principles of architectural thinking for supporting organizational agility by Horlach et al. (2020), which can be applied in the case company or any other organization scaling agile. In conclusion, applying a Lean approach to EA can be viewed as a promising solution to provide best of breed results in a large company scaling agile methods, most prominently, enabling organizational agility.

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APPENDICES

Appendix 1. EA Deliverables and Data Examples

Code	Partici-pant	Data Example
Modelling capabilities and product life cycles	C1, C2, C4, C5, C7, C8, C9, C10, U2, U3	"I like to tackle these [EA] topics basically more from a product perspective. I look these capabilities and the product life cycle. So creating these capabilities is basically creating a product and it's not all about just taking care of the product when you build it since it needs to be taken care of while it is been build and after it has been delivered and maybe also when you want to upgrade it and you don't move it back to the garage. So I basically try to always think more from a product lifecycle management, not the PLM domain but more like IT product services." (C4)
Epic portfolio and development portfolio guidance	C1, C3, C5, C9	"In the [SAFe] agile development, where you have an epic, where you have a busi-ness case, where you have an idea what we are doing and why we are doing and when we are handling that it is a plan basically. We evaluate the tools, we decide the tech-nologies and so on and there we do certain architectural work on which systems we use, which technologies we use and how the data flows basically… The as-is pictures, for example the application portfolio, are also important here, because if you have a future state then with the two you can pave the path." (C5)
Deducing high level vision into executable parts	C7, C8	"It is a kind of a combination of doing that long-term vision and strategy planning and identify the future capabilities or the future enablers that we need to have… but then once identified then we of course need to turn that into executable parts and build the roadmap in a way." (C7)
Taking care of the big picture of the technical	C2, C6, U1, U3	"There are a quite a few. I would say that we have been doing a lot lately the big pic-ture managed in power points, which tries to explain the world. There the idea is to show the business pro-cesses application, information flows and possibly functions and people so how the company works, how the machine works. It is kind of an ambitious way to explain the enterprise architecture in one glance." (C2) "I think the big pictures have been really valuable in just creating the sense of com-plexity… Sometimes developments are pretty

		small, sometimes big, so the guys show from the big picture that what is influenced so they communicate what is the complexi-ty and what are the parts that need to change." (U3)
Roadmaps and user journeys	C3, C4, C8, C10, U1, U3	"Well, the roadmaps I see, when I am in discussion with the higher-level people, for example, in supply chain… So it is im-portant to visualize the landscape and then like rationalize the ongoing and near future smaller development with those guys, that is something roadmaps are useful for." (C10) "I personally like a lot the user journeys that our [project busi-ness and ETO solution architect] has been using and others as well. That is really the way to explain, what is actually the need. If you come and explain that we need this and this system, this and this component and so forth, you go to really deep waters. You sort of lose the audience immediately, because not every-one knows exactly the technical details. So you cannot approach the stakeholders through complex technical jargon. You need to somehow clarify, what the actual users are seeing and doing, and user journeys are very nice for that." (U3)
Reference ar-chitectures, best practices, and guidelines	C1, C3, C6, C9	"We use common guidelines on how certain things are done and try reuse certain capabilities, systems and applications and so forth." (C3) "For the infrastructure side this kind of reference architectures are very important. In general, when you are doing mass items that is the idea and in some cases I like to reference that we were at the simplest terms crushing rocks, taking a big rock and turn-ing it into a smaller rock, so we shouldn't be redefining some of the most advanced infrastructure items on the IT side as it is not our business…. That is why I think the reference architecture and best practices in the industry are super important." (C6)
Defining and providing ar-chitectural principles	C1, C3, C5, C8, U1	"We have also on some level these kinds of architectural princi-ples that we then share with all the development teams that at some levels are quite detailed." (C1) "What I often do is refer to the architectural principles. So it doesn't matter whether it's short-term or long-term objectives. Speech is cheap and it is good to talk, but I also like to have somewhere a thing [architectural principles] where I can go back and kind of anchor my thoughts into. That is one artifact I often go back to. So, if we don't have a particular long-term architec-tural objective, it might be that everything is micro-service

