Agile XL in
Globally Distributed Environments

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Agile XL in
Globally Distributed Environments

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Agile XL in
Globally Distributed Environments

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Abstract

Agile is a software development approach based on a set of 4 values and 12 principles. Using this set Scrum was developed as a agile framework in the early 1990s, which still remains the most popular framework today. However, Scrum originated to be used by a small number of co-located teams. When the amount of teams and the distance between the teams becomes bigger, issues will start to arise. With the rise of the computer and internet, programming-related work environments have become very large and globally distributed, implying a friction when using agile in these environments. This study aims to explore what challenges occur when using agile in very-large globally distributed environments and explore for practices that can be used to deal with them. To do this, a variety of research methods is used to gain insight, those being a systematic literature review (SLR), interviews and online surveys. We identify 50 challenges that may be encountered and 72 practices that can be used to combat them. Our online survey verified that all found challenges are frequently encountered in practice and the majority have a significant impact when encountered. However we also identified multiple practices that are used often to combat certain high-impact challenges. The most important practices were identified to be training and coaching. Experts were invited to fill in an online survey to generate possible learning goals. These learning goals are used to create an education program prototype for very-large scale globally distributed agile software engineering. As examples, 4 use cases in different environments are provided to show the prototype can be used to construct a matching training program. We provide proposals for further research directions into challenges, practices and the education program based on the steps taken in this study.

Thesis Committee:

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Committee Member:	Prof. dr. A. van Deursen	Faculty EEMCS, TU Delft
Committee Member:	Dr. ir. J.A. Pouwelse	Faculty EEMCS, TU Delft

Preface

After 17 months of research, I can finally present this thesis as the fulfilment of my master's study. This thesis would not have been possible without the help of many people.

First of all I would like to thank my supervisor Dr. R. van Solingen. I was certainly not the easiest graduate to have, but he stuck with me and made sure I pulled through the moments I was struggling. He allowed me to use his expertise when needed, but would also allow me to just run into the uncharted research area and see if I could find my own path. One thing he was adamant about, was showing me how an agile approach to writing my thesis could increase the overall quality of it. Of course, this did not mean I not often skirted around certain aspects of said approach and conducted some fake agile myself.

I would also like to thank Dr. M. Paasivaara, Dr. R. Prikladnicki and Dr. S. Marczak for answering any questions I had about their papers.

A big thank you to every person that participated in the interviews or filled in one of the surveys. You allowed me to gain insights into the challenges found and practices used by organizations in many different disciplines.

Finally I would like to extend my gratitude to Dr. D. Rico, who provided me with valuable advice during multiple phases of my research.

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Jens Voortman
Delft, the Netherlands
November, 2020

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Chapter 1

Introduction

1.1 Problem Statement

Agile is a software development approach based on a set of 4 values and 12 principles [5]. Using this set Scrum was developed as a agile framework in the early 1990s, which still remains the most popular framework [12]. However, Scrum originated to be used by a small number of co-located teams [53]. Once the amount of teams and the distance between the teams becomes bigger, issues start to arise [8] [44]. With the rise of the computer and internet, programming-related work environments have become very large and globally distributed [6] [18]. The Annual State of Agile report is a yearly survey with over a thousand participants that tries to map the global state of enterprise agile. In its 13th edition, released in May, 2019 [11], 73% of the respondents worked for organizations with software development organizations of over a 100 people. Furthermore, 78% said their organization practices agile with distributed team members, while 68% said their organization practices agile with multiple co-located teams, collaborating across geographic boundaries.

This means there is a implicit friction present in a lot of organizations when using agile in these environments. Over the past 15 years multiple frameworks have been created to be able to scale agile for use in very-large environments [47] [38] [52] [51] [62] [37]. However these are aimed to tackle the issues created by the size and not the distribution [55]. This thesis aims to explore what challenges occur when using agile in very-large globally distributed environments, whether their origin lies within the scale, distribution or both and explore for practices that can be used to deal with them.
Note: For ease of reading, henceforth we will refer to very-large as XL.

1.2 Scope of Research

To be able to define the scope for XL scale globally distributed agile engineering, we need to define the boundaries for the scale and distribution separately first. After defining them we can combine the definitions and boundaries to place boundaries on our scope.

1.2.1 Scope of XL scale agile software engineering

The concept of scale with regards to words as 'small' or 'large' depends on the person and the given context [24]. Due to this there have been made various definitions for large and XL scale agile software engineering. We will elaborate on them in this section.

The first definition of large-scale agile was made by Elshamya et al. in 2007 [20]. It defines agile as 'large agile' if the development team is anywhere between 50 and 100 people.

Then a taxonomy was suggested by Dingsøyr et al. [16] in 2014. They define 'large-scale' as 2 to 9 teams and 'very large-scale' as 10 or more teams. The numbers are based on the size of a Scrum team as recommended by The Scrum Guide [53].

Two years later Dikert et al. [15] made a definition based on their findings. They defined large-scale agile software engineering as "Software development organizations with 50 or more people or at least six teams. All people do not need to be developers, but must belong to the same software development organization developing a common product or project, and thus have a need to collaborate."

Finally Moe et al. [40] made an observation based on the International Workshop at XP 2017. They denote 'large-scale agile' as "a development effort with many teams – from 3 to 20 teams. Most people suggested that 3-5 teams qualified as large-scale.".

Decision: We think it is best to follow a definition that could be a possible standard. Therefore we use the taxonomy by Dingsøyr et al. [16] as a guide. However, to make sure there is a clear gap to 'large-scale', a safety margin was added our boundary. We set the boundary for XL scale agile software engineering at a minimum of 120 employees or 12 teams involved.

1.2.2 Scope of Globally Distributed Teams

As a base for this scope we use the definitions of globally distributed teams by Garrison et al. [25], who defined this in accordance with prior literature: "Globally distributed teams are teams of people who are connected via communication technologies across functional, organizational, and/or geographic boundaries in order to combine skills and resources to accomplish a goal."

This scope is not strict enough for our purposes for 2 reasons. First there is no quantity to the amount of locations. As we are looking at sizeable organizations, we need to define a suitable minimum that could fit such an organization. We will therefore define the minimum amount of locations as 3.

The other reason is the lack of clearly defined geographic boundaries. When looking at a world map, we need to account for both types of distribution: longitudinal and latitudinal.

Longitudinal distribution is distribution along the west-east axis. An organization with offices in North America, Europe and Asia has a high longitudinal distribution. This distribution can be expressed by the amount of time zones the offices are in.

Latitudinal distribution, this denotes the distribution along the north-south axis. An organization with offices in North and South America or Europe and Africa has a high latitudinal distribution. This distribution is harder to express, as it is possible for an organization to have offices in Canada, USA and Mexico, yet have them all in the same time zone. This means the amount of time zones is not adequate to express this distribution.

In our definition we need to pay attention to cases in which organizations have a high latitudinal distribution, but a low longitudinal distribution. For example, we need to make sure an organization with offices spread over Western and Northern Europe does not make the requirements. To cover these cases and assure enough geographical distance, we add a requirement for the office to be on at least 2 continents.

By modifying the base boundary with our changes, the new boundary becomes 'Globally distributed teams are teams of people who are connected via communication technologies from at least 3 sites or time zones across at least 2 continents, in order to combine skills and resources to accomplish a goal.'

1.2.3 Scope of XL scale globally distributed agile software engineering

Now by combining these scope boundaries we can define the scope of XL scale globally distributed agile software engineering. These requirements are summarized in Figure 1.1.

Minimum amount of employees:	120 employees or 12 teams
Minimum spread of locations:	3 sites or time zones
Minimum amount of continents:	2 continents

Figure 1.1: Scope requirements.

1.3 Research Questions

The goal of the research presented in this thesis is to investigate the origins of the problems and pitfalls that occur in XL globally distributed agile environments and if there are ways to deal with them. The formulated research questions for this can be divided into two types. The first type are the research questions aimed at the challenges:

- **RQ1:** What challenges have occurred in practical XL scale globally distributed agile environments due to the scale?

- **RQ2:** What challenges have occurred in practical XL scale globally distributed agile environments due to being globally distributed?

The second type are the research questions aimed at the practices.

- **RQ3:** What practices have been proposed to combat these challenges?

These question are answered in sequence, as the answers to **RQ1** and **RQ2** are needed as the base to be able to identify the practices for **RQ3**.

While trying to answer **RQ1** and **RQ2** the observation was made that we knew little about the impact caused by the found challenges and whether they appeared consistently. This lead to the formulation of 2 extra research questions aimed at these found challenges. They were formulated with the goal to obtain a better mapping of them in practice.

- **RQ4:** When the challenges occur in practice, what is their frequency?

- **RQ5:** When the challenges occur in practice, what is the severity of their impact?

That was not the only observation made during the research phases that tried to answer **RQ1** to **RQ3**. Firstly, the SLR gave only 5 accepted papers researching the usage of agile in XL scale globally distributed environments. Secondly, even though the importance of training is emphasized, using the search queries *"globally distributed" agile education "training program"* and *"globally distributed" agile training "education program"* on Google Scholar returned less than 200 search results. These observations led to the formulation of a sixth research question that is aimed to be able to create a base for a setup of an education program for XL scale distributed agile.

- **RQ6:** What learning goals could be part of a design for an education program for XL scale distributed agile?

1.4   Impact of COVID-19

On March 12, 2020 the Dutch government announced regulations due to COVID-19, with extra regulations being announced on March 15, 2020. Due to the infection risks involved with on-campus education and the regulated limitations on group gatherings, the TU Delft closed down education at that time. This meant the focus group event described in Section 3.3 and Appendix J, which was scheduled to take place on the TU Campus on March 20, 2020 could not be held.

At the time of the cancellation the first preparation round for the event had finished, while the second preparation round was still in progress. First an attempt was made to see if it would be possible to conduct the event online. However, by then multiple experts had already mailed they would not be able to attend an online version. This was due to the extended work pressure on them as they were working to convert their organizations to an online environment.

As such an alternative research method had to be found to replace the event. As stated due to the regulations, a requirement of this new method was that the participants would be able to complete everything online. Furthermore with the limited time possible participants had available, another requirement was that they needed to be able to do this on their own time. The selected method was an online survey, which is described in Section 3.4.

Some invited experts stated that due to the situation their time was too limited to participate. This implicates it as one of the issues causing the reduced response rate on both surveys, which extended the execution times of them considerably. The Challenges - Impact survey was open for 9 weeks and only got a response rate half what we expected it to be. The survey tool showed only a 21% completion rate for anyone opening the survey. The response rate for the Learning goals survey was even lower. Over the 11 weeks over 75 experts were contacted about the survey, to get the 14 needed responses. This meant a response rate of less than 20%.

1.5   Thesis Structure

The remaining part of this thesis is structured as follows. First, in Chapter 2 the background of the relevant topics related to agile will be highlighted. Then, in Chapter 3 we describe the methodologies used during the research. In Chapter 4 the conduction and results of the literature review are presented. Chapter 5 will present the progression and results of the conducted interviews, that were conducted after the SLR. Then in Chapter 6 the aggregation of the challenges extracted during the SLR and interviews is detailed. As the aggregation can not determine the impact of a challenge, in Chapter 7 the setup and results of the survey aimed to find this are shown. After that in Chapter 8 another aggregation is done, this time on the extracted practices. Based on this aggregation a focus group was prepared. In Chapter 9 the feedback of the executed parts of the focus group are presented. Furthermore the results of the survey that replaced the focus group are detailed. Then in Chapter 10 the results from Chapter 9 are used to create an education program prototype. To show the prototype could be used, 4 use cases are described and a timeline using the prototype is presented for each of them. Finally we present our conclusion and propose future work in Chapter 11.

Chapter 2

Background

In this chapter the essence of the research background is presented. First, the principles of agile are described. Second, the definitions of distributed and Globally Distributed Software Engineering (GDSE) and how they are used in context of this research is given. Then the idea behind the scaling technique Scrum-of-Scrums (SoS) is given. Finally, the concepts of ways used to scale agile that are mentioned in this thesis are described.

2.1 Agile

In the traditional waterfall approach to software engineering [50] one department will do their contributions to a project, then throw it over the wall to the next department. This continues on until the 'bottom' of the waterfall has been reached.

Agile however, goes for a completely different iterative approach which calls for collaborative cross-functional teams. It is a set of 4 values and 12 principles for software engineering first introduced in the 'Manifesto for agile software development' [5]. The values of the manifesto are:

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

The company Atlassian describes agile as "an iterative approach to project management and software development that helps teams deliver value to their customers faster and with fewer headaches. Instead of betting everything on a 'big bang' launch, an agile team delivers work in small, but consumable, increments. Requirements, plans, and results are evaluated continuously so teams have a natural mechanism for responding to change quickly." [3].

2.2 Globally Distributed Software Engineering

Distributed 'software engineering' is the act of developing a piece of software at multiple physical locations [48]. 'Globally distributed software engineering' is the scaled up version of distributed 'software engineering'. As the name suggests, in this case the locations are spread over multiple continents around the globe. It is different to distributed software engineering as it introduces new issues like time zone differences and cultural differences, which will less likely occur over small distances. In this research, we are researching a globally distributed setting. Therefore, when talking about distributed, globally distributed is meant.

During the globalization of business, it has been shown that gaining the benefits from globalization is not an easy task in itself [57]. However, that has not stopped software engineering to become GDSE as well. To put its rise in agile environments into perspective: in the 7th Annual State of Agile report in 2012 [13], only 35% of the participants stated their

organization had at least some distributed teams. However, 2 years later in the 9th edition [14], this amount had more than doubled and has been at least 70% every edition since.

Note: The terms 'software development' and 'software engineering' are synonyms. When talking about GDSE we will use the term 'software engineering' for consistency.

Note: This definition should not be confused with 'distributed software' engineering, which is the act of developing a piece of software which has its components spread over multiple computers in a network [60].

2.3 Scaling Agile

2.3.1 Scrum-of-Scrums

SoS is a technique first implemented by Jeff Sutherland and Ken Schwaber in 1996. They had a situation with 8 business units with each multiple product lines that needed to be coordinated and in those product lines the individual teams needed to be synchronized.

A SoS is a virtual team consisting of delegates from the original teams. The aim is to coordinate the smaller, independent teams, which is achieved by the interlinking team structure as it reduces the communication paths. The method is visualized in Figure 2.1.

During the meetings of the virtual team scaled versions of the normal questions are used. As an example, the questions that can be answered at the Scaled Daily Scrum (SDS) are:

- What has my team done since the last meeting that could affect other teams?
- What will my team do until the next meeting that could affect other teams?
- What problem is my team facing that might need help from another team to get it solved?

SoS can be found in various ways as a method used in multiple frameworks in **??**. For example when the Product Owner (PO) or Scrum Master (SM) of a team has their own alignment meeting with the other POs or SMs. Another example is a project level retrospective, for which each team sends a member.

Figure 2.1: SoS method, taken from [59].

2.3.2 Scaling Agile Frameworks

Multiple frameworks have been made to scale agile. This section gives a short overview of the essence of each of mentioned frameworks in this thesis.

DAD

Disciplined Agile Delivery (DAD) is a hybrid toolkit originally created by Scott Ambler and Mark Lines [2] and acquired by Project Management Institute (PMI) in 2019. To scale agile, it builds upon the foundation of other methods and frameworks. It adopts from existing sources and provides advice for when and how to apply their practices and strategies together. In their words, it uses "a hybrid approach which extends Scrum with proven strategies from Agile Modeling, Extreme Programming, Unified Process, Kanban, Lean Software Development, SAFe, LeSS, and several other methods." [47]. The concept is visualized in Figure 2.2.

It has a variety of different life cycles, which organizations can apply according to their needs. There are currently 6 different life cycles, which are:

1. Agile life cycle, a project life cycle based on Scrum, but extended to provide the project a streamlined strategy.
2. Lean life cycle, a project life cycle based on Kanban.
3. Continuous Delivery: Agile life cycle, a modern agile, stable-team life cycle based on Scrum.
4. Continuous Delivery: Lean life cycle, a modern agile, stable-team life cycle based on Kanban.
5. Exploratory/Lean Startup life cycle. This life cycle is based on Lean Startup strategies. It is depicted in Figure 6 and described in the article DAD life cycle Exploratory (Lean Startup).
6. Program life cycle, a life cycle for a team of teams.
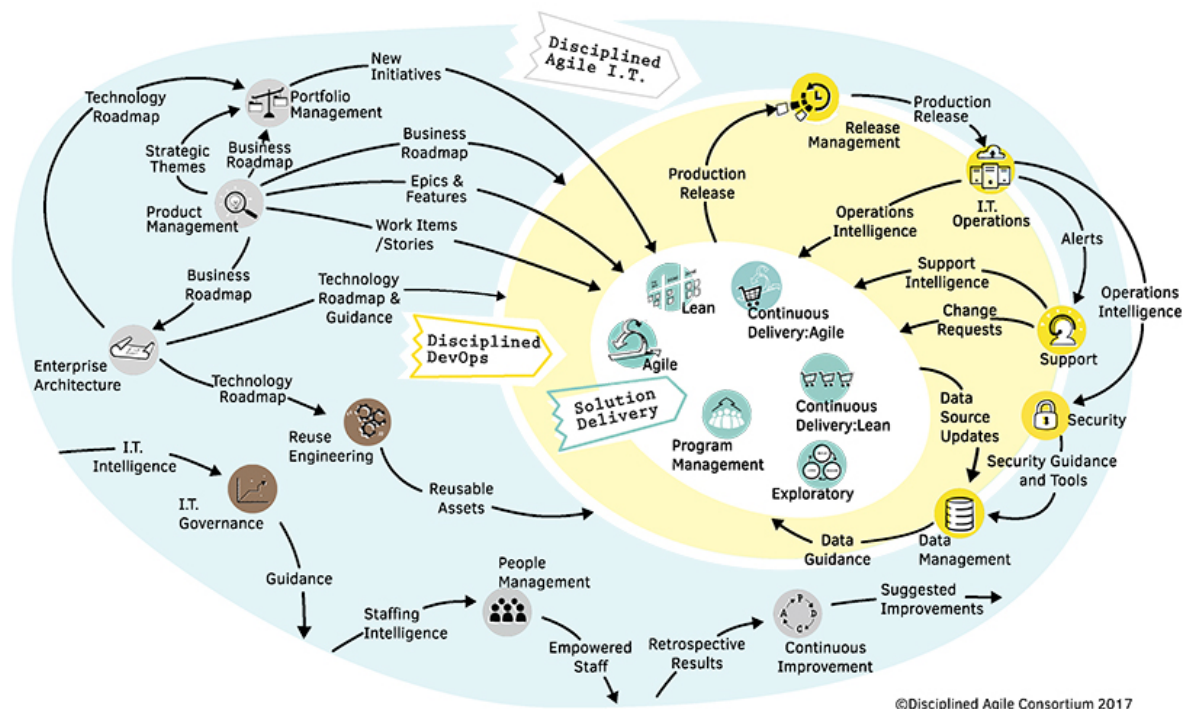
Figure 2.2: DAD toolkit, taken from [47].

LeSS

Large Scale Scrum (LeSS) is a framework created by Craig Larman and Bas Vodde and is short for Large-Scale Scrum [38]. As the name suggests, it is a framework based on scaling Scrum. Two versions of the framework exist, LeSS and LeSS Huge. LeSS supports up to 8 teams of 8 people. LeSS Huge supports up to a few thousand people on one product. Since LeSS Huge the one of the two that fits in the scope of the thesis, it is the one we focus on in this section.

The concept of LeSS Huge is to scale LeSS up by stacking multiple LeSS frameworks on top of each other. In essence it is a set of parallel LeSS sprint executions divided by Requirement Area. LeSS Huge keeps a lot of concepts from Scrum, like one Product Backlog, one Definition of Done, one Potentially Shippable Product Increment, one sprint and one PO. However new role is added, the Area Product Owners (APOs). The PO assigns every backlog item to a Requirement Area, after which the APOs create their Area Backlog based on the items in their Requirement Area. Within a Requirement Area, the teams are cross-functional, meaning they have to communicate with each other to spread information. The LeSS Huge framework is visualized in Figure 2.3.
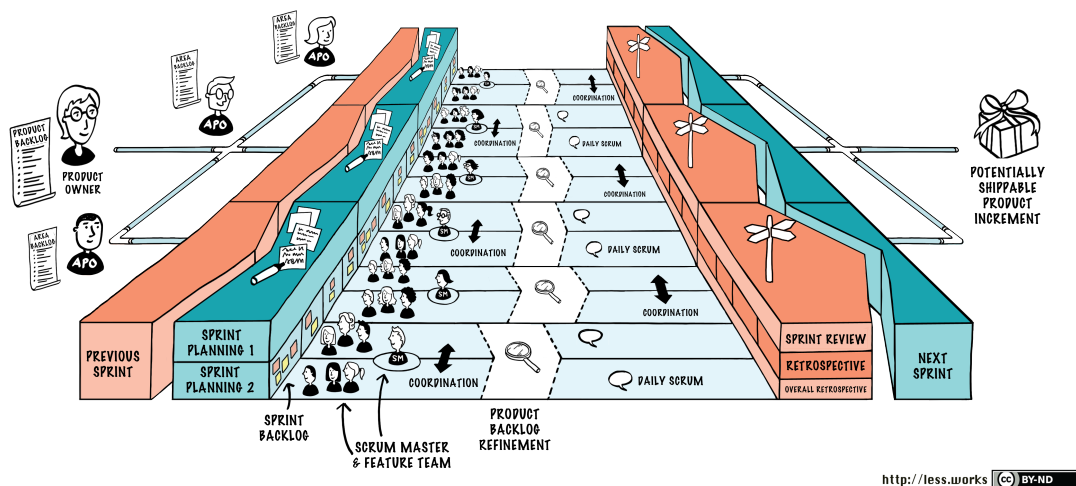
Figure 2.3: LeSS framework, taken from [38].

Nexus

Nexus is a framework created by Ken Schwaber, that uses Scrum as its building block [52]. It defines itself as "a process framework for multiple Scrum teams working together to create an Integrated Increment". An Integrated Increment represents the integrated work completed by a Nexus. Nexus extends on Scrum in various ways and is made for use with 3 to 9 teams. Multiple Nexuses can be used together and when done is called Scaled Professional Scrum. The framework adds a new role, the Nexus Integration Team. Its goal is to "coordinate, coach, and supervise the application of Nexus and the operation of Scrum." It also adds the Nexus Sprint Backlog, which is an aggregation of the items from the backlogs of the teams. To integrate the new role and backlog, a couple of new event are added as well, like the Nexus Sprint Planning. The Nexus framework is visualized in Figure 2.4.
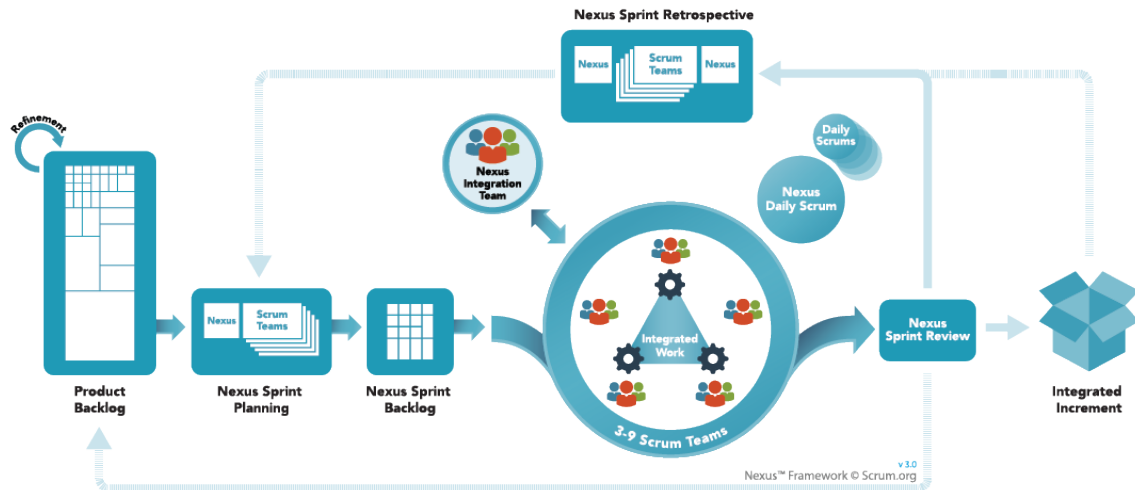
Figure 2.4: Nexus framework, taken from [52].

SAFe

Scaled Agile Framework (SAFe) was created by Dean Leffingwell and Drew Jemilo and had its first major release in 2011 [51]. The latest version of the framework available during this research is SAFe for Lean Enterprises 5.0, which was released in January, 2020. In the 14th Annual State of Agile report, released in May, 2020 [12], SAFe was cited as the most popular scaling method with a share of 35%. At the time of this research its share is bigger than all other frameworks mentioned in this section combined.