		based, loosely connected or everything is by default mobile free, everything is fit-for purpose and cost-effective." (U1)
List of applications, data models and integrations	C1, C2, C8, C10	"There [in Ardoq] we should have the full list of applications that we have in use and some sort of description on what they do and what business capabilities they support and so on. Furthermore, from data point of view the documented integration architecture was seen integral in bringing visibility to the API platform, which is a cornerstone for many of the business applications used in the company." (C1) "Also the other one relates more on the integration architecture, so what do we have there on the API platform, and what are the connections, especially, from the data point of view. Data is usually the one thing that application and business unit need, and if they don't have it in that specific application they use, they need it from somewhere else, and that sense it is kind of a key part of my role as well." (C8)
Extending and maintaining architectural runway	C1, C2, C4, C6, C7, U1, U3	"So to me the that is the architectural runway that you create the reusable components by looking at the bigger picture… Another good example is CIAM [customer identity access relationship management]. Once you have the customer identity, we are able to open a lot of things to them without creating a user identity for each and every system." (C4) "So when we have this kind of architectural runway or road map that is how the teams get there. They don't need to wait for anyone to come to them and tell how things are done, but the runway is made for them, so they know what are the components and they know the big picture so they can then very efficiently focus on the development. So this applies also for the larger point of view. As teams work together of course they need this bigger picture as well and that's where the organizational agility comes into play." (U3)
Non-business-driven architectural work	C5, C8, C10	"I think the API platform is probably a good example of this kind of activity-based def-inition that the one we build can be used as a basis and enabler for the other coming activities as well. So it is kind of building on top of the foundation and start adding on that when you have a good bases there available." (C8) "Yes, I think architectural work can be prioritized and I think it should be, but in a way there are different levels, because we need to do this non-value-adding architectural work basically

		and our internal work that later governs our business better creating this enterprise architecture." (C10)

Appendix 2. EA Benefits and Data Examples

Code	Participant	Data Example
EA enables flexible connection of developments to strategic themes	C2, C3, C7	"If the architecture is done well our applications and solutions are easier to integrate providing better value. Reporting capabilities should be much better, because technically then you can combine all the data. So drill down to different dimensions. I think IT should be quite cost efficient with good architecture and we have flexibility to change the architecture, whenever we have major disruptions like strategy changes, acquisitions, divestments and so forth." (C2) "The architecture work basically makes sure that we are taking that long-term view in planning and take the kind of holistic view as well. So that is the key, because agile by definition should be business driven or driving towards concrete outcomes in an agile and quick way, but that means that there might be an inherent risk of silo-thinking and optimization on a smaller scale that is not actually benefiting the whole corporation in a way. Architecture work can sort of help connect to a bigger context and make sure that there is a connection to the long-term benefits and that we are going to the right direction in the long-term…So if there was a clear strategy and vision behind all the development that is done in the agile sprints or PIs then that might enough at it is, but I don't think our maturity is there yet so we need to have architecture to make sure that somebody considers the big plan and the long term and the connection to the strategic themes for example." (C7)
EA enables scaling up	C3, C6, C7, C8, U1, U3	"If the initial proposal is too narrow or too big, architects can scale it into the right perspective." (C6) "Enterprise architecture helps with cost efficiency, leverage synergies, benefits of the scale and how do we scale up, support the business processes better with the IT landscape. The 'how' do we make the IT landscape more scalable and efficient, 'how' do we come more agile." (C7)