Version 5.0 has made significant changes and updates compared to version 4.6. This version is built around the "Seven Core Competencies of the Lean Enterprise", which are:

1. Lean-Agile Leadership competency
2. Continuous Learning Culture competency
3. Team and Technical Agility competency
4. Agile Product Delivery competency
5. Enterprise Solution Delivery competency
6. Lean Portfolio Management competency
7. Organization Agility competency

SAFe provides 4 out-of-the-box configurations that support a wide variety of environments. These configurations are:

1. Essential SAFe
   This is the most basic configuration and the simplest starting point. It includes core competencies 1, 3 and 4. This version is visualized in Figure 2.5.
2. Large Solution SAFe
   This configuration is aimed at "industries like aerospace and defense, automotive and government" and expands on the essential version by adding core competency 5.
3. Portfolio SAFe
   This configuration strives to fully enable business agility and expands on the essential version by adding core competency 2, 6 and 7.
4. Full SAFe
   This is the most comprehensive configuration and includes all of the 7 core competencies.

Depending on which of these configurations the organization chooses, different levels of SAFe are implemented into the organization. In version 5.0 there are 3 levels:

At the base there is the **Essential** level, which is a combination of the Team and Program levels of version 4.6. This is the level where the actual software is built by the teams. To be able to release the software a single Agile Release Train (ART) is managed here. An ART contains all necessary components to realize the promise of value to the customer. All teams that are on the train are synchronized to the same Program Increment (PI) length, which is typically 8 to 12 weeks. During a PI an ART chugs through 4 to 6 system increments, which are iterations of 2 weeks each. This means the teams on the train also have synchronized iteration start/end dates. To even further synchronization an ART has periodic face-to-face PI Planning events during a PI. At the end of a PI an Innovation and Planning event and an Inspect and Adapt event are held with the whole train.

Then there is the **Large Solution** level, which is layered on top of the **Essential** level. This level can be compared to the Value Stream level of version 4.6. If a value stream is too big for a single solution, a Solution Train is created on this level. A Solution Train adds new roles that allow for the coordination of multiple parallel ARTs.

Finally there is the **Portfolio** level, which can layered directly on top of the **Essential** level or if used on top of **Large Solution** level. In case a organization supports multiple value streams, this is the level that coordinates them..
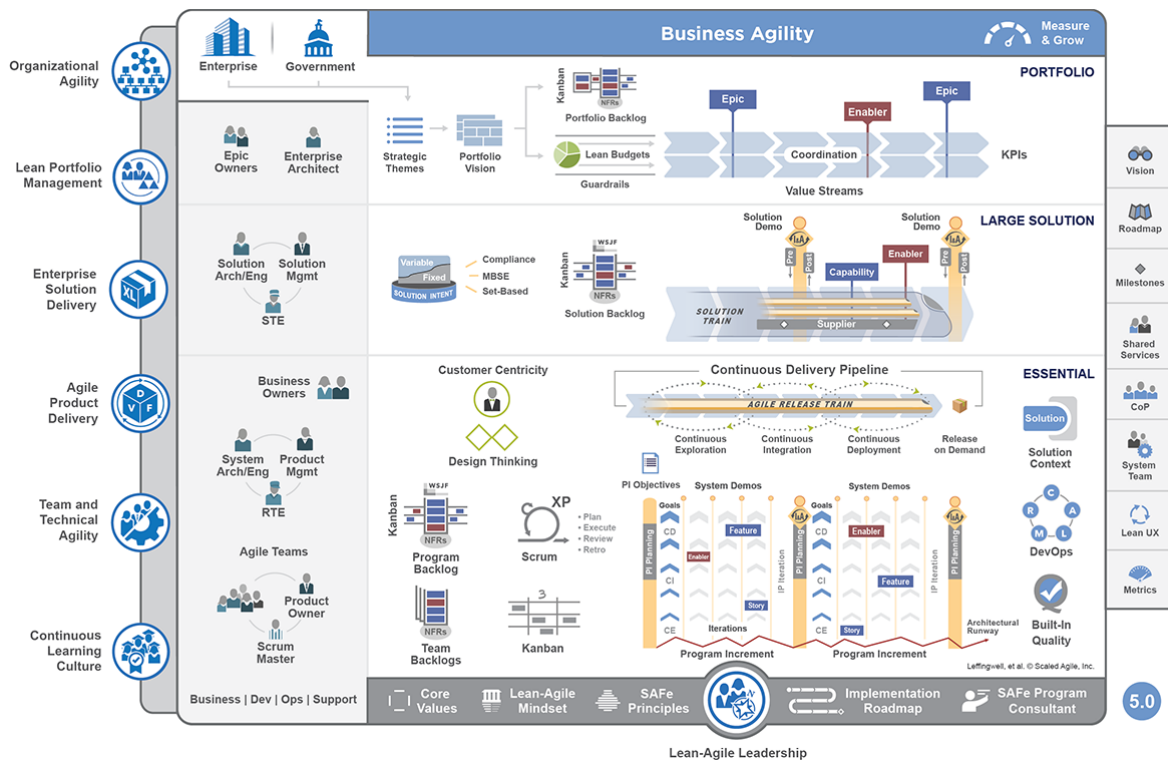
Figure 2.5: A Full SAFe configuration, taken from [51].

Scrum@Scale

The Scrum@Scale (S@S) framework is another framework made by the hands of Jeff Sutherland [62]. As the name suggests, it is a framework that focuses on scaling Scrum to larger environments. One of the ways this is achieved is by adding scaled versions of the events and roles. Examples of scaled events that are added are SoS, the SDS and the Scaled Retrospective. Some of the new roles that are introduced are the Scrum-of-Scrums Master (SoSM), the Chief PO and the Executive Action Team (EAT).

The framework is based on combining 2 different cycles. These cycles are visualized in Figure 2.6. On one side there is the SM cycle, which focuses on coordinating the 'how'. The EAT is at the core of this and fulfils the SM role for the entire organization. On the other side there is the PO cycle, which focuses on coordinating the 'what'. The Chief PO and his team of POs are at the core of this side. Their main responsibilities are a scaled version of what a Scrum PO would have.
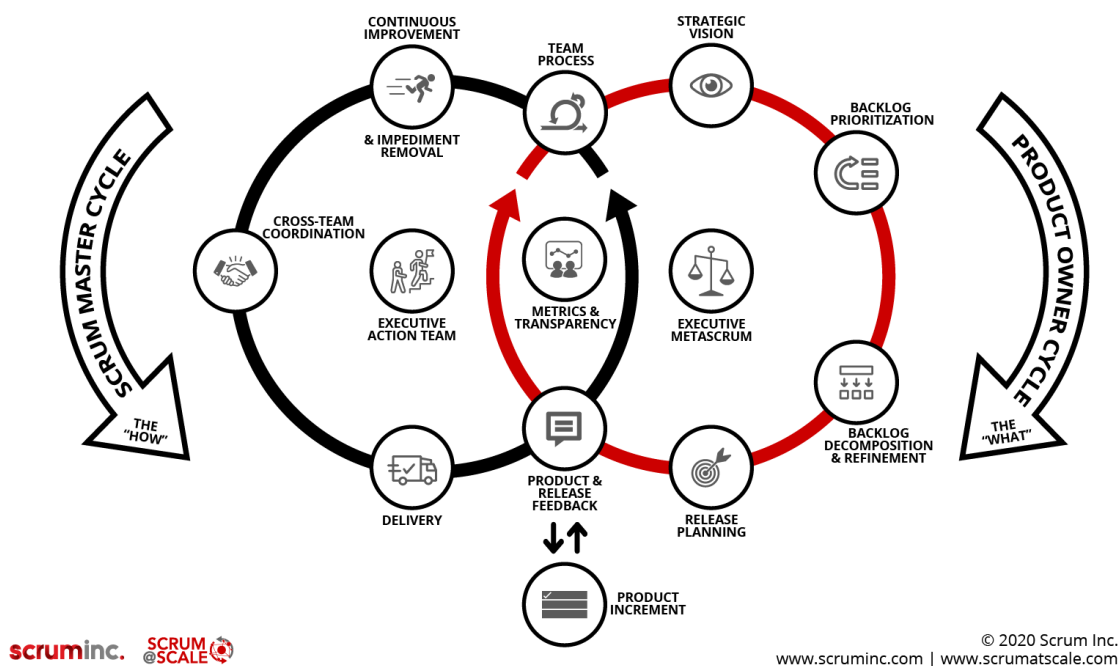
Figure 2.6: Scrum@Scale framework, taken from [62].

Spotify Model

Spotify has used its own version of scaling agile, which has become known as the 'Spotify model' [37]. Originally intended to be just an example of how Spotify approached agility, many organizations have copied the model [36]. The Spotify model is based around squads, tribes, chapters, and guilds. A squad is the lowest level of unit, comparable to a Scrum team. One level higher, we have a tribe, which consists of multiple squads working in related areas. It also contains the chapters, which are the groups of people with similar skills in a tribe. Lastly, at the highest level there are the guilds. These consist of all people across tribes who are interested in a certain topic, for example database management or automated testing. A visualization of this can be found in Figure 2.7.
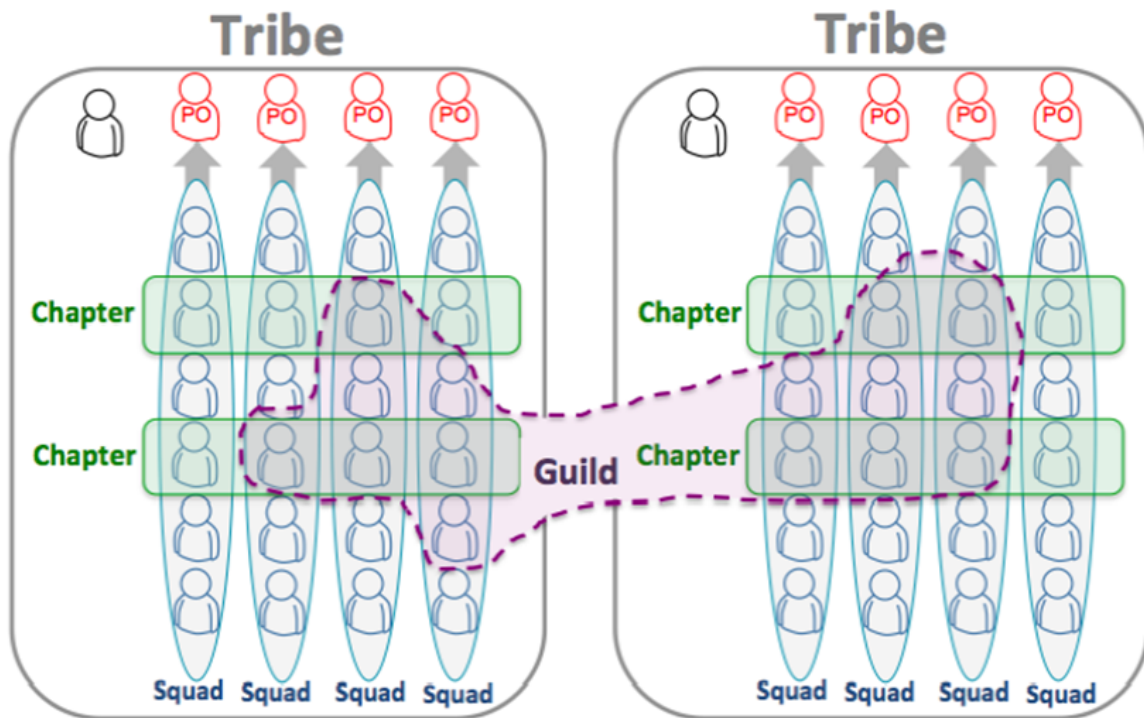
Figure 2.7: Spotify model, taken from [37].

2.3.3 ASK Matrix

For a more detailed comparison between the frameworks the Agile Scaling Knowledge (ASK) matrix [17] can be referred to. It has collected the most used ones to provide the community with the following things:

1. Provide the ability to compare, with an emphasis on objective criteria as much as possible.

2. Provide a model to be able to make your own comparisons.

3. Provide a variety of verbatim commentary for getting into the "opinion" side of comparing frameworks.

Chapter 3

Methodology

In this chapter the methodologies for the various research phases of the thesis are discussed. The protocols for the SLR and semi-structured interviews can be found in Section 3.1 and Section 3.2 respectively. Then in Section 3.3 the details of the Focus Group event is described. As stated in Section 1.4, due to the lockdown, the event itself could not be held. Some of the parts of the event and the data that was already gathered were repurposed for the alternative research method. The plans for the course of the event and final data output, that were not used can be found in Appendix J. The details of the repurposed and the methodology for the Learning Goals survey can be found in Section 3.4. Finally in Section 3.5 the setup of the Impact survey for the found challenges is explained. A visualization of the research flow can be found in Figure 3.1

Throughout this chapter, the researchers will be referred to multiple times during the explanation of various processes. We will define the way they are referred to as follows:

- Researcher I: J.M. Voortman, Master Student in Computer Science
- Researcher II: R. van Solingen, Professor in GDSE
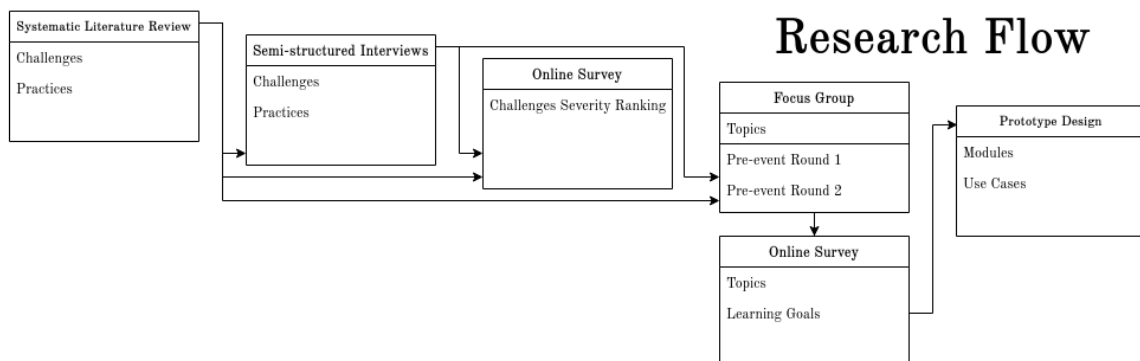
Figure 3.1: Visualization of the research flow.

3.1 Systematic Literature Review

3.1.1 Review Protocol

Inspiration for this review protocol was taken from two sources. The first source is Version 2.3 (July 2007) of [33], which has proven to be a respectable standard by follow-up studies in 2009 [34] and 2010 [35]. The other one is [7], which is a SLR in the field of GDSE that used the guidelines of [33].

Research Questions

- **SRQ1:** What challenges are presented in scientifically published case-studies about using agile in a XL globally distributed setting?
- **SRQ2:** What practices are used in these studies to solve the challenges?
- **SRQ3:** Are there correlations between the different case-studies?

Search Process

The papers are manually searched for through multiple databases. The nominated databases are IEEE Xplore, ACM, Elsevier Science Direct and Google Scholar. The searches on IEEE Xplore are limited to the filters 'Conferences' & 'Journals'. The search results will be collected and duplicates will be removed.

Inclusion Criteria

- The study is published in a formal format and in English.
- The study was a case study conducted with at least one real-life organization.
- The working environment fulfils the requirements set in Figure 1.1 in Section 1.2.3.

Exclusion Criteria

Reasons to specifically exclude studies are one or more of the following criteria:

- The results are coincidental, only based on intuitions, or without context.
- The study is about engineering "distributed software" or "globally distributed software".
- The study is a master thesis. These are excluded due to not being peer reviewed.

Primary Study Selection Process

The results will be tabulated as follows:

- Number of papers per search per source
- Number of candidate papers per search per source
- The selected papers per search per source
- The rejected papers per search per source

The relevant candidate and selected studies will be selected by a single researcher. A list of candidate papers with reasons for the rejection will be maintained.

Data Collection

The data extracted from each study will be:

- Author(s).
- Amount of times study has been referenced.
- The year of publishing.
- Collaborating organization(s).
- Number of employees or teams involved.
- Number of case studies executed.
- Mentioned challenges due to XL scale (marked with XL).
- Mentioned challenges due to being globally distributed (marked with GD).
- Mentioned practices with marks as to which challenges they solve.

3.1.2 Data Analysis

The mentioned challenges and practices shall be grouped and linked. For every group the amount of times mentioned and by which paper will tracked. This is done to gain insight into possible patterns.

3.1.3 Reducing bias

Due to the SLR being performed by one researcher, Researcher I, the possibility of bias in research design and study selection exists [33] [58]. To combat this Researcher II was requested to give feedback during the preparation and conduction of the SLR.

3.1.4 Project Timetable

The preparations for the conduction of the SLR were started on August 12, 2019. The review was finished on January 14, 2020

3.1.5 Data Output

The output of the SLR is as follows:

- The used queries, searches and their respective results.
- The general information of the accepted papers.
- The list of rejected papers as an appendix.
- The metadata per accepted paper as an appendix.
- The metadata of the challenges and practices extracted from each accepted paper.
- The challenges and practices extracted from each accepted paper.
- The grouping and linking of the challenges and practices.

3.2 Semi-structured Interviews

3.2.1 Interview Protocol

Guides used in the creation of this protocol were [42] and [28].
Introduction (2.5 minutes)
Thank you for giving me some of your time. I'm Jens Voortman, a master student from the Delft University of Technology, The Netherlands. (I also have my supervisor present to oversee.) I am speaking with IT engineers to get various impressions about the use of agile in large distributed environments. As a IT engineer involved in this, we would like to talk with you about the challenges that come with running agile in such an environment. What we learn from today's discussion will hopefully help us extend the current reach of research into this domain.

Introductory Protocol (2.5 minutes)
As stated in the email we would like to record our conversations today. Of course your answers will be treated as confidential. No names or any other information that could identify you will be published in the thesis.
We have planned this interview to last no longer than one hour. During this time, we have several questions that we would like to cover. If time begins to run short, it may be necessary to interrupt you in order to push ahead and complete this line of questioning.
Do you have any questions about the study?

A - Interviewee Background (5 minutes)

- Can you tell me about your experience in this company?
  - **Probe:** How long have you been working for this company?
  - **Probe:** How long have you been in your current position?

B - Interviewee Agile Background (5 minutes)

- How many years of experience do you have with agile ways of working?
- How many years of experience do you have with distributed teams?
- Have you previously worked at a large and globally distributed company?
  - **Probe:** Have there been instances here where you been able to use this experience?
  - **Probe:** What would be an example of this?
- What is your personal opinion on using agile in a large distributed setting?

C - Company Agile Background (5 minutes)

- What are the agile methods you are involved with in this company?
- How many employees are involved with you in this? (Range is fine.)
- How many different locations are you involved with?
  - **Probe:** Which countries are these locations in?
- Where you involved in the transformation of this company to agile?
  - **Probe:** During which period did the transition take please?
  - **Probe:** Do you remember the reasoning for the transformation?

D - Transformation to Agile (15 minutes)

- What were the concerns of the company during the planning phase of the transition?
- What was done to address these concerns?
- Did the company run into unexpected issues during the transformation?
- **Probe on yes:** Can you name a few examples?
- **Probe on yes:** Do you think this issue was due to the size, the distribution or both?
- **Probe:** What were the solutions implemented to deal with them?

E - Daily Running with Agile (15 minutes)
We will now move from the transition period into the daily running of agile in the company.

- Did the company run into challenges not foreseen during the preparations and transition?
- **Probe:** What were the solutions implemented to deal with them?
- Are there any unresolved issues still happening?
- Are there any practices that have emerged that were not directly tied to an issue showing up?
- **Probe on yes:** Can you name a few examples?
- **Probe on yes:** Do you think this issue was due to the size, the distribution or both?

Closing (5-10 minutes)
Those were all of the questions that we wanted to ask. I have a bunch of possible challenges that weren't mentioned, I'd like to run them by you.

- Do you have any final thoughts that you would like to share?

Thank you for your time.

3.2.2 Interview Analysis

Interview Conduction

The interviews will be recorded and be transcribed by Researcher I. For the duration of the thesis, access to the recordings is limited to Researcher I. The access to the transcripts is limited to Researcher I and Researcher II. At the end of the thesis, the recordings and transcripts will be destroyed.

Data Analysis

First all possible challenges and practices are marked by Researcher I and Researcher II. After extracting these from the transcripts, challenges not related to the XL scale and/or global distribution will be removed. Then the resulting challenges and practices shall be grouped and linked. For every challenge and practice, the amount of interviewees that mentioned them will be tracked. During the linking, practices that link only to removed challenges will be removed as well.

3.2.3 Reducing Bias

Due to the interviews being performed by one researcher, Researcher I, the possibility of bias in design and marking exists [33] [58]. To combat this Researcher II was requested to mark the challenges and practices in the transcripts as well. The pool of mentioned challenges and practices was made up by the unification of both marking processes.

3.2.4 Data Output

The output of the semi-structured interviews is as follows:

- The statistics for reactions to the interview requests.
- The general information of the interviewees and their companies.
- The metadata of the challenges and practices extracted from the interviews.
- The grouping and linking of the challenges and practices extracted from the interviews.
- Notes and remarks made by the interviewees as an appendix.

3.3 Focus Group Event

The goal of the focus group event is to generate guidelines for a design of an education program for XL scale distributed agile. The focus group will consist of 9 experts divided into 3 groups, each group representing a different part of agile process. The event will be held at Building 28, TU Delft on Friday, March 20, 2020. In the weeks prior to the event 2 pre-event questionnaires will be send to the experts to decide on the topics to be discussed during the event.

3.3.1 Roles

Selection Rules

- Participant must fulfil the requirements of one of the groups listed below.
- Participant was not an interviewee who was interviewed in Chapter 5.

Group 1: Large-scale Distributed Agile Business, 3x

- Product Owner, Scrum Master, Lead or Manager
- Must be experienced in the Business side, for example-Sales or Management.

Group 2: Large-scale Distributed Agile Engineers, 3x

- Engineer, Developer, Tester, QA or QC.

Group 3: Large-scale Distributed Agile Educators, 3x

- Trainer or Coach
- Must be trained in multiple XL-scale agile frameworks, this is to prevent single-framework-bias.

3.3.2 Pre-event Round 1: Adding to the List

A list of topics is created based on the challenges and practices found in Chapter 4 and Chapter 5. This list is sent to all participants with the request for feedback on the existing topics and to send in potentially missing topics. The responses are collected, after which the feedback and send in topics will be processed. The time expected to complete this round is a maximum of 30 minutes.

3.3.3 Pre-event Round 2: Topic Selection

In this round the filtering of topics for the event will be done. Time during the event is limited, therefor topics are pre-filtered if the participants are in at least a qualified majority agreement [29]. A survey is created on Survey AnyPlace [61], who provided us with a 'professional plan' to conduct the surveys.

For every topic the following questions are asked to the experts:
Question 1: 'Should this topic be part of an education program for XL scale distributed agile?'
The options to reply are 'Yes' or 'No' and a space for optional short reasoning is provided.
If the expert answers with Yes the following extra question is asked:
Question 2: 'On what level on the KSA model should this topic be implemented as a learning goal?'
The options to reply are 'K', 'KS' or 'KSA'. A visual representation of the KSA model [66] can be found in Figure 3.2.

It is possible that the experts think of extra topics while filling in the survey. To provide for this possibility a comment block is added to the completion screen, where these suggestions can be filled in. Topics suggested via this block will be added to the list for discussion during the event. The time expected to complete this round is a about 30 minutes.
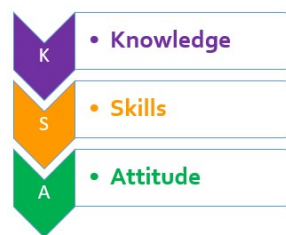
Figure 3.2: Visualization of the KSA learning model.

After the responses are gathered the topics will be divided based on the decision flowchart in Figure 3.3. For a topic to get filtered, it needs to gather at least 7 of the same answers to Question 1. This means the minimum divide over the groups for the same answer is '3-2-2' or '3-3-1', this condition ensures two things. Firstly, it means at least 1 person of each group has to give that answer. Secondly, it means at least 2 groups have to answer unanimously or all groups need to have at least a qualified majority [29].

If a topic has gathered 5 or 6 times the same answer, it will be considered a borderline topic. As there is a divide between the experts, the topic will need discussion time and is added to the discussion list for the event.
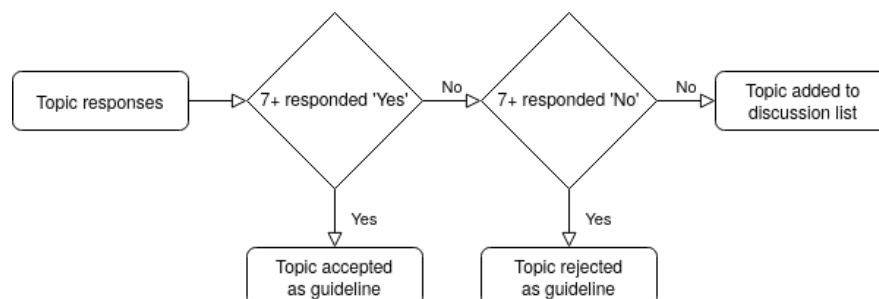
Figure 3.3: Flowchart for topic decision, based on the responses of pre-event round 2.

3.4 Learning Goals Survey

3.4.1 Survey Setup

The survey used in pre-event round 2 of Section 3.3 was repurposed and edited for broader use. This survey is hosted at Survey AnyPlace [61]. The topic and question order is kept the same, so that the responses can be merged with the responses of the event participants. A screenshot of one of the questions can be found in Figure 3.4

The event participants were asked to provide feedback for possible improvements to the survey. The feedback detailed it was hard to keep track of the topics and how far the participant had progressed through the pre-event round 2 survey. To combat this, a list of all topics was added as downloadable PDF on the introduction screen.