IT asset reusability	C3, C4, C8, C9	"Very classic example in our case was the transport management solution. Someone just came to us and said 'we are going to use the oracle transports management system' without thinking that we don't have any Oracle support capability in-house which means that one FTE [full-time equivalent] needs to be hired 100 000 euros per year to the company. Of course, that is not there in their [business's] TCO [Total cost of ownership] calculation, because to them they just buy the tool. So, then what turned out happening was that based on good architecture support to them we agreed that we will actually use transport management from another platform that already exists. So that platform already had that capability and we just plugged the switch on the transport management capability, instead of now creating a new technology expertise in house, getting new consultants from a new company that we have never work with before to develop this Oracle based solution, we can now use the existing expertise from our supplier to develop that. So that is the value we create." (C4) "All companies go through this efficiency improvement in demand which basically means various harmonization aspects. So, one BA [Business Area] or one function has been using other kinds of application sets and the other ones have been using totally different and then we never had this kind of company level overview that what are the tools that we have in hands that can be utilized; are there commonalities at least in the demand; can we utilized something in common; is there anything that the best practice could be enlarged to in a wide extent. So, that is where EA is very helpful." (C9)
Faster time-to-value	C3, C6	"You can get a bigger insight from us than when trying to figure out on your own and it is supposed to be more holistic so they save time by going through us even though it takes time to go through us at the end of the day." (C6)
Reduction of technical debt	C6, C7, C8, C10, U3	"One key point here also is to minimize or reduce the technical debt so if we would keep on doing point to point integrations it would increase the amount of work and technical debt." (C8) Businesses are still scattered, but then all the processes and the systems in IT landscape they are very scattered and corrupted, and we put a lot of effort for those topics and the architecture is only way out of that situation. (C10)

Cost effective IT landscape	C2, C3, C4, C5, C9	"I think first of all to ensure that everything we do in IT is cost-effective, so that we give common guidelines on how certain things are done and try use reuse certain capabilities, systems and applications and so forth. So cost-efficiency or effectiveness is clearly one… so we do things effectively from a cost point of view but we also can then provide solutions and answers to the questions that business is looking for." (C3) "I am a firm believer that when we buy ready-to-use platforms, let say Salesforce, dynamics, SAP, those companies have spent decades and probably billions developing what is there in the product. So business often forgets that they are paying 50 euros per user per month to use the things that are in there. So I like to remind the users and myself that if we use best of the class solutions, how do we use them to the best of our advantage based on what we are paying lets Salesforce to do… so I say we let Salesforce, Microsoft, SAP do the hard work and we should be wise enough to see how we can utilize that." (C4)
Visibility to the past and the future	C8, C9, C10, U3	"I think our main goal is to make sure that we have a long-term view and that the decisions we make today regarding certain application and IT related question have long term kind of stability. We have the visibility on the long-term so that the decision we make today are sustainable and can be used and managed in a long run…. On an organizational level I feel that we have been able to gain some visibility on our landscape, which in a way sounds a bit naive, but we have been able to put the visibility into place, and we have now some kind of nucleus for the future development." (C10) "It comes back to data I guess so if you want that the organization has the visibility of the things that happen and they can collaborate efficiently, this is this something that we need the enterprise architecture to support. Otherwise, it's just impossible to maintain the number of systems that need to work together." (U3
Breaking down silos	C1, C2, C9	"Most important benefit is that it [EA] gives kind of a helicopter view of the whole enterprise and breaks it down into smaller manageable pieces…It also helps with prioritization and connecting the dots, which can be completely outside of certain function and which might otherwise be totally unknown…That's why we are here to bring visibility to them." (C9)

Ensuring security matters	C3, C5, C6	"Then of course security related risks if we think about those without like having architectural work the security related things might not be considered… I always involve our or have been fortuned enough to have this security and compliance assessment team. So I always involve them from the very early stage, when we initiate the new requirement and ideas so they are part of the planning and thinking from the very beginning." (C3) "If you involve us in the planning events it should be the quick cart that there is somebody who is thinking about, who is involved, and do we have everybody who need to be involved. If the event is not planned holistically enough then architects probably will say something by doing x and changing an office in y and that kind of stuff and that is why you should involve architects early on… Architecture work is sort of same as security." (C6)
Future-proof development	C5, C6, C8	"For infrastructure side I think architects are used to validate the designs so even though the decisions are not made by architects the decision makers want some reassurance for projects and I think that is fairly important to ensure that there are people who have a little bit of more time to reflect it from distance." (C6) "EA gives us a good basis for developing things and ensuring they become future-proof. If there is no architectural consideration the app integration would be kind of whatever and it would only create more mess." (C8)
Providing competitive edge	C3, C4, U3	In our business it is very profitable to actually deliver services, because first of all you have the product knowledge, then you have the actual margin rate quite good as well, so it is very beneficial then in my area to bring in the broader view. (C4) From my standpoint enterprise architecture is part of being a modern company providing the capabilities that modern business needs and to really compete in the market...It is also a cost matter. We would easily come up with much more systems than we actually need so it is a dialogue between the architecture and the rest, but it is essential part in becoming competitive. (U3)