The other changes made to the survey were the following. First the participants select their own group now as opposed to being classed by us. Secondly, the multiple-frameworks-requirement was dropped for the Educators group. Due to the higher amount of experts in the group and therefore the possibility to target experts with different framework experiences, the chance for single-framework-bias is reduced. Finally a short explanation on the research was added to introduction screen, to give the participants more background and context.

Figure 3.4: Screenshot of a question screen of the Learning Goals survey.

3.4.2 Data Analysis

The MoSCoW method [65] is combined with a two-third qualified majority [29] per group to classify the topics as learning goals. To enable this, the requirement is to have at least 6 responses per group. In case the number responses of a group is higher, the required number of positive answers is rounded to the number closed to two-third. The rules for MoSCoW classification can be found in Table 3.5.

The classification of the implementation level, based on the KSA model (Figure 3.2), is based on plurality voting (winner-takes-all) [26]. In case there is a tie between implementation levels, the highest level of the tie will be chosen to break the tie.

QMs:	Classification
3	Topic must be in there as learning goal.
2	Topic should be in there as learning goal.
1	Topic could be in there as learning goal.

Table 3.5: Guidelines for qualification based on MoSCoW and qualified majorities.

3.4.3 Data Output

The revised output of the survey is as follows:

- First version of the topic list, send with pre-event round 1.

- Topics that were added in to the list after pre-event round 1.

- The full description of all topics used in pre-event round 1, pre-event round 2 and the survey as an appendix.

- A summary of the survey responses.

- The full results of the survey as an appendix.

- The list of resulting learning goals ordered with the MoSCoW-model.

3.5 Challenges - Impact Survey

3.5.1 Survey Setup

The goal of this survey is to gather information on the impact of the found challenges in organizations worldwide. As a side effect an indication of the frequency of them appearing can be measured as well.

At the beginning of the survey, every participant was asked to fill in the following 3 characteristics: years of agile experience, current agile role(s) and the area their company was active in. Then for every challenge found in Chapter 4 and Chapter 5 the participant is asked to rank the severity of the impact the challenge made. The possible rankings start at *1 - Negligible* and go up to *5 - Severe*. In case a challenge was not encountered, a *Not Applicable*-option is added to every question.

One of the lessons learned from the Learning Goals survey was that in the current situation the length of a survey is very important. Multiple experts noted this as their feedback for the Learning Goals survey, as they stated their time was very limited. Therefore one of the design goals was to keep the length of the survey under 10 minutes. Various answering systems of Survey AnyPlace [61] were tested to improve the flow of the survey. A screenshot of one of the question screens of the final version of the survey can be found in Figure 3.6.

Figure 3.6: Screenshot of a question screen of the Challenges - Impact survey.

3.5.2 Data Output

- Metadata of the responses to the survey.
- The distribution of participants based on their years of agile experience.
- The distribution of participants based on the group rules from Section 3.3.
- The distribution of the amount of *Not Applicable*-responses.
- The list of challenges ranked using their severity calculated using the responses.
- The full results of the survey as an appendix.

Chapter 4

Systematic Literature Review

Research Flow
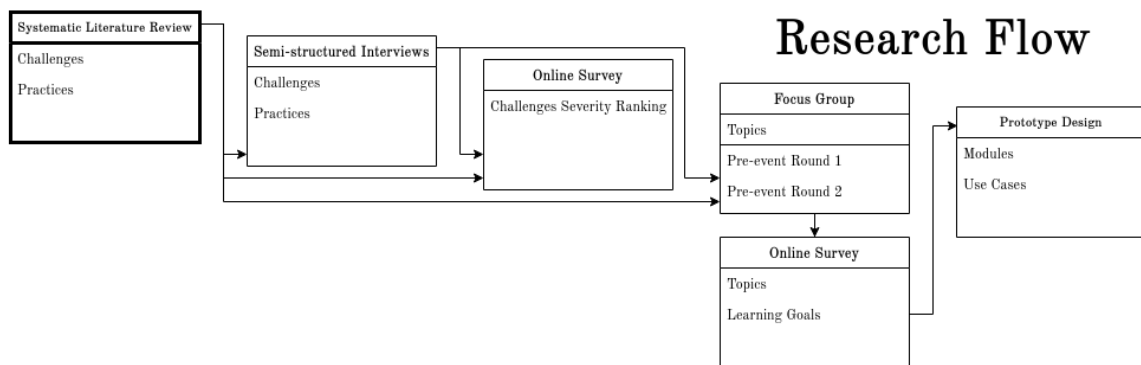
In this chapter the results of the SLR are presented. First the searches for papers are listed. Secondly the general information about the accepted is displayed. Then the synthesis and grouping of the extracted data is shown. Finally the full results of the data extraction are listed.

4.1 Data Acquisition

In this section an overview of the data acquisition is presented. There were 8 different search queries used in the database search. These can be found in Table 4.1. The queries were used on 4 databases, those being IEEE Xplore[1], ACM, Elsevier Science Direct and Google Scholar.

An overview of the results of the searches can be found in Table 4.1 as well. To make the table more readable, any search returning 0 results has been removed from the table. Furthermore as the searches on the ACM database only returned no results or only returned a small amount of only irrelevant results, those rows have been removed from the table as well. Finally a list of rejected papers including rejection reason can be found in Appendix A.

4.2 Accepted Papers

The total amount of accepted papers is 5. During the conduction of the SLR all accepted papers were less than 5 years old. The general information of these papers can be found in Table 4.2.

Q Nr.[1]	Search Queries
1	`"Nexus framework" AND "globally distributed" AND "case study"`
2	`"Scrum at Scale" AND "globally distributed" AND "case study"`
3	`"LeSS Huge" AND "globally distributed" AND "case study"`
4	`"Spotify" AND "agile" AND "globally distributed" AND "case study"`
5	`"Scaled Agile Framework" AND "globally distributed" AND "case study"`
6	`"DAD" AND "agile" AND "globally distributed" AND "case study"`
7	`(((scrum) AND large scale) AND case study) AND globally distributed)`
8	`"agile" "large scale" "case study" "globally distributed" "challenge" "practice"`

S Nr.[2]	Q Nr.[1]	Source	Hits[3]	Candidates	Accepted papers
1	1	Scholar	4	0	-
2	2	Scholar	5	2	[45]
3	3	Scholar	11	3	[45]
4	4	Scholar	42	4	-
5	5	Scholar	92	10	[45], [43]
6	6	Scholar	142	12	[45], [43], [30]
7	7	IEEE Xplore	130	11	[45], [43], [19], [27], [49]
8	7	Science Direct	21	0	-
9	8	Science Direct	58	3	-

[1] Query number,
[2] Search number
[3] Searches returning 0 results have been removed from the table.

Table 4.1: Search queries used during the SLR and their corresponding results.

#	Ref	Authors	Year	Cited	Companies	Employees involved
1	[45]	Paasivaara et al.	2016	22	Nokia	20 teams
2	[19]	Eickhoff et al.	2018	7	IBM	1000+ engineers
3	[43]	Paasivaara	2017	25	Comptel	14 & 12 teams
4	[27]	Gupta et al.	2018	3	Siemens Healthcare	120
5	[49]	Roman et al.	2015	4	'ORG'	200+[1]

#	Cases	Locations
1	1	Finland, Germany, Greece & India
2	1	Locations spread over 3 continents
3	2	Finland, Malaysia, Norway & UK | Finland, Malaysia, Bulgaria & Russia
4	1	3 locations in Germany & India
5	1	USA, Brazil, India, Malaysia, China, Japan, Ireland & Russia

[1] Paper was accepted after the authors responded with an indication of size.

Table 4.2: General information of the accepted papers.

4.3 Synthesis of the Extracted Data

This section summarizes the extracted data from Section 4.4. The metadata of the summary can be found in Table 4.3, while the metadata per paper can be found in Appendix C. One study had ongoing challenges without a practice found for them. Meanwhile another study had implemented a practice without a challenge directly leading to it. Finally multiple studies had challenges being attributed to both the XL scale and the global distribution.

Metadata	Amount
Number of challenges & practices	57
Number of challenges	27
Number of practices	30
Number of challenges being XL & GD	4
Number of challenges with practices	23
Number of challenges without practices	4
Number of practices with challenge	29
Number of practices without challenge	1

Table 4.3: SLR - Metadata from the extraction of challenges and practices.

4.3.1 Challenge Listing

This section answers 'Are there correlations between the different case-studies?' (SRQ3) for the challenges found. To do this, the challenges are grouped and summarized. The challenge groups for challenges mentioned by more than one paper can be found in Appendix D. There are 8 challenge groups and 8 challenges mentioned only once. The full list of challenges and their amount of mentions can be found in Table 4.5. To be able to link the practices to the challenges they solve, every challenge and challenge group listed in Table 4.5 has been converted to a how-to form. An example of a linking can be found in Figure 4.4.

4.3.2 Practice Listing

This section answers 'Are there correlations between the different case-studies?' (SRQ3) for the practices found. Just like for the challenges, the practices are also grouped and summarized. The practice groups for practices mentioned more than once can be found in Appendix E. There are 6 practice groups and 12 practices mentioned only once. The full list of practices and their amount of mentions can be found in Table 4.6. For readability the practices in the list have been standardized. Firstly the principal verb of a practice has been converted to use its root form. Secondly references to specific functions or meetings have been generalized, if this would not change the intention of the practice.

Challenge: How to scale agile to work effectively in a large environment.
Practice(s):

- Split meetings into local and global versions.
- Make sure all employees have had proper agile training.
- Let teams mix-and-match agile methods based on the needs of a project.

Figure 4.4: Example of a link between a challenge and relevant practices.

#	Challenge	Category	Mentioned by
1	How to have (major) meetings with everyone present due to time zones.	GD	3 ([43], [45] & [49])
2	How to eliminate change resistance towards agile methods and/or the transition.	XL	3 ([19], [43] & [49])
3	How to integrate customer collaboration in an effective way.	XL, GD	2 ([27] & [49])
4	How to streamline big meetings, due to the amount of participants and/or the usage of conferencing tools.	XL, GD	2 ([43] & [45])
5	How to let important meetings be useful, due to the amount of participants and/or conferencing tools.	XL, GD	2 ([27] & [45])
6	How to act on and implement feedback gathered during retrospectives.	XL	2 ([43] & [45])
7	How to scale agile to work effectively in a large environment.	XL	2 ([19] & [49])
8	How to enable the teams to see the big picture.	XL	2 ([19] & [27])
9	How to align release cycles between various modules or systems.	XL, GD	1 ([19])
10	How to have clear and proper communication within and between teams.	XL, GD	1 ([19])
11	How to stop self-managed scrum teams from becoming isolated islands.	XL	1 ([27])
12	How to stop tight scheduling leading to multiple teams, instead of a single one, working on the same feature in a chaotic way.	XL	1 ([45])
13	How to conduct the daily (SoS) meetings effectively as a teleconference.	GD	1 ([45])
14	How to make agile work in a fixed-budget-model environment, which clashes with agile's principles.	XL	1 ([49]
15	How to change the development method, which is a lot harder when being globally widespread.	GD	1 ([49])
16	How to apply agile methods on the maintenance cycle of old and/or legacy systems.	XL	1 ([49])

Table 4.5: SLR - Extracted challenges after grouping.

#	Practice	Challenges	Mentioned by
1	Split meetings into local and global versions.	1, 4, 5, 7, 9, 12	3 ([19], [43] & [45])
2	Make sure all employees have had proper agile training.	2, 7	3 ([19], [43] & [49])
3	Use physical and/or digital dashboards to give teams a visualization of the work.	3, 5, 8	2 ([19] & [27])
4	Hire coaches to help with and guide the adoption.	2, 14	2 ([43] & [49])
5	Standardize communication using means like a set of agreed-upon rules or workshops.	9, 11	2 ([19] & [45])
6	Have a dedicated focus on retrospective feedback.	6	2 ([43] & [45])
7	Invite an expert (e.g. a creator of the framework), to help with the setup of the framework.	-	1 ([45])
8	Specialize teams to certain knowledge areas based on previous knowledge.	11	1 ([45])
9	Have Delivery Playbacks to showcase project progress in demos.	8, 9	1 ([19])
10	Create collaboration between the teams early in the development phase.	2, 9	1 ([19])
11	Define Acceptance Criteria per user story for when it is considered done.	8	1 ([19])
12	Invest significantly in automated building, packaging & testing of the system.	10	1 ([19])
13	Have a full-time RTE who focuses on arranging and leading the major meetings, like the SoS and planning meetings.	4	1 ([43])
14	Have all employees understand the reasoning of the adoption before the first planning meeting.	2	1 ([43])
15	Move meetings to be held in open spaces.	5	1 ([27])
16	Have a OYA Day, based on [4], shortly after a sprint review and retrospective have been completed.	9	1 ([27])
17	Start with pilot projects instead of rolling everything out at once.	2	1 ([49])
18	Let teams mix-and-match agile methods based on the needs of a project.	7	1 ([49])

Table 4.6: SLR - Extracted practices after grouping.

4.4 Data Extraction

This section answers 'What challenges are presented in scientifically published case-studies about using agile in a XL globally distributed setting?'(SRQ1) and 'What practices are used in these studies to solve the challenges?' (SRQ2). The papers are listed in order of acceptance. Section 4.4.1 to Section 4.4.5 show per paper what challenges and practices were extracted.

4.4.1 Paasivaara et al. (2016)

Citation and Overview
Maria Paasivaara and Casper Lassenius. "Scaling Scrum in a Large Globally Distributed Organization: A Case Study". In: *2016 IEEE 11th International Conference on Global Software Engineering (ICGSE)*. IEEE, Aug. 2016. DOI: 10.1109/icgse.2016.34 [45]
The main subject of this paper is scaling Scrum in a project at Nokia. They attempted to apply the LeSS framework. The paper lists the adoption of the scaling, then proceeds to detail the experiments the company tried. Finally it describes what practices at the end of the adoption differed from the LeSS framework.

XL agile challenges
1. Tight scheduling leading to multiple teams, instead of a single one, working on the same feature in a chaotic way.
2. Usefulness of SoS meetings varying due to reduced information sharing and participation.
3. Stop presentations, instead of demonstrations, being given at the 'Common Demo' as it did not show the software quality.
4. Stop common retrospectives being considered useless as no changes were noticed from them.

GD challenges
i. Having concurrent Sprint Planning with different time zones.
ii. Dealing with the Daily SoS meetings not working well as a teleconference.

Practices
a. Invite Craig Larman, one of the creators of the LeSS framework, to help with the setup of their framework.
b. Improve communication between APOs and teams using regular workshops. (*1*)
c. Specialize teams to certain knowledge areas based on previous knowledge. (*1*)
d. Conduct a 'Common Sprint Planning', a one-hour teleconference in which each team sends one representative. Afterwards the teams convene for detailed planning and send their commitments for the coming sprint. (*i*)
e. Have a face-to-face 'Finnish SoS' and a teleconference 'Global SoS' with the project manager being the link between them. (*2, ii*)
f. Split the 'Common Demo' up back into smaller groups. (*3*)
g. Have an updated type of common retrospective which is more focused on solving problems. (*4*)

4.4.2 Eickhoff et al. (2018)

Citation and Overview

F. L. Eickhoff et al. "Large-scale application of IBM Design Thinking and Agile development for IBM z14". In: *IBM Journal of Research and Development* 62.2/3 (Mar. 2018), 1:1–1:9. DOI: 10.1147/jrd.2018.2795879 [19]

- -

This paper is about the practices used by IBM while developing its Z14. IBM Z is one of their mainframe-lines. One of the subjects is detailing the use of Agile in this project. They created a homegrown framework to be able to scale it to the whole project.

XL agile challenges

1. Scaling agile to work effectively with over a 1000 developers.
2. Establish a proper agile mindset into over a 1000 developers.
3. Being able to monitor the project progress on multiple levels.
4. Aligning the packaging and integration of the IBM Z code from 2 weeks cycle to Continuous Integration (CI), once a day.
5. Having clear and proper communication within and between teams.

GD challenges

  i. Aligning the packaging and integration of the IBM Z code from 2 weeks cycle to CI, once a day.
 ii. Having clear and proper communication between teams.

Practices

 a. Have a project-level Stand-up meeting focusing on critical issues only. (*1, 4, ii*)
 b. Have Iteration Planning, Stand-ups, and Iteration Reviews meetings per team. (*4*)
 c. Have Delivery Playbacks to showcase project progress in demos. (*3, 4, ii*)
 d. Give all teams proper agile education. (*1, 2*)
 e. Create collaboration between the teams early in the development phase. (*2, 4, ii*)
 f. Establish a 'social contract', a set of agreed-upon rules and understanding of how teams will behave and interact. (*4, ii*)
 g. Define Acceptance Criteria per user story for when it is considered done. (*3*)
 h. Use automated dashboards to track and visualize the project progress. (*3*)
 i. Use a 'Wall of Work' to clearly visualize the work, dependencies and bottlenecks for the teams. (*3*)
 j. Invest significantly in automated building, packaging & testing of the system. (*i*)

4.4.3 Paasivaara (2017)

Citation and Overview

Maria Paasivaara. "Adopting SAFe to Scale Agile in a Globally Distributed Organization". In: *2017 IEEE 12th International Conference on Global Software Engineering (ICGSE)*. IEEE, May 2017. DOI: 10.1109/icgse.2017.15 [43]

- -

The subject of this paper is the usage of SAFe in two projects by Comptel. It explains the adoption process of the two projects, then compares the differences. Finally it details the reasons why one project was more successful.

Note: The adoption of SAFe in case 1 was not that successful. However, as case 2 started 6 months after case 1, they could benefit from the trials and tribulations of case 1. Therefore only the challenges and practices of case 2 will be listed.

XL agile challenges

1. Minimizing change resistance towards SAFe and agile.
2. Minimizing chaos during major meetings due to the amount of participants.
3. Making sure possible improvements to the process do not get put on the shelf.

GD challenges

i. Having the major planning meetings with a 5 hour time difference.
ii. Minimizing chaos during major meetings due to the use of conferencing tools.

Practices

a. Have an external consulting company help support the adoption. (*1*)
b. Have all upper-level employees be trained in advance, then train the other employees internally shortly before the first planning meeting. (*1*)
c. Have all employees understand the reasoning of the adoption before the first planning meeting. (*1*)
d. Have a full-time RTE who focuses on arranging and leading the major meetings, like the SoS and planning meetings. (*2, ii*)
e. Have the RTE take point in assigning and following the implementation of improvement points brought up during site-specific retrospectives. (*3*)
f. Time the main events of the two-day-planning meetings in such a way that all sites could join. (*i*)

4.4.4 Gupta et al. (2018)

Citation and Overview

R. K. Gupta, S. Jain, and B. Singh. "Challenges in Scaling up a Globally Distributed Legacy Product: A Case Study of a Matrix Organization". In: *2018 IEEE/ACM 13th International Conference on Global Software Engineering (ICGSE)*. May 2018, pp. 72–76 [27]

- -

The main subject of this paper is the successful scaling of Scrum by a large team at Siemens Healthcare. Half of the paper describes the practices used to help with communication and collaboration. The other half gives the role definitions of the various managers and their experiences with these roles.

XL agile challenges

1. Making sure SoS is functioning effectively in such a large environment.
2. Making sure the teams are all seeing the big picture.
3. Being able to provide a customer view to the teams on a regular basis.
4. Stop self-managed scrum teams from becoming isolated islands.

GD challenges

i. Making sure SoS is functioning effectively in such a widespread environment.
ii. Being able to communicate effectively with global stakeholders.

Practices

a. Move the SoS meeting to be held in open spaces. (*1*)
b. Start using accessible physical and digital Obeya walls [32]. (*1, 2, 3, i, ii*)
c. Have a OYA Day, based on [4], shortly after a sprint review and retrospective have been completed. (*4*)

4.4.5 Roman et al. (2015)

Citation and Overview

Greice Roman et al. "On the Agile Transformation in a Large-Complex Globally Distributed Company: Why Boarding this Journey, Steps Taken and Main Foreseen Concerns". In: *2015 6th Brazilian Workshop on Agile Methods (WBMA)*. IEEE, Oct. 2015. DOI: 10.1109/wbma.2015.13 [49]

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The main subject of this paper is the company-wide roll-out of agile at a multinational. The paper was written after the initial steps of the transition has been taken. It explains the reasoning for going Agile as well as the steps taken to combat the initial concerns. The agile methods used differ throughout the company, like Scrum, Kanban or 'Scrumban'. Finally, it also explains current concerns for the next steps in the transition.

Note: The paper lists a couple of theoretical proposed practices, however 'ORG' has not tested these in practice and are therefor excluded.

XL agile challenges

1. Getting employees to go along with the transformation.
2. Being able to collaborate with customers effectively in a XL environment.
3. Getting agile to work in a varied environment with different needs.
4. Making agile work in a fixed-budget-model environment, due to clashing with agile's principles.
5. Applying agile methods on the maintenance cycle of old and legacy systems.

GD challenges

  i. Changing the development method is a lot harder when being globally widespread.
 ii. Having a synchronous meeting when a team is spread over 4 continents.

Practices

  a. Usage of training to put agile concepts into the company's perspective.(*1*)
  b. Start with pilot projects instead of rolling everything out at once. (*1, i*)
  c. Hire coaches to guide and give feedback. (*1, i*)
  d. Let teams mix-and-match agile methods based on the needs of a project. (*3*)

Chapter 5

Semi-structured Interviews
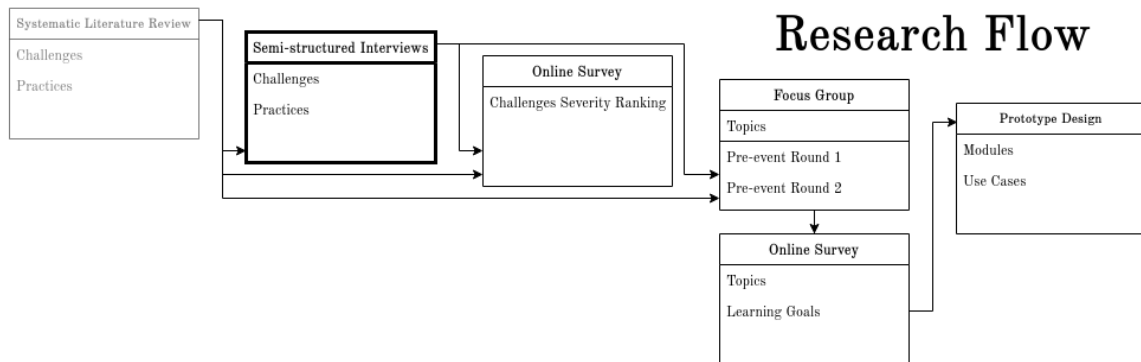
In this chapter the interview phase of the research is detailed. First the process of finding and approaching potential candidates will be described. Then the analysis of the interviews will presented.

5.1 Setting up the Interviews

5.1.1 Scouting Potential Candidates

Potential candidates were scouted through Researcher II's LinkedIn profile by making use of the Skill Endorsements section. In total 385 profiles, including duplicates, spread over 3 agile related endorsements were checked. To be marked as a potential candidate, the person needed to fulfil the following requirements:

1. The person needs to work for a company that fills the requirements in Figure 1.1.
2. The person is involved in the agile process and not just a consultant.
3. The person is currently not working for a research group or is a professor at a university.

5.1.2 Approaching Candidates

Potential candidates were sent the invitations between October 1 and 4, 2019. In case no response was given, a reminder was sent a week after the original invite. The metadata for the invitations and the responses can be found in Table 5.1.

In total 10 candidates were interviewed, representing 7 different companies. The details of the candidates can be found in Table 5.2. The first interview was held on October 16, 2019 and the final one on November 19, 2019. Another telephone interview was scheduled for the November 20, 2019, however the interviewee no-showed the interview.

Metadata:	Amount:
Originally approached candidates:	45
Responses with general forwards:	1 (to full department)
Responses with specific forwards:	4 (to 8 new candidates)
Suggested forwards:	1
Total approached candidates:	54

Positive responses:	10^1
Negative responses:	9^2
No response:	35^3
Unique companies:	7
Amount of generalized roles:	8

[1] This only includes candidates who actually had an interview.
[2] This includes candidates who responded positively, but turned out to not fulfil the requirements.
[3] This includes candidates who stopped responding or no-showed the interview.

Table 5.1: Statistics of mails send and received for interview requests.