Appendix 3. EA Concerns and Data Examples

Code	Partici-pant	Data Example
Immature formalization of EA work	C2, C6, C7, C9, U1	It's not clear whether architects should be more proactive so clarifying everything with all the teams so that you know everything that they are doing or should we be more like service organizations that whenever they need us they call us… Also when you are involved with a multiple open cases they eat up your time and energy. Architecture thinking takes time and iterations and when you are interrupted you might have to start over. (C2) A lot of people have asked me what it is that the architects do and sometimes even the architects themselves have asked me what it is. So for example when architects review of an epic is required what exactly does that entail, what exactly like with big E? Is it review of which aspects of the proposed development or security? Obviously that it matches or follows the architectural principles. Well, that makes sense, but what else? It is fairly grey area what the architectural work is and, in my opinion, the best architectural work would be to established by providing those guardrails for the teams. So that would breed the best benefits. (U1)
EA and agile incompatibility	C1, C2, C3, C5, C6, C7, C9, U2	Somehow my expectation was when we moved to the SAFe that it would remove these silos. I mean we had those silo effects also in Metso side doing the projects, but the SAFe kind of promise was that it would remove the silos and that there would be clear visibility into each other, but we still run each value stream as its own show… and I feel the pain of many of my colleges when I look at their portfolio boards that are so filled up because of the structuring we have in place. It is very unbalanced. (C3) The only concern in coordinating development in cross-team meetings is that it takes time from the calendar, so it eats up resources. So there needs to be some sort of balance how much we do it. Regardless of how much we do it is super important. (C7)
Structural silo persistence	C2, C3, C4, C6, U1	"I would say that whenever you are creating the organization and operating model there are silos." (C2) "The reality is that we have far more operational value streams than we present, because the product portfolio that the entire group has, the 5 businesses, there is a vast amount of different

		types of products and services, and value streams for those are all different. So, we probably have tens or probably close to hundred different types of value streams and only a bundle of these archetypes, like standard product and parts. That is oversimplification, if you really want to understand. That is why the job, for example, of our value stream architect is almost impossible and I am also close on the borderline of impossible, because the scope of this one area that we call standard products and parts is so large with tens of different value streams." (U1)
Unclear stakeholder engagement	C2, C4, C6, C10, U1, U2	"Even though the CoE [Central of Excellence] meeting is customer focused, this is now stretching a little bit, I think it isn't directly coming from the customer. We always have somebody interpreting the customers… and I don't think we truly get all the way back to the customer. So we have quite a good circle of critical people to produce the value, but some of the critical pieces on the demand side are still missing." (C6) "The main concern here let's admit when we are now running our development and business in agile way on a SAFe model is that we have huge missing peace there. We have the architects there in place, value stream engineers and business product owners and so forth, but what we are now missing from the IT side is the product owners." (C10) "We still have these review boards and even the CoE (Central of Excellence) that we run, if you have noticed, it is mostly consisting of architects and value stream leads, but where are the product owners and the development team members?" (U1)
Insufficient EA compliance follow-up	C1, C2, C3, C5, C6, C7, C8, C9, C10, U1, U2	"These qualitative measurers on architecture, like how good designs we make and how well we do, these are really challenging… First of all, architectural governance must not only relate to SAFe, but it must also relate to all the development which are outside SAFe" (C5) "Unfortunately, we don't have the time to maybe allocate the amount of time to participate in the so-called execution or roll out of the solution and to see how it all works and whether the benefits have been realized." (C9)
EA in a reactive mode	C1, C2, C4, C5, C6, C9	"I think the challenge is that the long-term vision is missing as we are very hurried to take the next step without actually realizing if it is in the right direction. We just take the next step and we are self-correcting ourselves later." (C4)