C-Tag[1]	Area	Countries	Agile Methods	Agile Employees/Teams
Ba	Banking Software	2-5	Scrum	10+ teams
Bu	Business Software	2-5	SoS, Kanban	500-600 employees
Co	Continuous Delivery	X^2	Scrum, SAFe & Kanban	Varies[2]
In	Information Services	5-10	SoS	X^3
Lo	Logistics	5-10	SoS	10+ teams
Oi	Oil & Gas	2-5	Scrum $\rightarrow$ SAFe[4]	350-400 employees
Te	Telecommunications	5-10	Homegrown	90-100 teams

E-Tag[5]	Agile Experience	Role	Interview Type
Ba1	10+ years	Scrum Master	Face-to-Face
Bu1	10+ years	Product Manager Lead	Face-to-Face
Bu2	10+ years	Product Manager Lead	Face-to-Face
Bu3	10+ years	Product Manager	Face-to-Face
Co1	10+ years	Continuous Delivery Expert	Via Telephone
In1	10+ years	UX Team Lead	Face-to-Face
Lo1	15+ years	Scrum Master	Face-to-Face
Oi1	10+ years	Agile Coach Lead	Face-to-Face
Oi2	10+ years	Product Owner	Face-to-Face
Te1	5+ years	Lead Transformation	Face-to-Face

[1] Company Tag
[2] These numbers depend on running contracts.
[3] Exact number was undisclosed.
[4] Company was in transition at time of interview.
[5] Employee Tag

Table 5.2: Details of the interviewees and companies they represented.

5.2 Interview Analysis

This section summarizes the extracted data from the interviews. The metadata of the extracted data from the transcripts can be found in Table 5.3. From every interview transcript between 9 and 20 challenges were extracted and between 5 and 23 practices.

Metadata	Amount
Number of challenges & practices	254
Number of challenges	120
Number of practices	134
Number of challenges being XL & GD	36

Table 5.3: INTVW - Metadata from the extraction of challenges and practices.

5.2.1 Challenge listing

To ensure the data from Section 4.3 can be aggregated, the challenges are grouped and summarized the same way as the challenges found during the SLR. After removing irrelevant challenges there were 120 challenges marked. Out of these challenges, 29 different challenge groups could be created and 16 challenges were only mentioned once. Of the groups 8 were mentioned by at least half of the participants. After grouping the challenges were categorized. The categories were based on the SLR groups and/or the interviewees' context where possible. In case neither were available we deducted the categorization. The challenges and their categorizations can be found in Table 5.4.

#	Challenge	Category	Mentioned by
1	How to eliminate change resistance towards agile methods and/or the transition.	XL	7 (Bu1, Co1, In1, Lo1, Oi1, Oi2, Te1)
2	How to minimize the amount of code inter-dependencies.	XL	6 (Bu1, Bu2, Bu3, Lo1, Oi1, Oi2)
3	How to minimize the effect of time zones on the work.	GD	6 (Bu1, Bu2, Bu3, Co1,In1, Lo1)
4	How to improve on the agile implementation, when the organization thinks they are already agile (Fake agile).	XL	5 (Ba1, Bu3, Co1, Oi1, Oi2)
5	How to reduce the effect of cultural differences.	GD	5 (Ba1, Bu1, Co1, Lo1, Oi2)
6	How to minimize the effect of the physical distances on the work.	GD	5 (Ba1, Co1, Lo1, Oi1, Oi2)
7	How to implement agile in a standardized way, but still allowing for variations that suits the local situation.	XL, GD	5 (Ba1, Co1, Lo1, Oi1, Te1)
			Continued on next page

8	How to bring agility to all levels of the organization.	XL	5 (Co1, Lo1, Oi1, Oi2, Te1)
9	How to balance the travel budget with people's needs.	XL, GD	4 (Ba1, Bu1, Bu3, Oi1)
10	How to have effective communication with (non-agile) third-parties.	XL, GD	4 (Ba1, Lo1, Oi2, Te1)
11	How to have effective communication between teams.	XL, GD	4 (Ba1, Bu2, Bu3, In1)
12	How to apply agile methods on the maintenance cycle of old and/or legacy systems.	XL	4 (Bu1, In1, Oi1, Te1)
13	How to have (major) meetings with everyone present due to time zones.	GD	4 (Bu1, Bu3, In1, Oi2)
14	How to keep everybody aligned and up to date.	XL, GD	4 (Bu1, Bu2, In1, Te1)
15	How to align everyone to the same vision.	XL	4 (Bu2, Bu3, Oi1, Oi2)
16	How to find suitable metrics for value reporting.	XL	3 (Ba1, Bu1, Oi1)
17	How to clearly define the responsibility of every role.	XL	3 (Ba1, Oi1, Oi2)
18	How to run an efficient operation in a hybrid environment where the rest of the organization is still waterfall.	XL	3 (Bu2, Co1, In1)
19	How to align release cycles between various modules or systems.	XL,GD	3 (In1, Oi1, Oi2)
20	How to prevent distributed team members from becoming lonely and unhappy.	GD	2 (Ba1, Bu3)
21	How to balance team reallocation with people's needs.	XL, GD	2 (Ba1, Bu3)
22	How to reduce turnover rate to create more stability in teams.	GD	2 (Bu1, Bu3)
23	How to integrate customer collaboration in an effective way.	XL, GD	2 (Bu1, Lo1)
24	How to reduce differences in agile education levels across different locations.	GD	2 (Bu1, Oi1)
25	How to balance code ownership.	XL	2 (Bu2, Bu3)
26	How to improve on the agile workflow after its original implementation.	XL	2 (Bu3, Oi2)

27	How to streamline big meetings, due to the amount of participants and/or the usage of conferencing tools.	XL, GD	2 (In1, Te1)
28	How to deal with instability after reorganization due to scale and distribution.	XL, GD	2 (Oi1, Oi2)
29	How to ensure every role has had the proper amount of knowledge education.	XL, GD	2 (Oi1, Oi2)
30	How to improve trust in leadership with the distributed teams.	GD	1 (Ba1)
31	How to instil the principles of agile into everyone's mindset.	XL	1 (Bu1)
32	How to fix planning estimates between engineers and other departments not being in sync.	XL	1 (Bu2)
33	How to create a proper agile (hybrid, living) roadmap.	XL	1 (Bu2)
34	How to be creative with agile without losing the manifesto's values and principles.	XL	1 (Bu2)
35	How to minimize the effect of various public holidays in different locations on the work.	GD	1 (Bu2)
36	How to find the right balance between the flexibility and stability of teams to reduce knowledge and efficiency loss.	XL	1 (Bu3)
37	How to balance team personalities for improved co-operation.	XL	1 (Bu3)
38	How to have effective communication between teams and management.	XL, GD	1 (Bu3)
39	How to implement proper tools and data to analyse your way of working to encourage data-driven decision making.	XL	1 (Co1)
40	How to enable the teams to see the big picture.	XL	1 (Lo1)
41	How to align everyone to the same budget form.	XL	1 (Oi1)
42	How to perform proper task management (e.g. duration, amount of parallel tasks running)	XL	1 (Oi2)
43	How to act on and implement feedback gathered during retrospectives.	XL	1 (Oi2)
44	How to prevent teams from becoming isolated islands.	XL, GD	1 (Oi2)
45	How to create an environment where the teams have ownership and are independent.	XL	1 (Te1)

Table 5.4: INTVW - Extracted challenges after grouping.

5.2.2 Practice listing

Likewise, to ensure data aggregation with Section 4.3, the practices are grouped and summarized the same way as the practices found during the SLR. In total there were 134 practices marked. Out of these practices, 23 different practice groups could be created and 63 practices were only mentioned once. Of the groups 4 were mentioned by at least half of the participants. The created practice groups and the challenges they link to can be found in Table 5.5. The practices that were only mentioned once can be found in Appendix G.

#	Practice	Challenges	Mentioned by
1	Make sure all employees have had proper agile training.	1, 3, 4, 7, 8, 11, 14, 15, 16, 17, 18, 19, 24, 25, 26, 29, 31, 32, 33, 34, 38, 41, 42, 44	7 (Bu1, Bu2, Bu3, Co1, In1, Oi1, Oi2)
2	Divide the teams in a way (e.g. value streams, domains) that creates knowledge areas.	2, 25, 45	6 (Ba1, Bu1, Bu2, In1, Lo1, Te1)
3	Hire coaches to help with and guide the adoption.	4, 7, 8, 9, 11, 15, 17, 18, 21, 26, 27, 30, 36, 37, 48, 43, 44	5 (Ba1, Bu3, Co1, In1, Oi2)
4	Invest in the automation of testing and/or building environment.	12, 19, 39	5 (Bu1, Co1, In1, Oi1, Oi2)
5	Create a structured rhythm for the conduction of rituals and sprints (e.g. staggered sprints).	14, 19	4 (Bu1, Bu2, Bu3, In1)
6	Make use of tele- or videoconferencing tools.	6, 23	4 (Bu1, In1, Oi1, Oi2)
7	Co-locate all POs in a single location.	3, 6, 40	3 (Bu1, Bu2, Lo1)
8	Talk directly to the customers (e.g. sending representatives to them, flying them in).	23, 39	3 (Bu1, Co1, Lo1)
9	Give responsibility to the POs on alignment (e.g. amongst themselves, by use of Lead PO).	11, 14, 15, 31, 38, 40	3 (Bu1, Bu3, Lo1)
10	Have a set time window for meetings with distributed locations.	3, 6, 11, 13	3 (Bu2, In1, Oi1)
11	Take care in clearly defining the responsibilities of each role.	4, 8, 17, 18, 32	3 (Bu2, Oi1, Oi2)
12	Make use of visualization boards and/or tools.	2, 11, 12, 14, 16, 19	3 (In1, Oi1, Te1)
13	Work in a way that makes everybody feel part of the team.	21, 25	2 (Ba1, Bu2)
			Continued on next page

14	When there is distribution within a team, have a minimum of two co-located team members.	20	2 (Ba1, Bu3)
15	Make use of insourcing to reduce external dependencies.	2	2 (Bu1, In1)
16	Have a focus on creating a fun work environment.	22, 25	2 (Bu1, Bu2)
17	Have stable teams for a longer duration of time.	11, 22, 25, 36, 37	2 (Bu2, Bu3)
18	Make use of a single roadmap and backlog, instead of multiple.	11, 14, 15, 33	2 (Bu2, In1)
19	Have a focus on keeping meetings small enough to keep them efficient.	27	2 (Bu3, Te1)
20	Co-locate everybody for the quarterly planning meeting (e.g. every time, after every x times).	3, 6, 9, 11, 13	2 (In1, Oi1)
21	Split up bigroom planning days in half a day of local and half a day of global.	6, 13	2 (Oi1, Oi2)
22	Encourage teams to be responsible for their own alignment with third-parties.	10, 45	2 (Oi2, Te1)
23	Split up meetings as used in the SoS model.	14, 15, 27, 45	2 (Oi2, Te1)

Table 5.5: INTVW - Extracted practices with more than one mention after grouping.

Chapter 6

Aggregation of Challenges

In this chapter an aggregation of the mentions of challenges found in Chapter 4 and Chapter 5 is made. This will be done by calculating the mention score of each challenge. There are 5 accepted papers and 10 interviewees. To ensure the weight of a mention is fair between them, a formula will be used to balance the weights. As there are twice as many interviewees than accepted papers, a mention by an accepted paper will be worth double. The formula used for calculation can be found in Figure 6.1. Furthermore, for a challenge to be listed, it needs to be mentioned in both the SLR and interviews.

$$mention\ score = 2\ *\ SLR\ mentions\ +\ interview\ mentions$$

Figure 6.1: Formula used to calculate a challenge's mention score.

The results of the aggregation can be found in Table 6.2. It shows that the majority of the challenges found in the SLR (11/16) have occurred in at least one of the interviewed companies as well. It could be an indication these challenges could structurally appear when conducting XL agile in a globally distributed environment. The 3 most prevalent challenges coming out of the aggregation are eliminating change resistance, conducting meetings due to time zones differences and the integration of customer collaboration. However this aggregation does not say anything about the impact said challenges have had. Therefore in Chapter 7 research is conducted into the impact.

Rank	Challenge	Cat.[1]	Mentioned by	CNr.[2]	Score
1	How to eliminate change resistance towards agile methods and/or the transition.	XL	3 papers 7 interviewees	2 1	13
2	How to have (major) meetings with everyone present due to time zones.	GD	3 papers 4 interviewees	1 13	10
3	How to integrate customer collaboration in an effective way.	XL GD	2 papers 2 interviewees	3 23	6
3	How to streamline big meetings, due to the amount of participants and/or the usage of conferencing tools.	XL GD	2 papers 2 interviewees	4 27	6
3	How to have clear and proper communication within and between teams.	XL GD	1 papers 4 interviewees	10 11	6
3	How to apply agile methods on the maintenance cycle of old and/or legacy systems.	XL	1 papers 4 interviewees	16 12	6
7	How to act on and implement feedback gathered during retrospectives.	XL	2 papers 1 interviewee	6 43	5
7	How to enable the teams to see the big picture.	XL	2 papers 1 interviewee	2 40	5
7	How to align release cycles between various modules or systems.	XL GD	1 papers 3 interviewees	9 19	5
7	How to run an efficient operation in a hybrid environment where the rest of the organization is still waterfall.	XL	1 papers 3 interviewees	14 18	5
11	How to stop self-managed scrum teams from becoming isolated islands.	XL	1 papers 1 interviewee	11 44	3

[1] Category
[2] Challenge number in Table 4.5 (SLR) and Table 5.4 (INTVW)

Table 6.2: Aggregation of the mentions of challenges.

Chapter 7

Challenges - Impact Survey
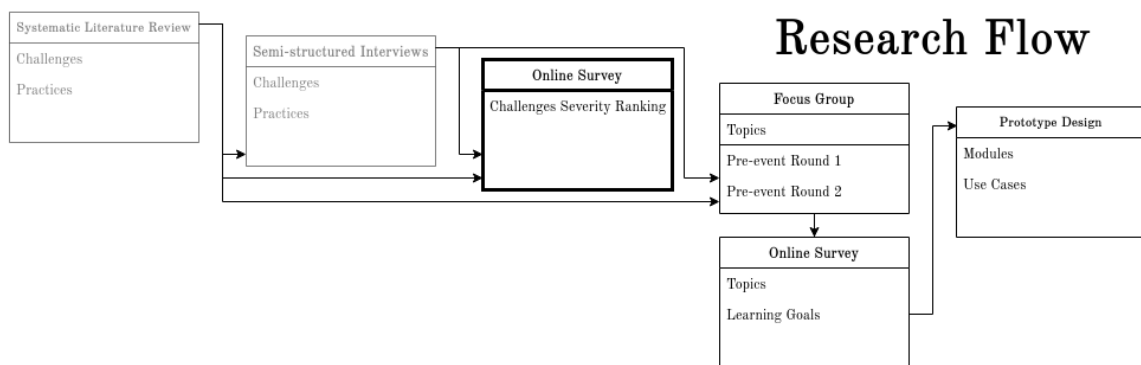
The aggregation of the challenges in Chapter 6 does not say anything about the impact they have had. In this chapter the research using the Challenges - Impact survey is detailed. First the setup of the survey is discussed. Then the results of the survey are presented.

7.1 Survey Setup

To create the list of challenges, first the challenges from the SLR and interviews in Chapter 4 and Chapter 5 were retrieved. Then the duplicates and linked challenges, which could be retrieved from Chapter 6 were removed from the list. After this there were a total of 50 challenges. The survey is aimed at the challenges only, which means there is no linking to the practices. This could mean the how-to form the challenges are in can be unclear and cause confusion. Therefore all challenges are converted from their how-to format to the-challenge-of format.

The survey was activated online on May 25, 2020 and a general call was made aimed at practitioners of agile in a XL scale globally distributed environment. This call for responses was made through the following channels:

- Researcher I's LinkedIn feed
- Researcher II's LinkedIn feed
- LinkedIn groups related to XL scale globally distributed agile
- The Twitter feed of one of the authors of [49]
- The email list of a prominent agile expert
- Contacts acquired during snowballing on expert's recommendation

7.2 Data Analysis

7.2.1 Metadata

The survey was open for responses for 9 weeks and was closed on July 24, 2020. In total 53 responses were gathered, with the respondents listing 17 different fields of work for their organization's area. The distribution of the years of agile experience of the respondents can be found in Figure 7.1.
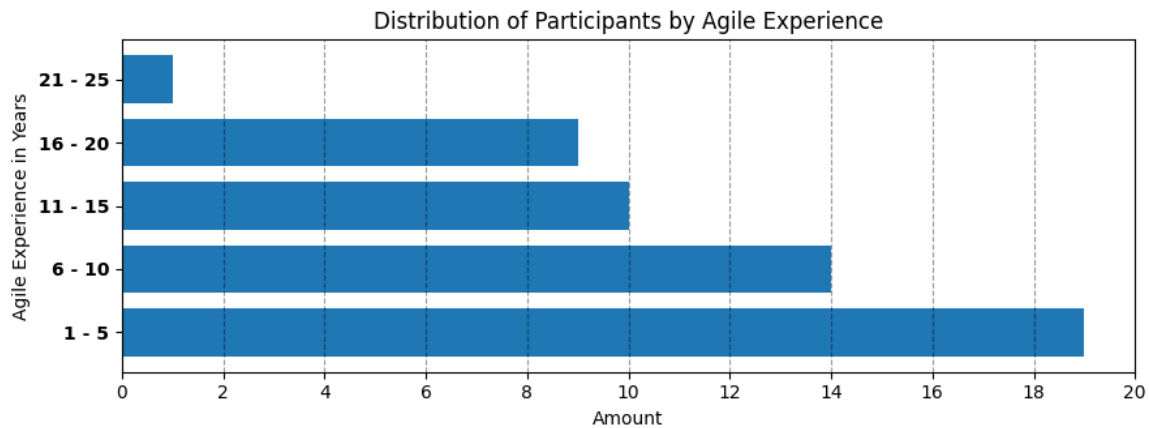
Figure 7.1: Distribution of agile experience of the participants.

To get an insight into the distribution of the agile areas of the respondents we take a look at their current roles. These roles are used to divide the respondents based on the rules of the groups that were set for the focus group and the Learning Goals survey in Section 3.3. Out of the 53 respondents, 4 listed multiple roles as their current roles. Of these 3 respondents can be classified into 2 groups, while 1 can be classified in all 3 groups. Furthermore 1 respondent stated he or she was retired.
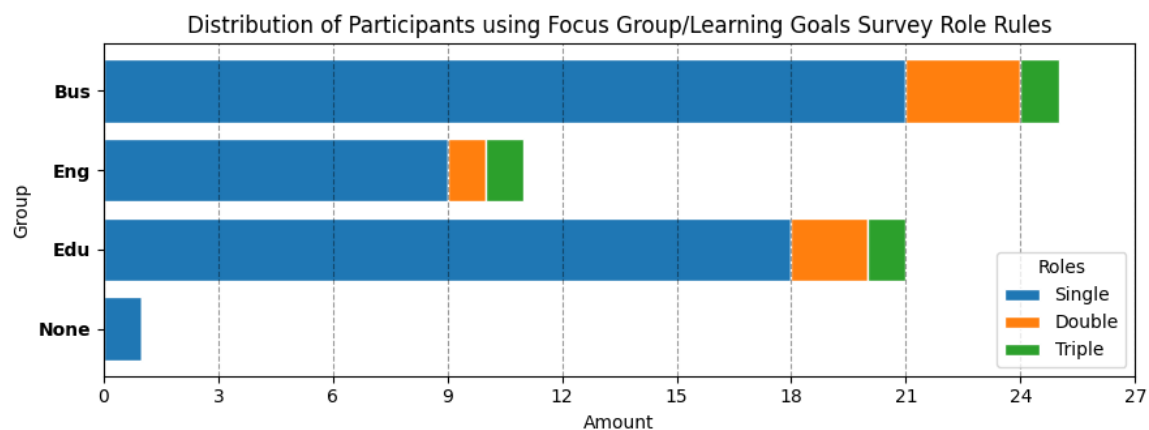
Figure 7.2: Distribution of participants by the rules of Section 3.3.

7.2.2 Results

The amount of N/A responses denotes how often a challenge was not encountered by the respondents. As a side effect of the survey an indication of the frequency of a challenge can be gained this way. From Figure 7.3 it can be seen only 2 challenges had a N/A response percentage bigger than 10% ($7/53 = 13.2\%$). These are both the budget-related challenges, being 'aligning everyone to the same budget form' and 'balancing the travel budget with people's needs'. All other challenges had a N/A response percentage less than 8% ($4/53 = 7.5\%$). This indicates all 50 challenges are very frequently encountered in practice.
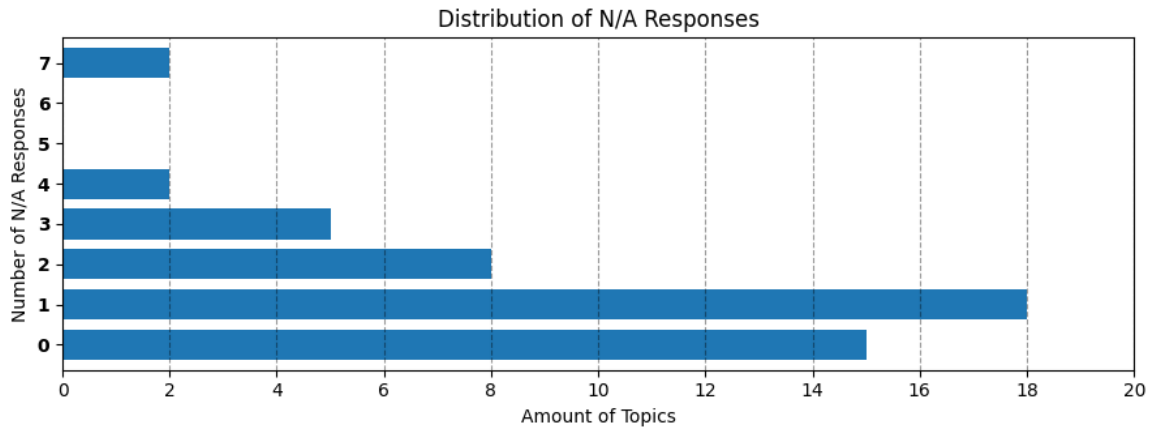
Figure 7.3: Distribution of N/A Responses.

If the severity of all responses are considered, a N/A response would be used as a 0 in the calculation. Such a response would lower the calculated severity by roughly $0.02 * avg\ of\ non-zero\ severities$. As all challenges have a N/A response percentage of less than 15%, with it being less than 5% for majority of the topics ($2/53 = 3.7\%$), the N/A responses could have a small, but unfair skewing of the ranking of challenges with a high calculated severity. Therefore these responses were not considered when calculating the average severity. This means the formula for severity calculation needs a small modification to account for this change. The modified formula can be found in Figure 7.4.

$$severity = \frac{\sum(severity\ level * responses)}{total\ responses - N/A\ responses}$$

Figure 7.4: Formula used for challenge severity calculation.

The results with the challenges ranked by their calculated severity can be found in Table 7.5. The mean of the calculated severities is 3.31, with 41 of 50 challenges having a calculated severity of at least 3.00 (*Significant*).

When looking at the challenges with the highest calculated severity, one thing immediately sticks out. In some shape or form, the top 3 challenges are all related to how agile affects the way of working of the organization as a whole. A proposal for new research that looks into the origins of the high impact of the challenges in this area and how this impact could be lessened could be made.

Rank	Challenge	Sev
1	The challenge of bringing agility to all levels of the organization.	4.21
2	The challenge of improving on the agile implementation, when the organization thinks they are already agile (fake agile).	4.13
3	The challenge of running an efficient operation in a hybrid environment where the rest of the organization is still waterfall.	3.88
4	The challenge of minimizing the amount of code inter-dependencies.	3.80
5	The challenge of scaling agile to work effectively in a large environment.	3.70
6	The challenge of eliminating change resistance towards agile methods and/or the transition.	3.65
7	The challenge of dealing with instability after reorganisation due to scale and distribution.	3.64
8	The challenge of creating an environment where the teams have ownership and are independent.	3.63
9	The challenge of having effective communication between teams and management.	3.62
10	The challenge of integrating customer collaboration in an effective way.	3.58
11	The challenge of having effective communication with (non-agile) third-parties.	3.55
12	The challenge of tight scheduling leading to multiple teams, instead of a single one, working on the same feature in a chaotic way.	3.54
13	The challenge of balancing team personalities for improved cooperation.	3.51
14	The challenge of improving trust in leadership with the distributed teams.	3.50
15	The challenge of aligning everyone to the same vision.	3.49
15	The challenge of implementing proper tools and data to analyse your way of working to encourage data-driven decision making	3.49
17	The challenge of enabling the teams to see the big picture.	3.47
17	The challenge of improving on the agile workflow after its original implementation.	3.47
17	The challenge of instilling the principles of agile into the mindset.	3.47
20	The challenge of changing the development method, which is harder when being globally widespread.	3.43
21	The challenge of creating a proper agile (hybrid, living) roadmap.	3.42
21	The challenge of finding suitable metrics for value reporting.	3.42
23	The challenge of letting important meetings be useful, due to the amount of participants and/or conferencing tools.	3.40
23	The challenge of planning estimates between engineers and other departments not being in sync.	3.40
25	The challenge of balancing team reallocation with people's needs.	3.37
26	The challenge of applying agile methods on the maintenance cycle of old and/or legacy systems.	3.35
	Continued on next page	

26	The challenge of streamlining big meetings, due to the amount of participants and/or the usage of conferencing tools.	3.35
28	The challenge of ensuring every role has had the proper amount of knowledge education.	3.34
29	The challenge of aligning release cycles between various modules or systems.	3.33
30	The challenge of reducing turnover rate to create more stability in teams.	3.30
31	The challenge of finding the right balance between the flexibility and stability of teams to reduce knowledge and efficiency loss.	3.29
32	The challenge of keeping everybody aligned and up to date.	3.26
32	The challenge of reducing differences in agile education levels across different locations.	3.26
34	The challenge of task management (e.g. duration, amount of parallel tasks running).	3.25
35	The challenge of acting on and implementing feedback gathered during retrospectives.	3.24
36	The challenge of preventing teams from becoming isolated islands.	3.23
37	The challenge of implementing agile in a standardized way, but still allowing for variations that suits the local situation.	3.20
38	The challenge of having effective communication between teams.	3.19
39	The challenge of being creative with agile without losing the manifesto's values and principles.	3.04
40	The challenge of having (major) meetings with everyone present due to time zones.	3.02
41	The challenge of clearly defining the responsibility of every role.	3.00
42	The challenge of aligning everyone to the same budget form.	2.93
43	The challenge of preventing distributed team members from becoming lonely and unhappy.	2.90
44	The challenge of conducting the daily rituals, that work less well as a teleconference.	2.83
45	The challenge of minimizing the effect of time zones on the work.	2.81
45	The challenge of reducing the effect of cultural differences.	2.81
47	The challenge of balancing code ownership.	2.77
48	The challenge of minimizing the effect of the physical distances on the work.	2.53
48	The challenge of minimizing the effect of various public holidays in different locations on the work.	2.53
50	The challenge of balancing the travel budget with people's needs.	2.52

Table 7.5: Challenges ranked by calculated severity.

Chapter 8

Aggregation of Practices

In this chapter an aggregation of the mentions of practices found in Chapter 4 and Chapter 5 is made. This will be done by calculating the mention score of each practice. There are 5 accepted papers and 10 interviewees. To ensure the weight of a mention is fair between them, a formula will be used to balance the weights. As there are twice as many interviewees than accepted papers, a mention by an accepted paper will be worth double. The formula used for calculation can be found in Figure 8.1. Furthermore, for a practice to be listed, it needs to be mentioned in both the SLR and interviews.

$$mention\ score = 2 * SLR\ mentions + interview\ mentions$$

Figure 8.1: Formula used to calculate a practice's mention score.

The results of the aggregation can be found in Table 8.2. It clearly shows the importance of proper education and coaching, with these practices topping the ranking. Furthermore, this belief is reinforced when looking at the challenges the practices link to. Proper education and coaching link to over half of the found challenges. This does include the highest ranked challenge of the challenges aggregation in Chapter 6, eliminating change resistance.

However conducting an internet search on training for (XL scale) distributed agile revealed that only a handful of short courses for this exists [1][39][41][54]. Therefore in Chapter 9 research is conducted into the content that could be in an education program for XL scale distributed agile, which will be the building blocks for a prototype in Chapter 10.

Rank	Practice	Mentioned by	PNr.[1]	Score
1	Make sure all employees have had proper agile training.	3 papers 7 interviewees	2 1	13
2	Hire coaches to help with and guide the adoption.	2 papers 5 interviewees	4 3	9
3	Split meetings into local and global versions.	3 papers 2 interviewees	1 21	8
3	Divide the teams in a way (e.g. value streams, domains) that creates knowledge areas.	1 papers 6 interviewees	8 2	8
5	Make use of visualization boards and/or tools.	2 papers 3 interviewees	3 12	7
5	Invest in the automation of testing and/or building environment.	1 papers 5 interviewees	12 4	7
7	Create collaboration between the teams early in the development phase.	1 papers 3 interviewees	10 13, 25 & 50	6
8	Bring in an expert for external advice.	1 papers 1 interviewee	7 59	3
8	Clearly convey the 'why' and the added value of agile to all employees.	1 papers 1 interviewee	14 64	3
8	Make use of a hybrid model that creates a base of connecting rules, but allows for adaption to the local situation.	1 papers 1 interviewee	18 80	3
8	Use a staggered rollout of agile per project, instead of the whole organization at once.	1 papers 1 interviewee	17 53	3

[1] Practice number in Table 4.6 (SLR), Table 5.5 (INTVW) and Table G.1 (INTVW)

Table 8.2: Aggregation of the mentions of practices.

Chapter 9

Learning Goals Survey

Research Flow
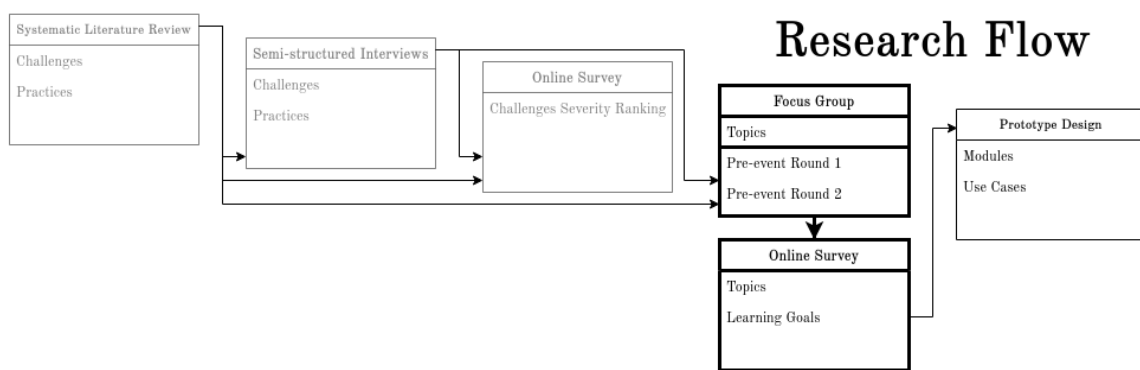
Chapter 8 has shown proper education as the most mentioned practice. Furthermore, it was linked to over half of the total extracted challenges. Therefore in this chapter we present the research to find suitable learning goals for an Education Program prototype. As stated in Section 1.4, the Learning Goals survey was originally a focus group, but got changed due to COVID-19. First the preparations and results of pre-event round 1 will be described. Then the details of gathering responses for the replacement Learning Goals Survey will be described. Finally the results of the aggregation of the and pre-event round 2 and the Learning Goals survey will be presented and analysed.

9.1 Event Preparations

9.1.1 Invitations

To be able to conduct the focus group, experts are needed that take part in the event. Experts who fulfilled the requirements of one of the groups in Section 3.3 were approached. The experts who got an invitation to be part of the focus group can be divided into the following types:

- Experts working for an organization that helped with the interviews. Extra requirement was they were not a direct colleague of any of the interviewees.
- Experts who were invited after being sought out on LinkedIn using searches with agile-related keywords.
- Experts who were invited after being found through Researcher II's network.
- Experts who were invited by snowballing on another expert's recommendation. Extra requirement was they were not part of the same organization as the recommending expert.

The extra requirements were added to reduce the chance of bias [58]. The 'not a direct colleague'-requirement was to eliminate participant's bias. There is a possibility of direct colleagues talking to each other about the pre-event rounds. This might influence their choices, instead of performing independently. The 'not from the same organization as the recommending expert'-requirement was added to eliminate measurement bias. If too many experts are representing the same organization, there is a possibility it might skew the results to their specific situation.

9.1.2 Converting Challenges and Practices to Topics

As stated in Section 3.3 the topics in this list are based upon the challenges and practices found in Chapter 4 and Chapter 5. To create a list of possible topics on every challenge and practice the following conversion protocol is used:

1. Determine the generalized subject of the challenge or practice.
2. Determine if the subject is a teachable subject.
3. If the subject is teachable and **not yet** in the topic list, add it as a topic and link the challenge or practice to it.
4. If the subject is teachable and **already** in the topic list, link the the challenge or practice to the existing topic.

After all challenges and practices have been processed certain topics in the list are still ambiguous, which could lead to experts having different interpretations. Therefore the following clean-up protocol is used on the topic list:

1. If the topic contains the word 'and', try to split the topic into subtopics.
2. If the topic on its own is ambiguous, add an explanation based on the linked challenges and practices to make its intention clear.

9.1.3 Topics List used for Pre-event Round 1

In total 35 topics were created and can be found be found in Table 9.1. This table also includes the origin of the challenges and practices a topic was based on. The full description of the topics as send to the focus group participants can be found in Appendix I.1.

Topic	Origin
Agile roadmap	(INTVW)
Agile workflow specifics	(SLR, INTVW)
Agile workflow iterating	(SLR, INTVW)
Automation of the development environments	(SLR, INTVW)
Balance of team personalities	(INTVW)
Balance of code ownership	(INTVW)
Creativity in agile without losing the manifesto's values and principles	(SLR, INTVW)
Communication with customers	(SLR, INTVW)
Communication with non-agile departments	(INTVW)
Communication with non-agile third-parties	(INTVW)
Communication with remote teams	(SLR, INTVW)
Communication with remote team members	(SLR, INTVW)
Cultural awareness training	(INTVW)
Cultural soft skills training	(INTVW)
Impact of differing Public Holidays	(INTVW)
Legacy systems in agile workflows	(SLR, INTVW)
Management of code inter-dependencies	(INTVW)
Management of testing ownership	(INTVW)
Measures to prevent teams from becoming isolated islands	(SLR, INTVW)
Minimization of chaos in meetings with over 50 participants	(SLR, INTVW)
Minimization of chaos in teleconference meetings	(SLR, INTVW)
Minimization of the effect of time zones on work	(SLR, INTVW)
Practical considerations for team autonomy	(SLR, INTVW)
Practical considerations for team resource allocation	(INTVW)
Practical considerations for travel decision making	(INTVW)
Project Progress Tracking	(SLR, INTVW)
Release cycle alignment	(SLR, INTVW)
Responsibility Assignment (RACI) matrix	(INTVW)
Ritual implementation	(SLR, INTVW)
Suitable Project Progress metrics	(INTVW)
Teambuilding	(INTVW)
Teams with dislocated team members	(INTVW)
The reasons why the organization is doing agile	(SLR, INTVW)
User story breakdown into tasks	(SLR, INTVW)
Usage of feedback gathered at rituals	(SLR, INTVW)

Table 9.1: List of topics that was used for pre-event round 1.

9.1.4 Additions after Pre-event Round 1

After the list in Table 9.1 was sent out, multiple participants mailed in their feedback. This resulted in 10 additions to the list as well as tweaks to multiple descriptions of original topics. Below the added topics are listed, the full description for these can be found in Appendix I.2.

- Embedment of the documented values, principles and behavior in everything you do and design
- HR processes in agility
- Impact of agility on the complete organization
- Item Product Definition
- Leadership Role
- Organizational hierarchy
- Team career paths facilitation
- The difference between efficiency and effectivity
- The people side of change
- Working agile in a traditional enterprise context

9.2 Learning Goals Survey

As stated in Section 3.4 the survey was an edited version of the survey used for pre-event round 2. After the edits were made, the survey was put online on April 1, 2020. In total 21 responses were gathered over the course of 11 weeks, with the final response on June 15, 2020. Table 9.2 contains the metadata of the gathered responses. Over 10 organizations were represented in the survey. The respondents to the survey can be divided into 4 different types of experts:

- Experts who were going to attend the focus group event.
- Experts who wanted to help, but were not available on March 20, 2020.
- Experts who were invited to take the survey after being sought out on LinkedIn using searches with agile-related keywords.
- Experts who were invited to take the survey after being found through Researcher II's network.

Responses	Amount
Total	21
Event	4
Survey	17

Group	Total	Event	Survey
Business	7	2	5
Engineering	7	1	6
Educators	7	1	6

Table 9.2: Responses metadata of the Learning Goals Survey.

The amount of responses per group is **7**, this means the calculated two-third qualified majority (QM)[29] is $7 * 2/3 = 4\ 2/3$. Rounding this number means the amount of Yes-votes needed for a qualified majority is **5**. The metadata for the results can be found in Table 9.3. Furthermore, the full results of the survey can be found in Appendix K. The experts rejected 5 topics, which means 40 topics got a qualified majority from at least 1 group.

Group	Yes - QM votes
Business	26
Engineers	32
Educators	33

Type	Amount
Topics with 0 Yes - QM votes	5
Topics with 1 Yes - QM vote	9
Topics with 2 Yes - QM votes	11
Topics with 3 Yes - QM votes	20

Table 9.3: Voting metadata of the Learning Goals Survey.

9.2.1 MoSCoW Learning Goals

The 40 accepted topics from the results in Appendix K were combined with the MoSCoW [65] qualifications set in Table 3.5. Based on the results the topics have been divided into their ranking and turned into learning goals. To help with the generation of proper learning goals, Section 2 of [9] was used as a guide.

Firstly, the 20 'must haves' can be found in Table 9.4. Secondly, the 11 'should haves' can be found in Table 9.5. Finally, the 9 'could haves' can be found in Table 9.6. The created learning goals will be used as input to create an Education Program prototype in Chapter 10.

9.2.2 Discussion

From the results in Appendix K, it can be seen that the MoSCoW-ranking of the topics in the majority of cases is based on a single vote. Of the 11 topics marked as 'Should', there were 7 missing a single vote to be ranked 'Must'. Furthermore, of the 9 topics being marked as 'Could', 8 were missing a single vote to be ranked 'Should'.

Likewise, we can also look at the single votes that were just enough to get the higher ranking. In total, 23 of the 40 ranked topics got their ranks determined on a single vote. Of these 12 are ranked 'Must', 6 are ranked 'Should' and 5 are ranked 'Could'.

Finally we can take a look at the 5 unranked topics that were rejected by the experts. Of these there were 2 topics that missed a single vote be ranked.

The experts worked through the survey independently and had no contact with each other. In the case where the event would have been conducted, the experts would have been able to discuss the border cases. If an expert would have changed his vote as a result of the discussions, it could have affected the ranking of the majority of topics. Therefore it can be concluded the event could have had a significant impact on the ranking of the topics.

After the education program, the participants **must**...		
#	**Learning Goal**	**Level**
M1	...be able to explain the differences between a traditional and an agile roadmap, and can create and work with an agile roadmap.	KSA
M2	...be able to explain proper procedures how to describe and document workflow adaptions and improvements, and can create said documentation.	KS
M3	...be able to explain how to use the automated tools used within the development environments and can use them in practice.	KSA
M4	...be able to evaluate and adjust the balance of the personalities of a team.	KSA
M5	...be able to conduct proper and clear communication with customers.	KSA
M6	...be able to conduct proper and clear communication with remote teams.	KSA
M7	...be able to conduct proper and clear communication with remote team members.	KSA
M8	...be able to conduct themselves with normal and expected behaviors within specific other cultures.	KSA
M9	...be able to explain how agility affects the complete organization.	K
M10	...be able to explain the overall product the organization is developing and can create documentation for changes to this product.	KS
M11	...be able to explain how the roles of leadership and distributed leadership differ and can use this knowledge in their daily workflows.	KSA
M12	...be able to identify issues leading to autonomous teams becoming an isolated islands and can apply measures to keep the communication going.	KSA
M13	...be able to create and distribute a visualization of 'The Big Picture' to all layers of a project.	KS
M14	...be able to explain how to align release cycles of various modules or projects.	K
M15	...be able to do an analysis to find proper metrics for measuring project progress.	K
M16	...be able to explain how team building can improve the organization, can identify which areas would see benefits from it and can organize events to promote it.	KSA
M17	...be able to explain the differences between agile and lean processes.	K
M18	...be able to recall practical considerations when striving for continuous improvement and/or sustainable growth and use them in the decision making process.	KSA
M19	...be able to explain the reasons why the organization is adopting agile ways of working.	K
M20	...be able to explain ways to benefit from agile ways of working when the organization at large is still operating in a waterfall mindset, identify which ways can be used in the organization and apply those in practice.	KSA

Table 9.4: Resulting learning goals with a ranking of **Must**.

After the education program the participants **should**...		
#	**Learning Goal**	**Level**
S1	...be able to evaluate and adjust the balance of code ownership.	KSA
S2	...be able to apply creativity to their agile workflow without losing the manifesto's values and principles.	KSA
S3	...be able to conduct proper and clear communication with non-agile departments.	KSA
S4	...be able to use HR processes in agility.	KSA
S5	...be able to integrate the development and/or maintenance of legacy systems into their agile workflows.	KS
S6	...be able to explain how to reduce the amount of code inter-dependencies and can create proper documentation on the responsibilities for the connecting parts.	KS
S7	...be able to explain how to minimize the effect of time zones on work.	K
S8	...be able to recall practical considerations for team autonomy.	K
S9	...be able to recall the definitions of their role and the responsibilities that come with it.	K
S10	...be able to explain the pitfalls that can occur when spreading a team over multiple locations.	K
S11	...be able to explain methods to spread feedback and improvements throughout the organization, identify which methods are suitable for the organization and apply those in practice.	KSA

Table 9.5: Resulting learning goals with a ranking of **Should**.

After the education program the participants **could**...		
#	**Learning Goal**	**Level**
C1	...be able to recall and use the documented way of working of the organization.	KSA
C2	...be able to conduct proper and clear communication with non-agile third-parties.	KSA
C3	...be able to recall soft skills that are useful when dealing with people from other cultures and apply them in practice.	KSA
C4	...be able to justify how the documented values, principles and behavior are embedded in the things they do and design.	KSA
C5	...be able to explain how to minimize chaos in teleconference meetings.	K
C6	...be able to identify signs of problems being solved by putting people back into a traditional hierarchy and can apply measures to prevent this.	KSA
C7	...be able to recall practical considerations for team resource allocation and use them in the decision making for allocation.	KS
C8	...be able to explain ways to grow team members from start to outflow, can evaluate which ways are suitable for application and apply those practice.	KSA
C9	...be able to generate tasks of manageable size and duration from a user story.	KS

Table 9.6: Resulting learning goals with a ranking of **Could**.

Chapter 10

Education Program Prototype
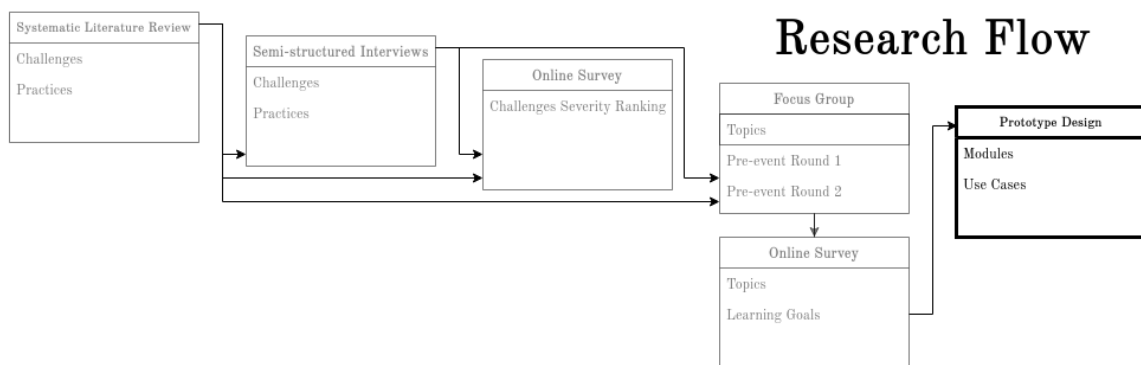
In this chapter we create a prototype of an education program for XL scale distributed agile. First the description of the modules created using the input of Chapter 9 are presented. Then 4 use cases are discussed to show how these modules can be used to design courses. Finally we suggest teaching methods that could be used to teach part of the modules.

The importance of planning for a proper education program is noted by Gandomani et al. [23]. To ensure the effects of the education can take hold and possible improvements can be spotted and implemented, the program should have a length of about 6 months, which would be equal to 26 weeks. The weeks can be divided into the 'Teaching' part and the 'Coaching' part.

The 'Teaching' part consists of 2 weeks formatted as 1-week courses in which the students are taught the basics they need. This is on Researcher II recommendation to split the 2 teaching weeks up. We recommend one teaching week to be planned at the beginning of the education program. The other should be planned after the end of a sprint around the halfway point of the program, around week 13.

The other 24 weeks are the 'Coaching' part and are run as actual sprints. There is of course the possibility of running a trial sprint first, then implement the lessons learned from this trial into the first real sprint. The amount of weeks was chosen this way as both 12 and 24 is dividable by all of the most used sprint lengths (2, 3, 4 or 6 weeks). This allows for the end of the education program to sync up with the end of the sprints. It also allows for easier scheduling of the second 'Teaching' week in case not all departments run at the same sprint length. During these coaching weeks the educators should stay active and guide the students through the more intricate parts of the modules.

10.1   Modules

10.1.1   Must Have-modules

Module A - Agile and the Organization

Topics covered:
1. Impact of agility on the complete organization
2. Item Product Definition
   The overall product the organization is developing as described or documented.
3. The reasons why the organization is doing agile
4. Agile workflow specifics
   The formal way of working of the organization as described or documented.

- -

After this module the students...
1. ...must be able to explain how agility affects the complete organization.
2. ...must be able to explain the overall product the organization is developing and can create documentation for changes to this product.
3. ...must be able to explain the reasons why the organization is adopting agile ways of working.
4. ...could be able to recall and use the documented way of working of the organization.

- -

For: Everyone

Module B - Agile in a Mixed Enterprise Context

Topics covered:
1. Working agile in a traditional enterprise context
   The ways to benefit from agile ways of working when the organization at large has not embraced this and is still operating in a stage gated waterfall mindset.
2. Communication with non-agile departments
3. Communication with non-agile third-parties

- -

After this module the students...
1. ...must be able to explain ways to benefit from agile ways of working when the organization at large is still operating in a waterfall mindset, identify which ways can be used in the organization and apply those in practice.
2. ...should be able to conduct proper and clear communication with non-agile departments.
3. ...could be able to conduct proper and clear communication with non-agile third-parties.

- -

For: Everyone
Note: This is a situational module. This module should only be used when the organization is partially agile and partially waterfall.

Module C - Agile Mindset

Topics covered:

1. The difference between efficiency and effectivity
   Details on how the agile and lean processes differ from each other.
2. The people side of change
   Practical considerations when striving for continuous improvement and/or sustainable growth.
3. Embedment of the documented values, principles and behavior in everything you do and design

After this module the students...

1. ...must be able to explain the differences between agile and lean processes.
2. ...must be able to recall practical considerations when striving for continuous improvement and/or sustainable growth and use them in the decision making process.
3. ...could be able to justify how the documented values, principles and behavior are embedded in the things they do and design.

For: Everyone

Module D - Code Development in an Agile Environment

Topics covered:

1. Automation of the development environments
   Details of the automated tools used within the development environment.
2. Release cycle alignment
   Details on the alignment of the release cycles of various modules or projects.
3. Legacy systems in agile workflows
   Integration of legacy development and/or maintenance into the agile workflow.
4. Management of code inter-dependencies
   Documentation of which team is responsible for which test and procedures if tests break down.

After this module the students...

1. ...must be able to explain how to use the automated tools used within the development environments and can use them in practice.
2. ...must be able to explain how to align release cycles of various modules or modules or projects.
3. ...should be able to integrate the development and/or maintenance of legacy systems into their agile workflows.
4. ...should be able to explain how to reduce the amount of code inter-dependencies and can create proper documentation on the responsibilities for the connecting parts.

For: Engineers, Management with code-related responsibilities

Module E - Cultural Awareness

Topics covered:

1. Cultural Awareness Training
Training individuals and/or teams in normal and expected behaviors within specific other cultures.

After this module the students...

1. ...must be able to conduct themselves with normal and expected behaviours within specific other cultures.

For: Everyone

Module F - Customer Communication

Topics covered:

1. Communication with customers

After this module the students...

1. ...must be able to conduct proper and clear communication with customers.

For: Everyone with customer-facing responsibilities

Module G - Dealing with Distributed Teams

Topics covered:

1. Communication with remote teams
2. Communication with remote team members
3. Teams with dislocated team members
The pitfalls when spreading a team over multiple locations

After this module the students...

1. ...must be able to conduct proper and clear communication with remote teams.
2. ...must be able to conduct proper and clear communication with remote team members
3. ...should be able to explain the pitfalls that can occur when spreading a team over multiple locations.

For: Every team member

Module H - Iterative Improvement of Agile Workflows

Topics covered:

1. Agile workflow iterating
   Describing or documenting adaptions and improvements to the original agile implementation.
2. Creativity in agile without losing the manifesto's values and principles
   Adaption of the agile implementation with retainment of agile's key values.
3. Usage of feedback gathered at rituals
   Spreading feedback and improvements through the organization.

- -

After this module the students...

1. ...must be able to explain proper procedures how to describe and document workflow adaptions and improvements, and can create said documentation.
2. ...should be able to apply creativity to their agile workflow without losing the manifesto's values and principles
3. ...should be able to explain methods to spread feedback and improvements throughout the organization, identify which methods are suitable for the organization and apply those in practice.

- -

For: Everyone

Module I - Planning in an Agile Environment

Topics covered:

1. Agile roadmap
   Differences with a normal roadmap and the different types of agile roadmaps.
2. User story breakdown into tasks
   Management of the size and duration of a task.

- -

After this module the students...

1. ...must be able to explain the differences between a traditional and an agile roadmap, and can create and work with an agile roadmap.
2. ...could be able to generate tasks of manageable size and duration from a user story.

- -

For: Everyone with planning-related responsibilities

Module J - Team Creation in a Distributed Agile Environment

Topics covered:

1. Balance of team personalities
   The way in which a healthy mix of personalities in a team creates balance.
2. Teambuilding

After this module the students...