		"Maybe first is the speed. Everybody is pushing for the new thing instead of doing things properly, so that it would be scalable or serve as the foundation for the next step and you just put something together fast and off you go to the next thing. And that kind of leads to a high maintenance cost and technical debt." (C5) I have to admit that at the moment we are really focusing on burning topics and the definition done is coming very quickly for us. (C9)
EA seen as the bad police	C2, C4, C7, C9	"I'm sure that business feels that architects are always slowing down things when well-thought-out development proposals are stopped, because architects want, let's say, re-evaluate everything… so business things that things would move faster without the architects." C2 "So often IT and architecture are seen as the bad police by business, because they see us disruptive… and why do they see us disrupting? Because we focus too much on making things right now while thinking of the future roadmap but not actually explaining to the business why we are doing that." (C4) "What I have been having challenges with is to kind of explain this capability and the link to the capability model to our business counterparts… most of the time they understand but they say, 'hey it is very nice kind of sales or marketing speech, but how will you solve my problem?', and that takes a little longer to explain." (C9)
Negligence of integration architecture and master data management	C3, C7, C8	"I mean from year to year, month to month and day to day the master data issue comes up. I mean that's probably not only MO [Metso Outotec], but clearly one of these anti-patterns I see reoccurring every time… We have this data but the quality is really poor or it is very scattered in several places. Many times the solutions that we like to use are limited by the fact that there is not enough data or it is not high quality or it's unreachable." (C3) "The other anti-pattern that should have more emphasize is to think more about the data architecture and the data flows and focusing a little bit more on building this kind of integration architecture… and on the importance of data." (C7) "I think one of the things we have seen in the past and somewhat still happening is that there is too much demand for point-to-

		point connections… and the same kind of applies for the application development as well. For example, when the business demands solution or functionalities it should be given more the business process point of view or business demand point of view instead of getting too far in the details on the actual solution itself." (C8)

Appendix 4. EA Enablers and Data Examples

Code	Participant	Data Example
Clear communication enables execution of EA objectives	C1, C2, C4, C5, C7, C8, C9, C10, U2, U3	"Each and every role is important. You can have that person in that role but unless they communicate and coordinate it is as useless as not having that person. So, the biggest thing that people don't understand at SAFe is that they feel that if they implement the model, follow the model, everything is going to work. No, it is them who need to open their mouth and keep their ears and eyes open as well. So in my opinion all the roles are important, but what is more important is that communication and collaboration there, because otherwise if you don't do that you might as well do your own development." (C4) "Well obviously the business feedback is important, which I don't usually receive directly but trough the value streams." (C5) "So it doesn't matter whether it's short-term or long-term objective, speech is cheap, and it is good to talk." (U1)
Continuous engagement with the key stakeholders	C4, C7, C9	"Architecture is not one time judgement; it is a continuous engagement with the teams… I am not a big fan of that every week you should have a meeting. It is about more like a common constant pulse, where you press the gas when you need to, you press the brake when you have to but the point is to move at the right pace. So, I would say that it is more like a continuous engagement to ensure that things don't go out of let say the groove in the sense." (C4) "It is important that the solution architects work in close collaboration with the development teams, at least the product owners, the scrum masters or some sort of lead developer or architect

		working withing those teams. I think that is the first and most important thing." (C7)
Having good relationship with the key stakeholders	C3, C2, U2	"I think the most efficient one would be to build actual relationships with the people so getting a good relationship with the key stakeholders in your domain or an area as a person. That way when they hear about something, they know that I wanna contact this familiar architects." (C3) "In practical terms, I don't know how persons really come together, but we do have a very good connections to each other and we know each other. That is one of the essential points as well that we know who we should contact. So for example if a value stream architect would have a requirement, he would know that OK this lands to our value stream area and he would need to discuss it with value stream lead, but he should also be able to give a heads up to supply chain manager, and to also review it with her." (U2)
Architecture board is a forum for EA governance	C2, C5, C7, C8, C9, C10, U2	"For architecture governance we have the architecture board and then the weekly meetings, but then we have other meetings as well like following-up the cost savings and other things." (C5) "At least if we take a look at our company's as-is, the way we have been addressing EA governance is that we have this architecture board, which is kind of formulating. It is a very good forum to discuss various initiatives and then see how that fits to our current landscape and also from capability perspective what are we going to address and what are we going to solve or improve. So the governance model is good." (C9) "Yes, I have been participating both the Center of Excellence and the architectural board meetings in a way or trying to participate whenever I can. Those are good mechanisms in place." (U2)
Weekly CoE call as an EA governance forum	C2, C7, C9	"We do have these weekly CoE [Central of Excellence] calls where we can take up any topic which requires any information sharing or discussion, which is good. Most of the stakeholders are involved there in addition to the architecture team." (C2) "We have these weekly CoE [Central of Excellence] meetings where we discuss and share ideas, get comments from the rest of the [IT organization] teams." (C7) "We have these weekly architectural Central of Excellence calls where people outside of our team are also invited. It gives also