1. ...must be able to evaluate and adjust the balance of the personalities of a team.
2. ...must be able to explain how team building can improve the organization, can identify which areas would see benefits from it and can organize events to promote it.

For: Team Leads

Module K - Team Leading in a Distributed Agile Environment

Topics covered:

1. Measures to prevent teams from becoming isolated islands
   Measures to keep communication going between autonomous teams.
2. Balance of code ownership
   The way in which the right amount of code ownership creates a more flexible organization.

After this module the students...

1. ...must be able to identify issues leading to autonomous teams becoming an isolated islands and can apply measures to keep the communication going.
2. ...should be able to evaluate and adjust the balance of code ownership.

For: Team Management, Team Leads

Module L - Tracking and Monitoring

Topics covered:

1. Project Progress Tracking
   The ways in which 'The Big Picture' can be provided to all layers of the project.
2. Suitable Project Progress metrics
   Goodhart's law: 'When a measure becomes a target, it ceases to be a good measure.'

After this module the students...

1. ...must be able to create and distribute a visualization of the high-level perspective to all layers of a project.
2. ...must be able to do an analysis to find proper metrics for measuring project progress.

For: Everyone with planning-related responsibilities

Module M - Your Agile Role

Topics covered:

1. Leadership Role
   Details on how the roles of leadership and distributed leadership differ.
2. Responsibility Assignment (RACI) matrix
   Clarification and definitions of the roles and responsibilities.
3. Organizational hierarchy
   Measures to prevent problems being solved by putting people back into a traditional hierarchy.

After this module the students...

1. ...must be able to explain how the roles of leadership and distributed leadership differ and can use this knowledge in their daily workflows.
2. ...should be able to recall the definitions of their role and the responsibilities that come with it.
3. ...could be able to identify signs of problems being solved by putting people back into a traditional hierarchy and can apply measures to prevent this.

For: Everyone
Note: Not all learning goals are needed for all roles, this module can be partially taught as a whole group and partially targeted for each role.

10.1.2 Should Have-modules

Module N - Dealing with Distribution

Topics covered:

1. Minimization of the effect of time zones on work
   The ways to overcome the lower overlap of common working hours.
2. Minimization of chaos in teleconference meetings

After this module the students...

1. ...should be able to explain how to minimize the effect of time zones on work.
2. ...could be able to explain how to minimize chaos in teleconference meetings.

For: Everyone

Module O - HR Agility

Topics covered:

1. HR processes in agility
   The ways in which agility impacts HR.

After this module the students...

1. ...should be able to use HR processes in agility.

For: HR

Module P - Team Management in a Distributed Agile Environment

Topics covered:

1. Practical considerations for team autonomy
2. Practical considerations for team resource allocation
3. Team career paths facilitation
   The ways to grow team members from start to outflow: realizing their dreams, maximizing impact of their work.

After this module the students...

1. ...should be able to recall practical considerations for team autonomy.
2. ...could be able to recall practical considerations for team resource allocation and use them in the decision making for allocation.
3. ...could be able to explain ways to grow team members from start to outflow, can evaluate which ways are suitable for application and apply those practice.

For: Team Management

10.1.3   Could Have-modules

Module Q - Cultural Soft Skills

Topics covered:

1. Cultural soft skills training
   Training individuals and/or teams in soft skills that are useful in dealing with people from other cultures.

After this module the students...

1. ...could be able to recall soft skills that are useful when dealing with people from other cultures and apply them in practice.

For: Everyone
Note: This module can be used as follow-up to module 'E - Cultural Awareness'. It can be used to give certain locations additional cultural training if it turns out to be needed.

10.1.4 Conversion Protocol from Topics to Modules

The modules described in the previous subsections are created from the accepted topics and their respective learning goals in Chapter 9. To create the list of modules on every associated combination of accepted topics and learning goals the following conversion protocol was used:

1. Determine the roles that have responsibilities related to the combination.
2. Determine overarching subject for the combination.
3. If the overarching subject is **already** present in the modules list and the determined roles **do** match, add the combination to this module.
4. If the overarching subject is **already** present in the modules list and the determined roles **do not** match, split the existing module into 2 new modules and reassign all relevant combinations.
5. If the overarching subject is **not yet** present in the modules list, create a new module and assign the combination to it.
6. Rank the module based on its highest rank learning goal (Must, Should or Could).

10.2 Use Cases

Now we have made a detailed description of the learning goals for 17 modules. However, these are not yet fully detailed to give a course tomorrow. What we will do is explain how these module descriptions can be used to design custom fit courses. For that we will provide 4 example use cases. We will sketch 4 settings in which a course for XL scale distributed agile will be needed, and how, keeping in mind the specific setting, the list of modules can be used to construct a matching training program.

In the first use case we describe a course for an organization that is already working in a XL globally distributed environment, but is not using agile yet. Then for the second use case we flip the scenario and describe a course for an organization that already has a XL scale agile environment, but is not globally distributed yet. In the third case we assume neither of these environments is already existing. The organization does not have a XL scale agile nor XL globally distributed environment yet, but wants to make the switch to both. Finally for the last use case, we will take the previous use case and add an extra stipulation to it. In this fourth use case we take a variation of the environment as the organization is now starting up. However, due to this they will only be able to co-locate every employee for a limited time, so the course can only last for 2 days. A summary of the different situations is tabulated in Table 10.1.

Use case:	Already agile:	Already distributed:	Special situation:
Use case 1	No	Yes	-
Use case 2	Yes	No	-
Use case 3	No	No	-
Use case 4	No	No	16 hour Crash Course

Table 10.1: Overview of the organization's situation in every use case.

10.2.1 Use Case 1 - Description

Organization A currently has 10 teams in The Netherlands, 5 teams in India and 5 teams in Malaysia. They are currently using the waterfall model and want to move the whole organization over to using agile.

10.2.2 Use Case 1 - Program

Selected modules:

- A - Agile and the Organization
- B - Agile in a Mixed Enterprise Context
- C - Agile Mindset
- D - Code Development in an Agile Environment
- F - Customer Communication
- H - Iterative Improvement of Agile Workflows
- I - Planning in an Agile Environment
- L - Tracking and Monitoring
- M - Your Agile Role
- O - HR Agility

Optional modules:

- E - Cultural Awareness
- K - Team Leading in a Distributed Agile Environment
- P - Team Management in a Distributed Agile Environment
- Q - Cultural Soft Skills

Due to the organization being already distributed, it affects the selection process for distributed-related modules. Certain modules have been selected as optional. Whether or not these modules are used should depend on how much the distributed mindset is already ingrained in the organization. Furthermore, there will be a transition period during the first coaching period while the whole organization settles into its new rhythm. As there might be some differences in getting up to speed between different departments, this might lead to temporary discrepancies between them. To help the organization get through these temporary discrepancies module B is selected.

Teaching: Week 1 & Week 14

Certain modules could be combined to be taught on the same day, these combinations are:

- A - Agile and the Organization & C - Agile Mindset
- B - Agile in a Mixed Enterprise Context & F - Customer Communication
- K - Team Leading in a Distributed Agile Environment & P - Team Management in a Distributed Agile Environment
- M - Your Agile Role & O - HR Agility

Coaching: Week 2-13 & Week 15-26

The modules are divided into modules that the students should be coached on during the first coaching period or during both coaching periods.

First period:

- A - Agile and the Organization
- B - Agile in a Mixed Enterprise Context
  Suggested feedback session: At the beginning every week, can be phased out once all departments are up to speed.
- D - Code Development in an Agile Environment
  Suggested feedback session: Every 6 weeks.
- M - Your Agile Role
- O - HR Agility

Both periods:

- C - Agile Mindset
- F - Customer Communication
- H - Iterative Improvement of Agile Workflows
  Suggested feedback session: After every sprint
- I - Planning in an Agile Environment
  Suggested feedback session: After every 2 sprints
- (K - Team Leading in a Distributed Agile Environment)
- L - Tracking and Monitoring
  Suggested feedback session: Every 4 weeks
- (P - Team Management in a Distributed Agile Environment)

10.2.3   Use case 2 - Description

Organization B currently has 10 teams in The Netherlands and 10 teams in Finland. Now as part of an expansion, they want to add 10 teams in Singapore. B is already using agile throughout all departments.

10.2.4   Use Case 2 - Program

Selected modules:

- D - Code Development in an Agile Environment
- E - Cultural Awareness
- F - Customer Communication
- G - Dealing with Distributed Teams
- H - Iterative Improvement of Agile Workflows
- J - Team Creation in a Distributed Agile Environment
- K - Team Leading in a Distributed Agile Environment
- L - Tracking and Monitoring
- N - Dealing with Distribution
- P - Team Management in a Distributed Agile Environment

Optional modules:

- Q - Cultural Soft Skills

As a mirror to the previous use case, this time the selection process for agile-related modules is affected. The selection includes modules D, H and L, even though these modules are primarily intended for organization that are not agile yet. They have been selected as it can be useful to show how the existing processes the organization already has might be impacted by the global distribution. Finally, module Q is made an optional module again. This module is a follow-up module to module E and thus whether the module is used depends on the results from module E.

Teaching: Week 1 & Week 14

Certain modules could be combined to be taught on the same day, these combinations are:

- G - Dealing with Distributed Teams & N - Dealing with Distribution
- J,K & L - Team Creation, Team Leading & Team Management in a Distributed Agile Environment

---

Coaching: Week 2-13 & Week 15-26

The modules are divided into modules that the students should be coached on during the first coaching period or during both coaching periods.

First period:

- D - Code Development in an Agile Environment
  Suggested feedback session: Every 6 weeks.
- J - Team Creation in a Distributed Agile Environment

Both periods:

- F - Customer Communication
- G - Dealing with Distributed Teams
- H - Iterative Improvement of Agile Workflows
  Suggested feedback session: After every sprint
- K - Team Leading in a Distributed Agile Environment
- L - Tracking and Monitoring
  Suggested feedback session: Every 4 weeks
- N - Dealing with Distribution
- P - Team Management in a Distributed Agile Environment

10.2.5   Use Case 3 - Description

Organization C currently has 10 teams in The Netherlands, but are planning a big expansion. They want to add 10 teams in the USA, 10 teams in Malaysia and 10 teams in India. They are currently using the waterfall model, but want to move the development departments over to agile as part of the expansion.

10.2.6   Use Case 3 - Program

Selected modules:

- A - Agile and the Organization
- B - Agile in a Mixed Enterprise Context
- C - Agile Mindset
- D - Code Development in an Agile Environment
- E - Cultural Awareness
- F - Customer Communication
- G - Dealing with Distributed Teams
- H - Iterative Improvement of Agile Workflows
- I - Planning in an Agile Environment
- J - Team Creation in a Distributed Agile Environment
- K - Team Leading in a Distributed Agile Environment
- L - Tracking and Monitoring
- M - Your Agile Role
- N - Dealing with Distribution
- O - HR Agility
- P - Team Management in a Distributed Agile Environment

Optional modules:

- Q - Cultural Soft Skills

Due to the organization being neither agile or distributed already, the selection process for this use case is straightforward. All modules will be used in this case, with the following motivations for 2 specific modules: Firstly, there will be a transition period during the first coaching period while the whole organization settles into its new rhythm. As there might be some differences in getting up to speed between different departments, this might lead to temporary discrepancies between them. To help the organization get through these temporary discrepancies module B is selected. Secondly, just like the previous use case, module Q is made an optional module again due to its dependency on the results of module E.

Teaching: Week 1 & Week 14

Certain modules could be combined to be taught on the same day, these combinations are:

- A - Agile and the Organization & C - Agile Mindset
- B - Agile in a Mixed Enterprise Context & F - Customer Communication
- G - Dealing with Distributed Teams & N - Dealing with Distribution
- I - Planning in an Agile Environment & L - Tracking and Monitoring
- K - Team Leading in a Distributed Agile Environment & P - Team Management in a Distributed Agile Environment
- M - Your Agile Role & O - HR Agility

Coaching: Week 2-13 & Week 15-26

The modules are divided into modules that the students should be coached on during the first coaching period or during both coaching periods.

First period:

- A - Agile and the Organization
- B - Agile in a Mixed Enterprise Context
  Suggested feedback session: Early on every week, can be phased out once all departments are up to speed.
- D - Code Development in an Agile Environment
  Suggested feedback session: Every 6 weeks.
- J - Team Creation in a Distributed Agile Environment
- M - Your Agile Role
- O - HR Agility

Both periods:

- C - Agile Mindset
- F - Customer Communication
- G - Dealing with Distributed Teams
- H - Iterative Improvement of Agile Workflows
  Suggested feedback session: After every sprint
- I - Planning in an Agile Environment
  Suggested feedback session: After every 2 sprints
- K - Team Leading in a Distributed Agile Environment
- L - Tracking and Monitoring
  Suggested feedback session: Every 4 weeks
- N - Dealing with Distribution
- P - Team Management in a Distributed Agile Environment

10.2.7 Use Case 4 - Description

Organization D is starting up with 10 teams in The Netherlands, 10 teams in the USA, 10 teams in Malaysia and 10 teams in India. As part of this start they want the whole organization to use agile. However, due to time constraints they are only able to co-locate everybody for just 2 days. They have requested the education program to be a crash course and there is only a maximum of 16 hours of education time available.

10.2.8 Use Case 4 - Program

> **Selected modules:**
>
> - A - Agile and the Organization
> - C - Agile Mindset
> - D - Code Development in an Agile Environment
> - E - Cultural Awareness
> - F - Customer Communication
> - G - Dealing with Distributed Teams
> - H - Iterative Improvement of Agile Workflows
> - I - Planning in an Agile Environment
> - J - Team Creation in a Distributed Agile Environment
> - K - Team Leading in a Distributed Agile Environment
> - L - Tracking and Monitoring
> - M - Your Agile Role
> - N - Dealing with Distribution
> - O - HR Agility
> - P - Team Management in a Distributed Agile Environment

As with the other use cases, we first need to consider which modules will be needed. Since the starting situation is the same as use case 3, we can base most choices of that. However, we drop 2 modules off the list. First, as there is no transitional period this time module B is not used. Secondly, the module Q is a situational follow-up module to E. However, as the crash course is only 2 days, we do not have the time to evaluate if it will be needed and thus is also not used. This means we are using 15 out of 17 modules in the creation of this crash course.

The schedule for both days of the course can be found in Table 10.2. The days are aimed to be about 9 hours total, including coffee breaks and lunch. This is in line with a full lecture day at the TU Delft [63]. The days are divided into blocks, which each teaches a different aspect of XL scale distributed agile. The last hour of day 2 is designed to provide the students context to the full course, to give the students perspective into 'This is how what you have learned the past 2 days applies to you.'.

Of course with this being a crash course with limited time, there are some restrictions to what can be done. First of all, there is only time to teach the knowledge, the K parts for each module. Secondly, all the students will follow every block as opposed to more role-specialized education.

Day 1	
Hour	**Education**
H1	**Agile Block**
H2	A - Agile and the Organization, C - Agile Mindset,
H3	D - Code Development in an Agile Environment &
H4	H - Iterative Improvement of Agile Workflows
Break	
H5	**Distribution Block**
H6	E - Cultural Awareness, G - Dealing with Distributed Teams &
H7	N - Dealing with Distribution
H8	
Day 2	
Hour	**Education**
H1	**Teams Block**
H2	F - Customer Communication, J - Team Creation,
H3	K - Team Leading & P - Team Management in a Distributed Agile Environment
H4	
Break	
H5	**Management Block**
H6	I - Planning in an Agile Environment, L - Tracking and Monitoring &
H7	O - HR Agility
H8	M - Your Agile Role

Table 10.2: Use Case 4 - Schedules for Day 1 & 2.

10.3 Teaching Method Suggestions

The modules are still described at high-level. Researcher I is not an expert on agile training and this lack of knowledge means the implementation can not be described down to low-level. However, we can provide suggestions on what could possible be used as teaching methods.

We divide these suggestions into 2 lists. First we list the suggestions that can be used to teach the Knowledge parts of the modules. The second list contains the suggestions to teach the Skills and Attitude parts of the modules.

Suggestions to teach Knowledge:

- Books
- Articles
- Flipped Classroom Model [21]
- Lectures (possible held by students)
- Socratic Questioning [46]
- Videos

Suggestions to teach Skills and Attitude:

- Buzz Groups [64]
- Capstone projects (aka Inquiry-based Learning) [22]
- Cooperative Learning [56]
- Demonstrations
- Discussions
- Exercises (aka Kinesthetic Learning) [22]
- Games (aka Game-based Learning) [22]
- Mentoring [22]
- ShipIt Day [4] (E.g. have the team leaders organize this as part of one of their modules)
- Workshops [22]

Our final suggestion is for modules that contain topics that have an implementation level of 'KS' or 'KSA'. We recommend to use the 70-20-10 framework [31] as the learning framework for these modules. It should be noted that the 70-20-10 divide is a guideline and has its limitations. This means the divide should not be followed blindly [10][31]. We suggest the experts to survey the local situation and use it to update the distribution of the percentages.

Chapter 11

Conclusions

11.1 Research Questions

In this section we provide our conclusions based on the work in this thesis. We do this by answering our research questions formulated in Section 1.3.

RQ1: What challenges have occurred in practical XL scale globally distributed agile environments due to the scale?
RQ2: What challenges have occurred in practical XL scale globally distributed agile environments due to being globally distributed?

In the duration of the SLR and interviews we managed to identify 50 challenges, of them 11 where both mentioned in the SLR and interviews. Of the challenges, 25 had their origins in the scale, 11 had their origins in the global distribution and 14 had their origins in both.

When looking at the 14 challenges with origins in both, if we would remove one of the origins the challenge would still exist due to the other origin. We conclude that the combination of the XL scale and distribution does not add new challenges that are solemnly the result of the combination. However, adding the other origin can add a new dimension to a challenge. Examples of these are the challenge of streamlining big meetings when distribution is added and how to have effective communication.

RQ3: What practices have been proposed to combat these challenges?

We identified 72 practices used to combat the challenges, of them 11 where both mentioned in the SLR and interviews. A total of 56 practices were only mentioned by 1 paper or 1 interviewee. We conclude a lot of the practices might only work situationally and not be the be-all-and-end-all to combat a challenge.

However we were able to identify multiple practices that are often mentioned. The aggregation of practices showed that training and coaching are the most mentioned practices. The other practices that were found to be mentioned often through the congregation are:

1. Splitting meetings up into local and global versions.
2. Dividing teams into knowledge areas or value streams.
3. Making use of visualization tools to create an overview.
4. Investing significant budget in the automation of testing and building.
5. Making sure the teams have socialized with each other (the way how is situational).

We conclude these practices could be used to combat their linked challenges in a wide variety of XL scale globally distributed agile environments.

RQ4: When the challenges occur in practice, what is their frequency?

RQ5: When the challenges occur in practice, what is the severity of their impact?

The survey results showed all found challenges were frequently encountered in practice. Every challenge had an encounter rate of at least 85% under our 53 respondents.

Of the 50 challenges, 41 of them were found to on average have at least a *Significant* impact when encountered in practice. Furthermore, for 2 of those challenges this was at least a *Severe* impact.

The amount of respondents was only 53, which means the sample size of this survey could definitely be improved. However, they were representing organizations in no less than 17 different discipline areas, providing a wide variety in environments. We conclude an organization should make preparations to deal with the found challenges when operating in an XL scale globally distributed agile environments as the chances of them occurring and their impact should not be underestimated.

RQ6: What learning goals could be part of a design for an education program for XL scale distributed agile?

We converted the challenges and practices into 45 topics. With the help of 21 experts we ranked them on whether they should be part of an education program. The experts were gathered from the business, engineering and education sides of agile making up 3 groups of 7 experts each. This resulted in 20 **Must**, 11 **Should** and 9 **Could** learning goals, while 5 topics were rejected. Using the topics and learning goals we created an education program prototype that contained 17 modules. We provided 4 use cases with different environments to show the prototype can be used to design custom fit courses. We conclude the created learning goals could used as part of an education program for XL scale distributed agile using our prototype as a base. However, we do need to mention that the use cases and the designed courses are only hypothetical and the designed courses have not been tested in practice.

11.2 Future Work

This thesis aimed to take steps towards a better understanding of the challenges occurring when using agile in very-large globally distributed environments and the practices that can be used to deal with them. However, in the overall picture there is still a lot uncharted territory. In this section we recommend more research directions based on the work done in this thesis.

11.2.1 Recommendations for Research

In Chapter 7 we found that the 3 challenges with the highest impact were all related to how agile affects the way of working of the organization as a whole. These were:

- The challenge of bringing agility to all levels of the organization.
  (*Serious* to *Severe* impact)

- The challenge of improving on the agile implementation, when the organization thinks they are already agile (fake agile). (*Serious* to *Severe* impact)

- The challenge of running an efficient operation in a hybrid environment where the rest of the organization is still waterfall. (*Significant* to *Serious* impact)

Out of the 50 challenges, only the first 2 above had an average impact between *Serious* and *Severe*. However the survey did not research the origins of why the impact of these challenges

is so high. By conducting research towards uncovering these origins, it could lead to updates to practices found in our work or the creation of new practices to combat these challenges and lessen their impacts.

Secondly there is the further detailing of the modules' description of Chapter 10 down to low-level. Researcher I is not a expert on agile education and the modules have been described to the limits of his knowledge. A group of experts on this subject would be able to flesh out the modules. They could expand the learning goals to include even more detail as well as add pointers related to the topics that are considered 'must know' in the field..

Finally there is a research direction recommended by interviewee Bu3. He/She stated their organization had conducted some experiments on having distributed whole teams versus having inter-team distribution. The reasoning by Bu3 revolved around information flow. When a team has inter-team distribution the amount of support coverage hours during a day is increased. If a client runs into an issue related to the service that such a team is responsible for, the delay before acting could be reduced. E.g. if an European client alerts an issue around noon local time and the responsible team is fully in Asia, then the European teams will have to wait for the Asian teams to wake up before they can tackle the issue. With inter-team distribution however, the European teams would be able to ask the European part of that team immediately. Furthermore during one of the experiments it was reported communication issues between departments in different locations going down. The indication was that this was due to the local team members adding more context to gained information, before passing it on to their remote counterparts.

This study could focus on the advantages and disadvantages of both versions of team distribution and compare them. The setup would be running a project where the teams are divided into whole teams and inter-distributed teams. To ensure the results aren't skewed by teething issues, we recommend to start the monitoring 2 months after the start of the project and run the monitoring for at least 3 to 6 months.

11.2.2 Focus Group Event for Education Program Creation - Proposal

Four of the leading European organizations for agile training were involved in various parts of this thesis. It shows there is interest to continue further with the Education Program prototype.

The research in Section 9.2 showed the ranking of a lot of the topics were dependent on a single vote. We propose a scaled up version of the focus group event, in which every group would consist of 9 experts.

For this event each of the agile organizations would provide 2 participants for the Educators group. They would also provide 2 organizations where they were responsible for training. The trained organizations would provide the participants for the Business and Engineers groups. To round out the field of experts an independent organization could be approached to provide the last expert for each category.

For the conduction of the event itself a lot of the process from Section 3.3 can be reused: First the list of topics used in the Learning Goals survey can be send out. The participants will have the opportunity to give feedback and add topics to that list. Then the participants are asked to answer the same questions used in the Learning Goals survey about the inclusion and implementation level of the topics in this new list. The topics can then be filtered using a form of qualified majority and a selection can be made that are up for discussion at the event. During the event itself the 3-group Fishbowl can be scaled up to accommodate 27 participants. At the end of the event the participants can be asked to personally rank the accepted topics on their importance, which is a metric that can be used to rank the topics within the same MoSCoW-ranking.

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Acronyms

ACM Association for Computing Machinery

ASK Agile Scaling Knowledge

APO Area Product Owner

ART Agile Release Train

CI Continuous Integration

DAD Disciplined Agile Delivery

EAT Executive Action Team

GDSE Globally Distributed Software Engineering

IEEE Institute of Electrical and Electronics Engineers

LeSS Large Scale Scrum

OYA Out of Your Area

PI Program Increment

PM Product Manager

PMI Project Management Institute

PO Product Owner

QM qualified majority

RTE Release Train Engineer

S@S Scrum@Scale

SAFe Scaled Agile Framework

SDS Scaled Daily Scrum

SM Scrum Master

SoS Scrum-of-Scrums

SoSM Scrum-of-Scrums Master

SLR Systematic Literature Review

Appendix A

SLR - Rejected Papers

Ref	Search #	Reason for rejection
[R20]	2, 3, 4, 5, 6, 7	Less than 100 employees involved in the each of the relevant case studies.
[R18]	3, 4, 5	The 650 involved employees were all co-located.
[R16]	4, 5, 6, 7	This study is about implementing the specific roles of the SAFe framework.
[R23]	4	Involved companies are only based in Australia.
[R6]	5	Only 175 employees involved and are co-located.
[R15]	5, 6	The asian site was not involved in the transformation, therefore the global distribution requirement is failed.
[R5]	5	This paper has short summaries of the cases in [R6] and [R15].
[R19]	5	Does not meet employees involved and global distribution requirements.
[R21]	5	Does not meet employees involved requirement.
[R17]	6	Does not meet employees involved and global distribution requirements.
[R9]	6	Meets the requirements, but the paper only explains the benefits of using agile compared to the old waterfall model the company used.
[R2]	6	Has 1 case study that meets the requirement, however no qualitative information can be extracted from it.
[R11]	6	One case has 44 employees involved who are spread over 3 sites on 3 continents.
[R8]	6	Does meet the requirements, however the study is about the tensions within a single team. Does not include the big picture.
[R13]	6	Author was emailed. The author could not provide data on the amount of employees involved.
[R14]	6	Author was emailed. The author could not provide data on the amount of employees involved.
[R12]	7	Only 40 employees involved, who are spread over 2 sites.
[R7]	7	2 cases have 150 and 90 developers respectively, but those cases are not globally distributed.
		Continued on next page

Ref	Search #	Reason for rejection
[R3]	7	1 case study has 70 employees, who are spread over 4 locations on 2 continents. However the study focuses on employee policies.
[R4]	7	Paper is about problems in GDSE, that could be solved using agile methods.
[R22]	9	Case meets requirements, but study is about effort estimation.
[R1]	9	Case meets requirements, but study is about Value Stream Mapping.
[R10]	9	Unable to retrieve the amount of employees in each project. Developers for each project seem to be co-located.

Table A.1: SLR - List of rejected papers with reasoning.

Rejected Papers Bibliography

[R1]   Nauman Bin Ali, Kai Petersen, and Kurt Schneider. "FLOW-assisted value stream mapping in the early phases of large-scale software development". In: *Journal of Systems and Software* 111 (Jan. 2016), pp. 213–227. DOI: 10.1016/j.jss.2015.10.013.

[R2]   Yehia Ibrahim Ali Alzoubi. "An agile enterprise architecture driven approach to enhance communication in geographically distributed agile development". PhD thesis. University of Technology Sydney, 2016.

[R3]   J. M. Bass et al. "Employee Retention and Turnover in Global Software Development: Comparing In-House Offshoring and Offshore Outsourcing". In: *2018 IEEE/ACM 13th International Conference on Global Software Engineering (ICGSE)*. May 2018, pp. 77–86.

[R4]   Sarah Beecham, John Noll, and Ita Richardson. "Using Agile Practices to Solve Global Software Development Problems – A Case Study". In: *2014 IEEE International Conference on Global Software Engineeering Workshops*. IEEE, Aug. 2014. DOI: 10.1109/icgsew.2014.7.

[R5]   Finn Olav Bjørnson and Kathrine Vestues. "Knowledge Sharing and Process Improvement in Large-Scale Agile Development". In: *Proceedings of the Scientific Workshop Proceedings of XP2016 on - XP '16 Workshops*. ACM Press, 2016. DOI: 10.1145/2962695.2962702.

[R6]   Torgeir Dingsøyr et al. "Exploring software development at the very large-scale: a revelatory case study and research agenda for agile method adaptation". In: *Empirical Software Engineering* 23.1 (June 2017), pp. 490–520. DOI: 10.1007/s10664-017-9524-2.

[R7]   Smita Ghaisas et al. "Generalizing by similarity: Lessons learnt from industrial case studies". In: *2013 1st International Workshop on Conducting Empirical Studies in Industry (CESI)*. IEEE, May 2013. DOI: 10.1109/cesi.2013.6618468.

[R8]   Behnaz Gholami. *Self-Organizing, Social and Adaptive Nature of Agile Information Systems Development Teams : Essays on Leadership and Learning*. English. enthält 5 unbedruckte Seiten. Mannheim, 2015. URL: https://madoc.bib.uni-mannheim.de/39691/.

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[R10]   Liz Lee-Kelley and Tim Sankey. "Global virtual teams for value creation and project success: A case study". In: *International Journal of Project Management* 26.1 (Jan. 2008), pp. 51–62. DOI: 10.1016/j.ijproman.2007.08.010.

[R11]   Sabrina Marczak. "On the understanding of requirements-driven collaboration: a framework and an empirical field investigation". PhD thesis. University of Victoria, 2011.

[R12]   Maria Paasivaara, Sandra Durasiewicz, and Casper Lassenius. "Distributed Agile Development: Using Scrum in a Large Project". In: *2008 IEEE International Conference on Global Software Engineering*. IEEE, Aug. 2008. DOI: 10.1109/icgse.2008.38.

[R13]   Maria Paasivaara and Casper Lassenius. "Collaboration practices in global inter-organizational software development projects". In: *Software Process: Improvement and Practice* 8.4 (Oct. 2003), pp. 183–199. DOI: 10.1002/spip.187.

[R14]   Maria Paasivaara, Casper Lassenius, and P Pyysiainen. "Communication Patterns and Practices in Software Development Networks". In: *Helsinki, Finland: Helsinki University of Technology* (2003).

[R15]   Maria Paasivaara et al. "Large-scale agile transformation at Ericsson: a case study". In: *Empirical Software Engineering* 23.5 (Jan. 2018), pp. 2550–2596. DOI: 10.1007/s10664-017-9555-8.

[R16]   M. A. Razzak et al. "Scaling Agile across the Global Organization: An Early Stage Industrial SAFe Self-Assessment". In: *2018 IEEE/ACM 13th International Conference on Global Software Engineering (ICGSE)*. May 2018, pp. 116–125.

[R17]   Ingo Richter, Florian Raith, and Michael Weber. "Problems in Agile Global Software Engineering Projects especially within Traditionally Organised Corporations". In: *Proceedings of the Ninth International C* Conference on Computer Science & Software Engineering*. ACM Press, 2016. DOI: 10.1145/2948992.2949019.

[R18]   Abdallah Salameh and Julian Bass. "Influential Factors of Aligning Spotify Squads in Mission-Critical and Offshore Projects – A Longitudinal Embedded Case Study". In: *Product-Focused Software Process Improvement*. Springer International Publishing, 2018, pp. 199–215. DOI: 10.1007/978-3-030-03673-7_15.

[R19]   Viktoria Stray, Nils Brede Moe, and Andreas Aasheim. "Dependency Management in Large-Scale Agile: A Case Study of DevOps Teams". In: *Proceedings of the 52nd Hawaii International Conference on System Sciences*. Hawaii International Conference on System Sciences, 2019. DOI: 10.24251/hicss.2019.840.

[R20]   Ömer Uludağ et al. "Investigating the Adoption and Application of Large-scale Scrum at a German Automobile Manufacturer". In: *Proceedings of the 14th International Conference on Global Software Engineering*. ICGSE '19. Montreal, Quebec, Canada: IEEE Press, 2019, pp. 22–29. DOI: 10.1109/ICGSE.2019.00-11. URL: https://doi.org/10.1109/ICGSE.2019.00-11.

[R21]   Ömer Uludağ et al. "Supporting Large-Scale Agile Development with Domain-Driven Design". In: *Agile Processes in Software Engineering and Extreme Programming*. Ed. by Juan Garbajosa, Xiaofeng Wang, and Ademar Aguiar. Cham: Springer International Publishing, 2018, pp. 232–247. ISBN: 978-3-319-91602-6.

[R22]   Muhammad Usman et al. "Effort estimation in large-scale software development: An industrial case study". In: *Information and Software Technology* 99 (July 2018), pp. 21–40. DOI: 10.1016/j.infsof.2018.02.009.

[R23]   Anna Laura Kristiina Zaitsev. "Agile Software Development: Exploring the Values and Principles, Collaboration and Boundary Objects". PhD thesis. University of Sydney, 2018.

Appendix B

Earlier Iterations of the Scope

The requirements for the scope of XL scale globally distributed agile software engineering defined in Figure 1.1 in Section 1.2.3 were not the first version of the requirements. In this appendix the original version of the requirements and the results from attempting to expand the search for possible papers can be found.

B.1 First Iteration of the Scope

The original version of the requirements can be found in Figure B.1. However, during the conduction of the SLR these requirements only gave two accepted papers. Therefore a second iteration of the requirements was created with loosened boundaries to heighten the amount of data collected.

Minimum amount of employees:	200 employees or 20 teams
Minimum spread of locations:	4 sites or time zones
Minimum amount of continents:	2 continents

Figure B.1: First iteration of the requirements used in the scope.

B.2 Snowballing Accepted Papers: First Iteration

As stated in Appendix B.1, the SLR only gave two accepted papers within the scope of the first iteration. Therefore the Forward and Backward Snowball methods [A8] were used on these papers to search for possible other papers. The results of this search can be found in B.2. It did not reveal any new papers within the scope.

Paper:	Paasivaara et al. [A5]	Eickhoff et al. [A1]
Citations (Backward):	34	16
Cited by (Forward):	22	7
Candidates:	1	0
Accepted:	0	0

Table B.2: Results of snowballing on the accepted papers within the first scope.

B.3   Snowballing Accepted Papers: Second Iteration

The expanded boundaries originally gave two extra accepted papers within the new scope. On both of them the Forward and Backward Snowball methods [A8] were used. At the time the Snowballing was conducted, the authors of [A6] had not yet responded. This meant their paper was not yet accepted at that stage and was therefore not included in the Snowballing. The results of this extra search can be found in B.3. All of the candidate papers were found to have already been rejected during the execution of the SLR.

Paper:[1]	Paasivaara [A4]	Gupta et al. [A2]
Citations (Backward):	14	2
Cited by (Forward):	26	3
Candidates:	6	0
Accepted:	0	0

[1] At this time Roman et al. [A6] was not accepted as paper yet.

Table B.3: Results of snowballing on the newly accepted papers within the expanded scope.

Appendix C

SLR - Metadata per Paper

Metadata	P2016	E2018	P2017	G2018	R2015
Number of challenges & practices	13	15	10	8	11
Number of challenges	6	5	4	5	7
Number of practices	7	10	6	3	4
Number of challenges being XL & GD	0	2	1	1	0
Number of challenges with practices	6	5	4	5	3
Number of challenges without practices	0	0	0	0	4
Number of practices with challenges	6	10	6	3	4
Number of practices without challenges	1	0	0	0	0

Table C.1: SLR - Metadata from extraction per paper.

- **P2016** - Maria Paasivaara and Casper Lassenius. "Scaling Scrum in a Large Globally Distributed Organization: A Case Study". In: *2016 IEEE 11th International Conference on Global Software Engineering (ICGSE)*. IEEE, Aug. 2016. DOI: `10.1109/icgse.2016.34`

- **E2018** - F. L. Eickhoff et al. "Large-scale application of IBM Design Thinking and Agile development for IBM z14". In: *IBM Journal of Research and Development* 62.2/3 (Mar. 2018), 1:1–1:9. DOI: `10.1147/jrd.2018.2795879`

- **P2017** - Maria Paasivaara. "Adopting SAFe to Scale Agile in a Globally Distributed Organization". In: *2017 IEEE 12th International Conference on Global Software Engineering (ICGSE)*. IEEE, May 2017. DOI: `10.1109/icgse.2017.15`

- **G2018** - R. K. Gupta, S. Jain, and B. Singh. "Challenges in Scaling up a Globally Distributed Legacy Product: A Case Study of a Matrix Organization". In: *2018 IEEE/ACM 13th International Conference on Global Software Engineering (ICGSE)*. May 2018, pp. 72–76

- **R2015** - Greice Roman et al. "On the Agile Transformation in a Large-Complex Globally Distributed Company: Why Boarding this Journey, Steps Taken and Main Foreseen Concerns". In: *2015 6th Brazilian Workshop on Agile Methods (WBMA)*. IEEE, Oct. 2015. DOI: `10.1109/wbma.2015.13`

Appendix D

SLR - Challenge Groups

Note: The numeral behind a category denotes its corresponding numeral in Section 4.4.

#	Challenge	Category	Ref
1	Having concurrent Sprint Planning with different time zones.	GD (i)	[A5]
2	Having the major planning meetings with a 5 hour time difference.	GD (i)	[A4]
3	Having a synchronous meeting when a team is spread over 4 continents.	GD (ii)	[A6]

Table D.1: How to have (major) meetings with everyone present due to time zones.

#	Challenge	Category	Ref
1	Establishing a proper agile mindset into over a 1000 developers.	XL (2)	[A1]
2	Minimizing change resistance towards SAFe and agile.	XL (1)	[A4]
3	Getting employees to go along with the transformation.	XL (1)	[A6]

Table D.2: How to eliminate change resistance towards agile methods and/or the transition.

#	Challenge	Category	Ref
1	Being able to provide a customer view to the teams on a regular basis.	XL (3)	[A2]
2	Being able to communicate effectively with global stakeholders.	GD (ii)	[A2]
3	Being able to collaborate with customers effectively in a XL environment.	XL (2)	[A6]

Table D.3: How to integrate customer collaboration in an effective way.

#	Challenge	Category	Ref
1	Usefulness of SoS meetings varying due to reduced information sharing and participation.	XL (2)	[A5]
2	Minimizing chaos during major meetings due to the amount of participants and conferencing tools.	XL (2), GD (ii)	[A4]

Table D.4: How to streamline big meetings, due to the amount of participants and/or the usage of conferencing tools.

#	Challenge	Category	Ref
1	Stop presentations, instead of demonstrations, being given at the 'Common Demo' as it did not show the software quality.	XL (3)	[A5]
2	Making sure SoS is functioning effectively in such a large and widespread environment.	XL (1), GD (i)	[A2]

Table D.5: How to let important meetings be useful, due to the amount of participants and/or conferencing tools.

#	Challenge	Category	Ref
1	Stop common retrospectives being considered useless as no changes were noticed from them.	XL (4)	[A5]
2	Making sure possible improvements to the process do not get put on the shelf.	XL (3)	[A4]

Table D.6: How to act on and implement feedback gathered during retrospectives.

#	Challenge	Category	Ref
1	Scaling agile to work with over a 1000 developers.	XL (1)	[A1]
2	Getting agile to work in a varied environment with different needs.	XL (3)	[A6]

Table D.7: How to scale agile to work effectively in a large environment.

#	Challenge	Category	Ref
1	Being able to monitor the project progress on multiple levels.	XL (3)	[A1]
2	Making sure the teams are all seeing the big picture.	XL (2)	[A2]

Table D.8: How to enable the teams to see the big picture.

Appendix E

SLR - Practice Groups

#	Practice	Ref
1	Conduct a 'Common Sprint Planning', a one-hour teleconference in which each team sends one representative. Afterwards the teams convene for detailed planning and send their commitments for the coming sprint.	[A5]
2	Have a face-to-face 'Finnish SoS' and a teleconference 'Global SoS' with the project manager being the link between them.	[A5]
3	Split the 'Common Demo' up back into smaller groups.	[A5]
4	Have a project-level Stand-up meeting focusing on critical issues only.	[A1]
5	Have Iteration Planning, Stand-ups, and Iteration Reviews meetings per team.	[A1]
6	Time the main events of the two day planning meetings in such a way that all sites could join.	[A4]

Table E.1: Splitting meetings into local and global versions.

#	Practice	Ref
1	Give all teams proper agile education.	[A1]
2	Have all upper-level employees be trained in advance, then train the other employees internally shortly before the first planning meeting.	[A4]
3	Usage of training to put agile concepts into company's perspective.	[A6]

Table E.2: Making sure all employees have had proper agile training.

#	Practice	Ref
1	Use a 'Wall of Work' to clearly visualize the work, dependencies and bottlenecks for the teams.	[A1]
2	Use automated dashboards to track and visualize the project progress.	[A1]
3	Start using accessible physical and digital Obeya walls [A3].	[A2]

Table E.3: Use physical and/or digital dashboards to give teams a visualization of the work.

#	Practice	Ref
1	Have an external consulting company help support the adoption.	[A4]
2	Hire coaches to guide and give feedback.	[A6]

Table E.4: Hire coaches to help with and guide the adoption.

#	Practice	Ref
1	Improve communication between APOs and teams using regular workshops.	[A5]
2	Establish a 'social contract', a set of agreed-upon rules and understanding of how teams will behave and interact.	[A1]

Table E.5: Standardize communication using means like a set of agreed-upon rules or workshops.

#	Practice	Ref
1	Have a updated type of common retrospective which is more focused on solving problems.	[A5]
2	Have the RTE take point in assigning and following the implementation of improvement points brought up during site-specific retrospectives.	[A4]

Table E.6: Have a dedicated focus on retrospective feedback.

Appendix F

INTVW - Notes and Remarks by Interviewees

At the end of every interview the interviewee was given the possibility to make notes and remarks they wanted to see added to the thesis. These have been sorted by subject and are listed below.

- **Bu3:** There are certainly also some disadvantages to having product owners in one location and a team in another.
- **Lo1:** I had an eye-opening discussion with someone from Microsoft, she said: 'Nothing will change on the IT side, unless it changes on the business side.'
- **Lo1:** Create an environment in which Agile can be successful. Agile in itself is not going to be successful without the environment for it.
- **Te1:** An important factor for success is to work together with business.
- **Co1:** Testing automation helps improve value creation and when done correctly is a business thing, not a technical thing.
- **Co1:** Certain agile challenges will always be situational, depending on the scenario.
- **Oi1:** Sometimes the amount of change resistance is due to the organization situation. Our organization has to deal with lots of change, for example due to the introduction of a new law. That causes people to be less willing when you add even more change on top of that.
- **Oi1:** Even if you are conveying the same message, top management is more bound to listen to an external expert.
- **Bu3:** Kanban can be an interesting alternative for teams that need to have a reaction time faster than a sprint.
- **In1:** Aligning all departments into the same structure and way of working makes Data Driven Agility easier.
- **Oi2:** The retrospective is one of the key rituals. Be honest about what is going well or isn't and make sure to act on the action points to improve on the issues.
- **Lo1:** Having knowledge dedication and stability is extremely important, avoiding that knowledge loss is the biggest lesson we learned.

Appendix G

INTVW - Practices with Single Mention

#	Practice	Mentioned by
24	Co-locate employees in distributed locations.	1 (Ba1)
25	Have a co-located social event to have everybody socialize and get to know everyone.	1 (Ba1)
26	When a team is missing one of the roles temporarily (e.g. awaiting replacement), have them go on with the missing role, instead of merging two teams temporarily.	1 (Ba1)
27	Have a focus on creating a proper reward system.	1 (Bu1)
28	Have a focus on creating more flexible work times to highen the overlap in working hours.	1 (Bu1)
29	Have no distribution with the engineers within a team.	1 (Bu1)
30	Keep track of who travels to make it fair for everyone.	1 (Bu1)
31	Relocate employees from a foreign office to a local office for a longer period to get them accustomed to the local way of working.	1 (Bu1)
32	Break down the monolith into microservices where possible.	1 (Bu1)
33	Balance the level of formal and informal towards the team's needs.	1 (Bu1)
34	Start the planning for next release cycle at the start of current release cycle.	1 (Bu2)
35	Make sure all employees have had Cultural Awareness Training.	1 (Bu2)
36	Make use of a Central Architecture Team	1 (Bu2)
37	Make sure every team has a backup knowledge area to be able to cover other teams.	1 (Bu2)
38	In distributed locations, have a local representative that is allowed to make decisions.	1 (Bu2)
39	Have a flow of information and transparency from both engineers and management.	1 (Bu2)
40	Put trust in the teams' knowledge and their time estimates.	1 (Bu2)
41	Have teams be self-steering where possible, including problem/conflict solving.	1 (Bu3)
	Continued on next page	

42	Alternate between flying people to remote locations and vice verse.	1 (Bu3)
43	Make use of inter-team distribution.	1 (Bu3)
44	Keep improving on the original implementation, to make agile your own.	1 (Bu3)
45	Send a representative around the world to help the distributed teams improve.	1 (Co1)
46	Focus on the amount of value you bring, not on how long you work.	1 (Co1)
47	Be transparent about the way of measuring.	1 (Co1)
48	Analyse the usage of your application by the end-users.	1 (Co1)
49	Create spaces where it is easy to have meetings with distributed teams.	1 (In1)
50	Make sure co-operating teams have met in person to improve work relations between them.	1 (In1)
51	Put responsibility with the cross-functional teams keep each other updated.	1 (In1)
52	Align all departments into the same structure and way of working.	1 (In1)
53	Use a staggered rollout of agile per project, instead of the whole organization at once.	1 (In1)
54	Use the SoS meetings as a way to keep the flow of information going.	1 (In1)
55	Harmonise and unify the legacy code where it is possible.	1 (In1)
56	Check in with customers often for feedback.	1 (Lo1)
57	Transition to a agile framework that has better support for scaling.	1 (Oi1)
58	Have a dedicated team to assist with the implementation of agile.	1 (Oi1)
59	Bring in an expert for external advice.	1 (Oi1)
60	Have the assessments of ritual implementations on team level.	1 (Oi1)
61	Make use of the existing distributed working mindset, that is already there due to the organization's distributed history.	1 (Oi1)
62	Send employees to agile conferences to gain inspiration.	1 (Oi1)
63	Make use of a set amount of releases each year, with release candidates as backup.	1 (Oi1)
64	Clearly convey the 'why' and the added value of agile to all employees.	1 (Oi1)
65	Transfer people in teams with the incorrect mix.	1 (Oi1)
66	Have someone from the dedicated team fill in for teams in certain roles, as a practice run to promote alignment and cross-contamination between departments.	1 (Oi1)
67	Unite all visions into one vision.	1 (Oi2)
68	Have the PMs align the teams on their vision for the coming year at the start of every increment.	1 (Oi2)
69	Use representatives from distributed locations at the main location as connectors to those locations.	1 (Oi2)
70	At every location, have everyone come together in one room.	1 (Oi2)

71	If two teams are found to have a dependency, have them meet together in smaller meeting rooms.	1 (Oi2)
72	Have the POs and the SMs focus on reducing inter-team dependencies as much as possible.	1 (Oi2)
73	Have the POs and the SMs align at the end of the day and create a full list of dependencies.	1 (Oi2)
74	Add an extra meeting, if it turns out to be needed.	1 (Oi2)
75	Set the maximum size for a task to 3 days.	1 (Oi2)
76	Make use of a WIP limit for every employee.	1 (Oi2)
77	Make use of micro-increments to be able to align dependent teams.	1 (Oi2)
78	Make use of temporary (Spotify) tribes to improve the alignment of the relevant teams.	1 (Oi2)
79	Provide management with proper metrics to track project progress.	1 (Oi2)
80	Make use of a hybrid model that creates a base of connecting rules, but allows for adaption to the local situation.	1 (Te1)
81	Encourage teams to be responsible for their own alignment with third-parties.	1 (Te1)
82	Add a new role that defines a minimum set of rules.	1 (Te1)
83	Have the POs come from the business side of the organization.	1 (Te1)
84	Make sure the POs have prepared a half-ready backlog before the bigroom planning starts.	1 (Te1)
85	Have an Epic planning with all POs every six weeks.	1 (Te1)
86	Make use of a four sprint rolling forecast, POs are responsible for the alignment of it.	1 (Te1)

Table G.1: INTVW - Extracted practices with a single mention after grouping.