		then an opportunity to kind of hear what is cooking from architecture's perspective. Also we are the kind of forerunners that whenever a new thing comes we are the first filter and the first who are involved and then of course if something has been done or something concluded or decision made, we also use the opportunity to share that." (C9)
Cross-team meetings coordinating EA work	C1, C2, C7, C9, C10, U3	"Coordination of developments in cross-team meetings is definitely very important unless we want to go into silos again. Even in an architectural level it is easy to get siloed in your own value stream." (C2) "I think architect morning coffee meetings are excellent in my view as lot of things are popping up here and there and it is a very good format not to deeply discuss but just to raise awareness like drop something into to the common knowledge that I am dealing with this and I feel the pain, or I have challenges, or I need your input or support so let's come back to it at a certain point to discuss it deeper." (C9) "I would say that one of the reasons why cross team meetings are important is that people are pretty busy and people in development many times are bit maybe introverted so their primary instinct is not to connect with someone else to start solving a problem. They probably would try to solve that by themselves first and therefore it's good that the organization helps them." (U3)
Platforms for coordinating EA	C2, C3, C7, U3	"For example, what we have done in Jira basically is listed all the developments we are doing so even though you were not involved in there directly you can at least see what is happening there. Then if you need to know more you can contact the persons responsible and ask for clarification unless they already contacted you." (C2) "We also have the yammer group kind of lowering the barrier to engage with us the architecture team and it could be used more in the future." (C3)
A clear documentation process	C2, C4, C5, C8, U2)	"The better the sales and the handover is documented and handled from a process perspective the easier it is to sell something." (C4) "How it ideally should go is that we wouldn't have some separate bookkeeping process but once we operate in the process the books are kept up immediately. So the processes are made such

		that the information documentation is updated automatically… If documenting is not part of the normal way of operating, someone is always coming with a new request and people immediately delete the email because they are already 110% occupied with the new case." (C5) "No matter how many times we repeat, inform, and tell and we wink, someone is still not knowing anything, because there is no time to read or listen or they are thinking that 'OK, it is not for me at all'. So having the principles, having those documented and having them also repeated in every now and then, because I assume that it is something we still need to keep active in the forums in order to increase the EA awareness." (U2)
EA documentation tools	C1, C2, C3, C5, C7	Ardog tries to list all the different aspects of architecture applications, application platforms, integrations and basically also information, conceptual term definitions and capabilities. In addition of modelling these separate entities it also depicts the different relationship between these… Business process diagrams, conceptual models and logical data models can also be managed in QPR [a process modelling software] and that can be debated whether it is an architecture deliverable or not, but at least architects need to be in involved so that we can make sure it is aligned with the applications and data flows. (C2) "A good concrete example is the Ardog, which is a good practical way to ensure that we are aligned in this EA landscape overall very well because it is documented there from many different point of views… In addition, in intranet, this architecture website, we have also guidelines and principles visible for everyone." (C3)
Having just enough governance	C2, C5, C6, C9, C10, U1, U2, U3	"We operate with agile teams cross-functionally and they need to be able to make the decisions day-to-day in their own work so they need to have the freedom as much as possible to do decisions, but they need some guardrails. So you have to have some guardrails to sort of direct what kind of choices the development teams can make. Of course, the development makes the decisions, because we can't even talk about agile and boards and committees making the decision on the same day. The decisions need to be decentralized to where the information is and where the work is done. This is just lean and agile 101." (U1)

		"I think that enterprise architecture is one of the key enablers in defining the way forward… we have the mechanism there, because on the other hand we cannot have too heavy governance and too heavy meetings, but the board one, I think that resonates quite well and it's very structured." (U2)
Early enough planning	C1, C2, C3, C4, C5, C7, U2	More than the PI-planning I have found value in the pre-planning, because planning is chaotic and it is chaotic for a reason. It is time constrained for the fact that you don't over-plan or you don't actually create a waterfall project out the agility that you are supposed to have. I have seen that you may have very beautiful Jira boards and all this and that and all participating but without proper pre-planning you spent 3-4 days explaining the fundamentals and working with the fundamentals and not getting beyond anything. (C4) "I think for the MO point of view the month before PI-planning is the critical time because then we are preparing the epics, Lean business cases and we have the value stream steering meetings. So one month before the actual planning for the big things for the next three months." (C5)
Building an EA conscious culture	C1, C2, C6, C7, C10, U3	"It is important to build the culture and change the culture to kind of have a more architectural mindset among everyone who is involved in development initiatives and having that kind of mindset of look at thing from different point of views." (C1) "We cannot ensure EA compliance and it should be architects' that are ensuring it in a long run... EA should be non-authoritative and softer in a sense, otherwise it is not organizational capability, but it is just individual capability of that single architect and it doesn't scale and the same applies to any maturity right. So if we are solving the same problems all the time, then we are all in away screwed." (C6) "This architectural communication is maybe to educate the decision makers and the stakeholders that these are the fundaments in our architecture and this kind of capabilities are being built… so to instill this kind of more product mindset instead of always them coming up with a new piece of software that solves this sub-problem, but it doesn't solve me anything else." (U3)
Creating autonomous teams	C1, C4, C8, U1, U3	"Focus on creating successful teams and most of the work is done." (C4)

		From my point of view, the important thing is to work together with the team for the planning and the pre-planning purposes, because the team is doing a lot of things also for the other value streams, so it is kind of an enabler as such, so we also have a lot of discussion with the other teams. (C8) "If you were to have the teams do something and then submit their work to some architecture board then rate their work and send it back well I might think that might be slowing us down. Instead, establish those guardrails, continually sprint by sprint coach those teams, communicate to the teams what the architectural guardrails and principles are and you get much better result. Maybe you don't even need the board after that… In addition, then the development would be faster too." (U1) "The autonomy comes from that we really trust that the teams know what they are doing and they get the freedom to operate how they see best." (U3)
Core architecture team	C1, C2, C8, U3	"I would more or less rely on the existing team spread-ups. We have few enterprise architects that are cross value stream architects working on specific layers of EA like applications, information or processes so they are the horizontal layer in the architecture and then we have the value stream specific solution architects which is the vertical element in the architecture. Solution architects basically convert business requirements and capabilities into architecturally sound solutions, which these agile teams can implement, and architects are making sure that its according to our architecture principles and hopefully aligned with a vision." (C2) "I think we are getting there and the good thing is that we have the nominations now done for the solution architects like in each value stream so it helps that everyone knows that if they need architectural support they always know who to contact and of course we solution architects also utilize the support from enterprise architects whenever that is needed." (C8)
Sharing EA responsibilities with stakeholders	C2, C3, C5, C6, C9, U1, U2, U3	"At least I am trying to involve as many SMEs [subject matter experts] as possible in early day or early levels, because I can't be and none of our architects can be an experts on all the tools and all the aspects that we are kind of responsible for." (C9) "In the future we shall also invite to those calls [architecture board meetings], for example, the applications team leads to

		share the information, and then trying to really involve them when their area of topics is discussed, because they really need to understand and be following then. (U2) I think it's always business that is important in facilitating EA work as they bring in their needs and then there is most likely also the development teams that again look at the ways we can implement certain things and subject matter experts participating. Of course, there is a lot of subject matter expertise in the architecture team, but no one can manage it all. (U3)
Additional business architects	C3, U1	"In this agile way of working to better manage the architectural governance would be to almost have kind of cross value stream chief architect looking at the different things, because currently we have only solution architects within the value streams and they work in their own lanes. So if we want to look at the overall, I think our IT architecture manager is kind of doing it now in his role in these architectural meetings… but that still doesn't take into account all the other things we are not involved in like local IT or businesses, because they do their own decisions without having us involved." (C3) "Maybe we should have real business architects, because now we have this interface between the business and IT so there are things that the business does and there are things that the IT does. The business requests things from IT and IT delivers things to the business. Why should it have to be this client–vendor-relationship? We all know that nothing would happen in the company if there were no digital IT solutions. Why do we still have to have a separate IT organization? So maybe we should left-shift our understanding of architectural competence also to the business well before they bring us these ideas so that they can already start the architecting themselves." (U1)

Appendix 5. Introduction to the interview

Enterprise architecture (EA) and EA-based capabilities within the context of large-scale agile development has emerged as an interesting domain for both researchers and practitioners of EA. However, the concrete utilization of EA-based practices are vague and a substantial part of its practical use lacks a firm base in theory.

The deployment of agile methodologies in the confinements of large-scale development is perceived difficult task for many organizations as new challenges emerge, such as the cross-team coordination, the right balance between emergent and intentional architecture and handling distributed projects. To remove some of these hurdles, the case company Metso Outotec utilizes EA to manage top-level plans, share architectural guardrails for development initiatives, and to steer individual projects to comply with EA objectives. It supports business areas, market areas, group functions and IT teams to plan and initiate development projects with purpose-fit solution architecture design. Furthermore, the role of enterprise and solution architects is very important as they are the key practitioners to sustain a systematic management of enterprise solutions and development initiatives.

As part of a thesis, this interview aims to expand the understanding of EA to rigorously conceptualize EA practices with the example of the case company Metso Outotec.

Definitions:

Enterprise Architecture: The organizing logic for applications, data, and infrastructure technologies, as captured in a set of policies and technical choices, intended to enable the firm's business strategy and business-IT alignment.

Large-scale agile development: Organizations with 50 or more people working according to agile principles or at least six fully agile teams.

Appendix 6. Semi-structured questions

1. How long have you worked as an architect at Metso Outotec (MO)?
2. From your standpoint, why does MO take part in enterprise architecture practices?
3. What are the most essential architectural artifacts and tools that you use in agile environment (e.g. roadmaps, principles, business capability models)?   4. How are these artifacts and tools used at MO?
5. In your opinion, what are the most common roles and responsibilities of architectural work at MO?   6. What helps you to manage the architectural long-term development objectives in the agile environment?   7. and what are the practical ways to deduce the architectural development into smaller developments?   8. What is the role of EA governance in scaling agile?   9. What are the common quality management practices of EA in scaling?   10. What other parties, besides the architects, are critical in facilitating architectural work at MO?
11. In your opinion, what are the typical benefits of architectural work in agile development for the organization and projects? How do you enable that these benefits are accomplished?
12. What are the typical, perhaps often recurring, concerns/risks of architectural work in agile development, and how do you try to mitigate them?   13. Are there any architectural anti-patterns that MO has perhaps already identified, but still lack the maturity to deal with?
14. From your standpoint, what are the most efficient ways to promote and facilitate the importance of architectural benefits and practices at MO? Are there any hurdles in the way?
15. What role do architects have in defining and building the architectural runway at MO?   16. What helps you to get a sense that autonomous and self-organized teams conform to EA at different stages of the development (Program Increments/Gates)?   17. How do you make sure that teams conform to EA objectives in long-term?   18. How to prioritize actions between architectural development and business-driven development, if there exist a conflict of interest?   19. What are the typical practices at MO to make sure architects and developer teams are aligned on EA landscape?   20. In your opinion, what are the most important roles and responsibilities of architectural work in the planning of events, and why?   21. In your opinion, what is generally the most critical time for "architecting" in the planning of events, and why?   22. What is role of cross-team meetings in scaling agile? Are there some benefits or concerns?   23. What helps you to manage dependencies to other existing environments?   24. In what ways does EA manage decomposing of monolithic systems?