Appendix H

Challenges - Impact Survey - Full Results

The challenge of acting on and implementing feedback gathered during retrospectives.					
N/A: 2	**1:** 1	**2:** 11	**3:** 18	**4:** 17	**5:** 4
The challenge of aligning everyone to the same vision.					
N/A: 0	**1:** 4	**2:** 5	**3:** 17	**4:** 15	**5:** 12
The challenge of aligning everyone to the same budget form.					
N/A: 7	**1:** 5	**2:** 14	**3:** 11	**4:** 11	**5:** 5
The challenge of aligning release cycles between various modules or systems.					
N/A: 1	**1:** 2	**2:** 7	**3:** 23	**4:** 12	**5:** 8
The challenge of applying agile methods on the maintenance cycle of old and/or legacy systems.					
N/A: 1	**1:** 4	**2:** 8	**3:** 18	**4:** 10	**5:** 12
The challenge of balancing the travel budget with people's needs.					
N/A: 7	**1:** 9	**2:** 15	**3:** 14	**4:** 5	**5:** 3
The challenge of balancing code ownership.					
N/A: 0	**1:** 4	**2:** 20	**3:** 17	**4:** 8	**5:** 4
The challenge of balancing team personalities for improved cooperation.					
N/A: 0	**1:** 0	**2:** 8	**3:** 20	**4:** 15	**5:** 10
The challenge of balancing team reallocation with people's needs.					
N/A: 2	**1:** 2	**2:** 11	**3:** 14	**4:** 14	**5:** 10
The challenge of being creative with agile without losing the manifesto's values and principles.					
N/A: 1	**1:** 1	**2:** 15	**3:** 23	**4:** 7	**5:** 6
The challenge of bringing agility to all levels of the organization.					
N/A: 0	**1:** 0	**2:** 3	**3:** 8	**4:** 17	**5:** 25
The challenge of changing the development method, which is harder when being globally widespread.					
N/A: 2	**1:** 4	**2:** 5	**3:** 17	**4:** 15	**5:** 10
					Continued on next page

The challenge of clearly defining the responsibility of every role.					
N/A: 0	**1:** 4	**2:** <u>19</u>	**3:** 10	**4:** 13	**5:** 7
The challenge of conducting the daily rituals, that work less well as a teleconference.					
N/A: 0	**1:** 5	**2:** <u>23</u>	**3:** 7	**4:** 12	**5:** 6
The challenge of creating a proper agile (hybrid, living) roadmap.					
N/A: 1	**1:** 0	**2:** 9	**3:** <u>21</u>	**4:** 13	**5:** 9
The challenge of creating an environment where the teams have ownership and are independent.					
N/A: 1	**1:** 1	**2:** 5	**3:** 17	**4:** <u>18</u>	**5:** 11
The challenge of dealing with instability after reorganisation due to scale and distribution.					
N/A: 3	**1:** 1	**2:** 6	**3:** 12	**4:** <u>22</u>	**5:** 9
The challenge of enabling the teams to see the big picture.					
N/A: 2	**1:** 1	**2:** 8	**3:** 16	**4:** <u>18</u>	**5:** 8
The challenge of ensuring every role has had the proper amount of knowledge education.					
N/A: 0	**1:** 1	**2:** 12	**3:** <u>18</u>	**4:** 12	**5:** 10
The challenge of eliminating change resistance towards agile methods and/or the transition.					
N/A: 1	**1:** 0	**2:** 7	**3:** 16	**4:** <u>17</u>	**5:** 12
The challenge of finding suitable metrics for value reporting.					
N/A: 3	**1:** 2	**2:** 8	**3:** 14	**4:** <u>19</u>	**5:** 7
The challenge of finding the right balance between the flexibility and stability of teams to reduce knowledge and efficiency loss.					
N/A: 1	**1:** 1	**2:** 13	**3:** 13	**4:** <u>20</u>	**5:** 5
The challenge of having (major) meetings with everyone present due to time zones.					
N/A: 1	**1:** 3	**2:** <u>17</u>	**3:** 14	**4:** 12	**5:** 6
The challenge of having effective communication with (non-agile) third-parties.					
N/A: 2	**1:** 1	**2:** 7	**3:** <u>18</u>	**4:** 13	**5:** 12
The challenge of having effective communication between teams.					
N/A: 0	**1:** 1	**2:** 16	**3:** <u>17</u>	**4:** 10	**5:** 9
The challenge of having effective communication between teams and management.					
N/A: 0	**1:** 1	**2:** 7	**3:** <u>17</u>	**4:** 14	**5:** 14
The challenge of implementing agile in a standardized way, but still allowing for variations that suits the local situation.					
N/A: 2	**1:** 3	**2:** 12	**3:** <u>16</u>	**4:** 12	**5:** 8
The challenge of implementing proper tools and data to analyse your way of working to encourage data-driven decision making					
N/A: 4	**1:** 1	**2:** 7	**3:** <u>18</u>	**4:** 13	**5:** 10
The challenge of improving on the agile implementation, when the organization thinks they are already agile (fake agile).					
N/A: 1	**1:** 0	**2:** 2	**3:** 10	**4:** 19	**5:** <u>21</u>
				Continued on next page	

The challenge of improving on the agile workflow after its original implementation.					
N/A: 4	**1:** 2	**2:** 8	**3:** 14	**4:** <u>15</u>	**5:** 10
The challenge of improving trust in leadership with the distributed teams.					
N/A: 1	**1:** 1	**2:** 12	**3:** 12	**4:** <u>14</u>	**5:** 13
The challenge of instilling the principles of agile into the mindset.					
N/A: 0	**1:** 3	**2:** 9	**3:** 13	**4:** <u>16</u>	**5:** 12
The challenge of integrating customer collaboration in an effective way.					
N/A: 1	**1:** 2	**2:** 8	**3:** <u>15</u>	**4:** 12	**5:** <u>15</u>
The challenge of keeping everybody aligned and up to date.					
N/A: 0	**1:** 3	**2:** 10	**3:** <u>20</u>	**4:** 10	**5:** 10
The challenge of letting important meetings be useful, due to the amount of participants and/or conferencing tools.					
N/A: 1	**1:** 1	**2:** 12	**3:** 14	**4:** <u>15</u>	**5:** 10
The challenge of minimizing the amount of code inter-dependencies.					
N/A: 2	**1:** 1	**2:** 3	**3:** 15	**4:** <u>18</u>	**5:** 14
The challenge of minimizing the effect of time zones on the work.					
N/A: 1	**1:** 4	**2:** <u>19</u>	**3:** 15	**4:** 11	**5:** 3
The challenge of minimizing the effect of various public holidays in different locations on the work.					
N/A: 2	**1:** 8	**2:** <u>22</u>	**3:** 9	**4:** 10	**5:** 2
The challenge of minimizing the effect of the physical distances on the work.					
N/A: 0	**1:** 8	**2:** <u>21</u>	**3:** 14	**4:** 8	**5:** 2
The challenge of planning estimates between engineers and other departments not being in sync.					
N/A: 3	**1:** 2	**2:** 9	**3:** <u>15</u>	**4:** <u>15</u>	**5:** 9
The challenge of preventing teams from becoming isolated islands.					
N/A: 1	**1:** 5	**2:** 9	**3:** <u>17</u>	**4:** 11	**5:** 10
The challenge of preventing distributed team members from becoming lonely and unhappy.					
N/A: 1	**1:** 6	**2:** <u>16</u>	**3:** 15	**4:** 7	**5:** 8
The challenge of reducing turnover rate to create more stability in teams.					
N/A: 3	**1:** 0	**2:** 14	**3:** 13	**4:** <u>17</u>	**5:** 6
The challenge of reducing the effect of cultural differences.					
N/A: 0	**1:** 3	**2:** <u>22</u>	**3:** 15	**4:** 8	**5:** 5
The challenge of reducing differences in agile education levels across different locations.					
N/A: 0	**1:** 1	**2:** 13	**3:** <u>19</u>	**4:** 11	**5:** 9
The challenge of running an efficient operation in a hybrid environment where the rest of the organization is still waterfall.					
N/A: 3	**1:** 0	**2:** 5	**3:** 12	**4:** <u>17</u>	**5:** 16

The challenge of scaling agile to work effectively in a large environment.					
N/A: 0	**1:** 0	**2:** 4	**3:** <u>19</u>	**4:** <u>19</u>	**5:** 11
The challenge of streamlining big meetings, due to the amount of participants and/or the usage of conferencing tools.					
N/A: 1	**1:** 2	**2:** <u>15</u>	**3:** 10	**4:** 13	**5:** 12
The challenge of task management (e.g. duration, amount of parallel tasks running).					
N/A: 1	**1:** 1	**2:** 14	**3:** <u>16</u>	**4:** 13	**5:** 8
The challenge of tight scheduling leading to multiple teams, instead of a single one, working on the same feature in a chaotic way.					
N/A: 1	**1:** 3	**2:** 7	**3:** 14	**4:** <u>15</u>	**5:** 13

Table H.1: Full results of the Challenges - Impact survey.

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[1] Underlined numbers denote the severity with the highest amount of responses.

Appendix I

Full Topic Descriptions

I.1 Pre-event Round 1 - Original List

Listed below are the descriptions of the topics, that were sent to the participants of the focus group event as part of pre-event round 1. Based on the feedback of this round tweaks were made to certain descriptions, these have been processed into the list below.

- Agile roadmap
  Differences with a normal roadmap and the different types of agile roadmaps.
- Agile workflow specifics
  The formal way of working of the organization as described or documented.
- Agile workflow iterating
  Describing or documenting adaptions and improvements to the original agile implementation.
- Automation of the development environments
  Details of the automated tools used within the development environment.
- Balance of team personalities
  The way in which a healthy mix of personalities in a team creates balance.
- Balance of code ownership
  The way in which the right amount of code ownership creates a more flexible organization.
- Creativity in agile without losing the manifesto's values and principles
  Adaption of the agile implementation with retainment of agile's key values.
- Communication with customers
- Communication with non-agile departments
- Communication with non-agile third-parties
- Communication with remote teams
- Communication with remote team members
- Cultural awareness training
  Training individuals and/or teams in normal and expected behaviors within specific other cultures.
- Cultural soft skills training
  Training individuals and/or teams in soft skills that are useful in dealing with people from other cultures.

- Impact of differing Public Holidays
  The way in which a multitude of Public Holidays-schedules can cause impact on productivity.

- Legacy systems in agile workflows
  Integration of legacy development and/or maintenance into the agile workflow.

- Management of code inter-dependencies
  The ways to reduce teams waiting on each other and documentation of which team is responsible for the connecting part.

- Management of testing ownership
  Documentation of which team is responsible for which test and procedures if tests break down.

- Measures to prevent teams from becoming isolated islands
  Measures to keep communication going between autonomous teams.

- Minimization of chaos in meetings with over 50 participants

- Minimization of chaos in teleconference meetings

- Minimization of the effect of time zones on work
  The ways to overcome the lower overlap of common working hours.

- Practical considerations for team autonomy

- Practical considerations for team resource allocation

- Practical considerations for travel decision making

- Project Progress Tracking
  The ways in which 'The Big Picture' can be provided to all layers of the project.

- Release cycle alignment
  Details on the alignment of the release cycles of various modules or projects.

- Responsibility Assignment (RACI) matrix
  Clarification and definitions of the roles and responsibilities.

- Ritual implementation
  The formal way the rituals are conducted by the organization as described or documented.

- Suitable Project Progress metrics
  Goodhart's law: 'When a measure becomes a target, it ceases to be a good measure.'

- Teambuilding

- Teams with dislocated team members
  The pitfalls when spreading a team over multiple locations.

- The reasons why the organization is doing agile

- User story breakdown into tasks
  Management of the size and duration of a task.

- Usage of feedback gathered at rituals
  Spreading feedback and improvements through the organization.

I.2 Pre-event Round 1 - Additions

Listed below are the topics, that were added based on the responses of the participants as part of pre-event round 1.

- Embedment of the documented values, principles and behavior in everything you do and design

- HR processes in agility
  The ways in which agility impacts HR.

- Impact of agility on the complete organization

- Item Product Definition
  The overall product the organization is developing as described or documented.

- Leadership Role
  Details on how the roles of leadership and distributed leadership differ.

- Organizational hierarchy
  Measures to prevent problems being solved by putting people back into a traditional hierarchy.

- Team career paths facilitation
  The ways to grow team members from start to outflow: realizing their dreams, maximizing impact of their work.

- The difference between efficiency and effectivity
  Details on how the agile and lean processes differ from each other.

- The people side of change
  Practical considerations when striving for continuous improvement and/or sustainable growth.

- Working agile in a traditional enterprise context
  The ways to benefit from agile ways of working when the organization at large has not embraced this and is still operating in a stage gated waterfall mindset.

Appendix J

Unused Elements of the Focus Group Event

J.1 Event Rundown

During the course of the event, 2 documents will be updated in the background. The first document is a list which contains the resulting verdicts for every discussed topic. The second document keeps track of which topics have been accepted, including the ones that got accepted with the pre-event round 2 survey. At the end of the event the second document is printed and all participants are asked to personally rank the topics on their importance.

The topic to be discussed will be shown on screen. The discussion style will be a variation of 6-chair Fishbowl [A7]. In this variation every group will have 2 chairs assigned to them. At the start of each discussion 1 participant of each group is asked to sit in inner circle, leaving half of chairs empty. If a participant wants to join the conversation, they can only sit down in a chair assigned to their group. Once the chairs start filling up the speaking rules for regular 6-chair Fishbowl will go into effect. The setup and starting positions can be seen in Figure J.1.
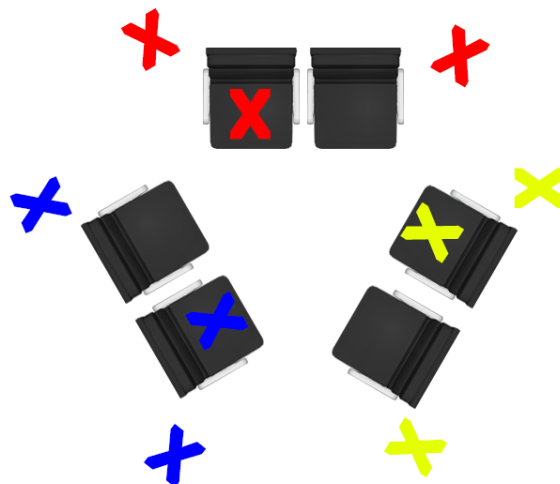

Figure J.1: Visualisation of the Fishbowl situation at the start of a discussion round.

Appendix K

Learning Goals Survey - Full Results

Agile roadmap			
Business: 7/7	**Engineers:** 6/7	**Educators:** 7/7	**Verdict:**
K: 0 | **KS:** 2 | **KSA:** 5	**K:** 4 | **KS:** 1 | **KSA:** 1	**K:** 1 | **KS:** 4 | **KSA:** 2	KSA
Agile workflow specifics			
Business: 4/7	**Engineers:** 7/7	**Educators:** 4/7	**Verdict:**
K: 1 | **KS:** 1 | **KSA:** 2	**K:** 2 | **KS:** 3 | **KSA:** 2	**K:** 2 | **KS:** 0 | **KSA:** 2	KSA
Agile workflow iterating			
Business: 5/7	**Engineers:** 6/7	**Educators:** 5/7	**Verdict:**
K: 1 | **KS:** 0 | **KSA:** 4	**K:** 3 | **KS:** 3 | **KSA:** 0	**K:** 0 | **KS:** 4 | **KSA:** 1	KS
Automation of the development environments			
Business: 5/7	**Engineers:** 6/7	**Educators:** 7/7	**Verdict:**
K: 1 | **KS:** 1 | **KSA:** 3	**K:** 0 | **KS:** 5 | **KSA:** 1	**K:** 2 | **KS:** 1 | **KSA:** 4	KSA
Balance of team personalities			
Business: 7/7	**Engineers:** 6/7	**Educators:** 7/7	**Verdict:**
K: 2 | **KS:** 1 | **KSA:** 4	**K:** 1 | **KS:** 0 | **KSA:** 5	**K:** 3 | **KS:** 1 | **KSA:** 3	KSA
Balance of code ownership			
Business: 5/7	**Engineers:** 4/7	**Educators:** 7/7	**Verdict:**
K: 1 | **KS:** 3 | **KSA:** 1	**K:** 1 | **KS:** 1 | **KSA:** 2	**K:** 1 | **KS:** 1 | **KSA:** 5	KSA
Creativity in agile without losing the manifesto's values and principles			
Business: 4/7	**Engineers:** 6/7	**Educators:** 6/7	**Verdict:**
K: 0 | **KS:** 1 | **KSA:** 3	**K:** 2 | **KS:** 1 | **KSA:** 3	**K:** 3 | **KS:** 1 | **KSA:** 2	KSA
Communication with customers			
Business: 6/7	**Engineers:** 5/7	**Educators:** 6/7	**Verdict:**
K: 1 | **KS:** 1 | **KSA:** 4	**K:** 1 | **KS:** 2 | **KSA:** 2	**K:** 0 | **KS:** 2 | **KSA:** 4	KSA
Communication with non-agile departments			
Business: 6/7	**Engineers:** 2/7	**Educators:** 5/7	**Verdict:**
K: 1 | **KS:** 1 | **KSA:** 4	**K:** 1 | **KS:** 1 | **KSA:** 0	**K:** 1 | **KS:** 2 | **KSA:** 2	KSA
			Continued on next page

Communication with non-agile third-parties			
Business: 4/7	**Engineers:** 2/7	**Educators:** 6/7	**Verdict:**
K: 1 | **KS:** 0 | **KSA:** 3	**K:** 1 | **KS:** 0 | **KSA:** 1	**K:** 4 | **KS:** 0 | **KSA:** 2	KSA[1]
Communication with remote teams			
Business: 6/7	**Engineers:** 6/7	**Educators:** 7/7	**Verdict:**
K: 1 | **KS:** 2 | **KSA:** 3	**K:** 1 | **KS:** 1 | **KSA:** 4	**K:** 1 | **KS:** 2 | **KSA:** 4	KSA
Communication with remote team members			
Business: 6/7	**Engineers:** 5/7	**Educators:** 6/7	**Verdict:**
K: 1 | **KS:** 1 | **KSA:** 4	**K:** 0 | **KS:** 0 | **KSA:** 5	**K:** 1 | **KS:** 0 | **KSA:** 5	KSA
Cultural awareness training			
Business: 6/7	**Engineers:** 6/7	**Educators:** 7/7	**Verdict:**
K: 2 | **KS:** 0 | **KSA:** 4	**K:** 2 | **KS:** 0 | **KSA:** 4	**K:** 1 | **KS:** 2 | **KSA:** 4	KSA
Cultural soft skills training			
Business: 4/7	**Engineers:** 4/7	**Educators:** 7/7	**Verdict:**
K: 0 | **KS:** 1 | **KSA:** 3	**K:** 2 | **KS:** 0 | **KSA:** 2	**K:** 1 | **KS:** 3 | **KSA:** 3	KSA
Embedment of the documented values, principles and behavior in everything you do and design			
Business: 4/7	**Engineers:** 3/7	**Educators:** 5/7	**Verdict:**
K: 2 | **KS:** 0 | **KSA:** 2	**K:** 0 | **KS:** 2 | **KSA:** 1	**K:** 0 | **KS:** 1 | **KSA:** 4	KSA
HR processes in agility			
Business: 5/7	**Engineers:** 3/7	**Educators:** 5/7	**Verdict:**
K: 1 | **KS:** 1 | **KSA:** 3	**K:** 1 | **KS:** 0 | **KSA:** 2	**K:** 2 | **KS:** 0 | **KSA:** 3	KSA
Impact of agility on the complete organization			
Business: 6/7	**Engineers:** 6/7	**Educators:** 7/7	**Verdict:**
K: 2 | **KS:** 1 | **KSA:** 3	**K:** 3 | **KS:** 0 | **KSA:** 3	**K:** 4 | **KS:** 1 | **KSA:** 2	K
Impact of differing Public Holidays			
Business: 1/7	**Engineers:** 2/7	**Educators:** 0/7	**Verdict:**
K: 1 | **KS:** 0 | **KSA:** 0	**K:** 2 | **KS:** 0 | **KSA:** 0	**K:** 0 | **KS:** 0 | **KSA:** 0	-[2]
Item Product Definition			
Business: 5/7	**Engineers:** 5/7	**Educators:** 6/7	**Verdict:**
K: 0 | **KS:** 3 | **KSA:** 2	**K:** 4 | **KS:** 1 | **KSA:** 0	**K:** 1 | **KS:** 5 | **KSA:** 0	KS
Leadership Role			
Business: 7/7	**Engineers:** 6/7	**Educators:** 6/7	**Verdict:**
K: 1 | **KS:** 0 | **KSA:** 6	**K:** 1 | **KS:** 1 | **KSA:** 4	**K:** 1 | **KS:** 2 | **KSA:** 3	KSA
Legacy systems in agile workflows			
Business: 4/7	**Engineers:** 7/7	**Educators:** 5/7	**Verdict:**
K: 1 | **KS:** 2 | **KSA:** 1	**K:** 3 | **KS:** 3 | **KSA:** 1	**K:** 0 | **KS:** 5 | **KSA:** 0	KS
			Continued on next page

Management of code inter-dependencies			
Business: 4/7	**Engineers:** 7/7	**Educators:** 6/7	**Verdict:**
K: 1 | **KS:** 1 | **KSA:** 2	**K:** 3 | **KS:** 2 | **KSA:** 2	**K:** 2 | **KS:** 3 | **KSA:** 1	KS[1]
Management of testing ownership			
Business: 3/7	**Engineers:** 4/7	**Educators:** 4/7	**Verdict:**
K: 0 | **KS:** 2 | **KSA:** 1	**K:** 0 | **KS:** 2 | **KSA:** 2	**K:** 0 | **KS:** 2 | **KSA:** 2	-[2]
Measures to prevent teams from becoming an isolated islands			
Business: 5/7	**Engineers:** 7/7	**Educators:** 5/7	**Verdict:**
K: 1 | **KS:** 1 | **KSA:** 3	**K:** 3 | **KS:** 0 | **KSA:** 4	**K:** 1 | **KS:** 3 | **KSA:** 1	KSA
Minimization of chaos in meetings with over 50 participants			
Business: 4/7	**Engineers:** 2/7	**Educators:** 3/7	**Verdict:**
K: 2 | **KS:** 0 | **KSA:** 2	**K:** 1 | **KS:** 1 | **KSA:** 0	**K:** 1 | **KS:** 2 | **KSA:** 0	-[2]
Minimization of chaos in teleconference meetings			
Business: 4/7	**Engineers:** 5/7	**Educators:** 4/7	**Verdict:**
K: 1 | **KS:** 0 | **KSA:** 3	**K:** 3 | **KS:** 1 | **KSA:** 1	**K:** 1 | **KS:** 3 | **KSA:** 0	K
Minimization of the effect of time zones on work			
Business: 3/7	**Engineers:** 5/7	**Educators:** 5/7	**Verdict:**
K: 2 | **KS:** 0 | **KSA:** 1	**K:** 3 | **KS:** 1 | **KSA:** 1	**K:** 3 | **KS:** 2 | **KSA:** 0	K
Organizational hierarchy			
Business: 2/7	**Engineers:** 4/7	**Educators:** 5/7	**Verdict:**
K: 1 | **KS:** 0 | **KSA:** 1	**K:** 2 | **KS:** 0 | **KSA:** 2	**K:** 1 | **KS:** 1 | **KSA:** 3	KSA
Practical considerations for team autonomy			
Business: 6/7	**Engineers:** 7/7	**Educators:** 3/7	**Verdict:**
K: 3 | **KS:** 0 | **KSA:** 3	**K:** 2 | **KS:** 4 | **KSA:** 1	**K:** 2 | **KS:** 1 | **KSA:** 0	K
Practical considerations for team resource allocation			
Business: 4/7	**Engineers:** 5/7	**Educators:** 4/7	**Verdict:**
K: 1 | **KS:** 2 | **KSA:** 1	**K:** 3 | **KS:** 2 | **KSA:** 0	**K:** 2 | **KS:** 2 | **KSA:** 0	KS[1]
Practical considerations for travel decision making			
Business: 2/7	**Engineers:** 2/7	**Educators:** 2/7	**Verdict:**
K: 1 | **KS:** 0 | **KSA:** 1	**K:** 2 | **KS:** 0 | **KSA:** 0	**K:** 1 | **KS:** 1 | **KSA:** 0	-[2]
Project Progress Tracking			
Business: 6/7	**Engineers:** 7/7	**Educators:** 6/7	**Verdict:**
K: 0 | **KS:** 4 | **KSA:** 2	**K:** 2 | **KS:** 3 | **KSA:** 2	**K:** 3 | **KS:** 2 | **KSA:** 1	KS
Release cycle alignment			
Business: 5/7	**Engineers:** 7/7	**Educators:** 6/7	**Verdict:**
K: 1 | **KS:** 0 | **KSA:** 4	**K:** 4 | **KS:** 1 | **KSA:** 2	**K:** 2 | **KS:** 4 | **KSA:** 0	K

Responsibility Assignment (RACI) matrix			
Business: 5/7	**Engineers:** 5/7	**Educators:** 4/7	**Verdict:**
K: 2 | **KS:** 1 | **KSA:** 2	**K:** 3 | **KS:** 0 | **KSA:** 2	**K:** 2 | **KS:** 1 | **KSA:** 1	K
Ritual implementation			
Business: 4/7	**Engineers:** 4/7	**Educators:** 4/7	**Verdict:**
K: 1 | **KS:** 0 | **KSA:** 3	**K:** 1 | **KS:** 2 | **KSA:** 1	**K:** 1 | **KS:** 3 | **KSA:** 0	-[2]
Suitable Project Progress metrics			
Business: 6/7	**Engineers:** 7/7	**Educators:** 7/7	**Verdict:**
K: 1 | **KS:** 3 | **KSA:** 2	**K:** 3 | **KS:** 2 | **KSA:** 2	**K:** 4 | **KS:** 1 | **KSA:** 2	K
Teambuilding			
Business: 5/7	**Engineers:** 5/7	**Educators:** 5/7	**Verdict:**
K: 2 | **KS:** 0 | **KSA:** 3	**K:** 1 | **KS:** 2 | **KSA:** 2	**K:** 0 | **KS:** 3 | **KSA:** 2	KSA
Team career paths facilitation			
Business: 3/7	**Engineers:** 3/7	**Educators:** 5/7	**Verdict:**
K: 1 | **KS:** 0 | **KSA:** 2	**K:** 1 | **KS:** 1 | **KSA:** 1	**K:** 1 | **KS:** 2 | **KSA:** 2	KSA
Teams with dislocated team members			
Business: 4/7	**Engineers:** 6/7	**Educators:** 7/7	**Verdict:**
K: 1 | **KS:** 2 | **KSA:** 1	**K:** 3 | **KS:** 0 | **KSA:** 3	**K:** 5 | **KS:** 0 | **KSA:** 2	K
The difference between efficiency and effectivity			
Business: 5/7	**Engineers:** 5/7	**Educators:** 5/7	**Verdict:**
K: 3 | **KS:** 0 | **KSA:** 2	**K:** 4 | **KS:** 0 | **KSA:** 1	**K:** 4 | **KS:** 0 | **KSA:** 1	K
The people side of change			
Business: 5/7	**Engineers:** 5/7	**Educators:** 6/7	**Verdict:**
K: 0 | **KS:** 0 | **KSA:** 5	**K:** 1 | **KS:** 0 | **KSA:** 4	**K:** 3 | **KS:** 0 | **KSA:** 3	KSA
The reasons why the organization is doing agile			
Business: 7/7	**Engineers:** 7/7	**Educators:** 5/7	**Verdict:**
K: 3 | **KS:** 0 | **KSA:** 4	**K:** 6 | **KS:** 0 | **KSA:** 1	**K:** 3 | **KS:** 0 | **KSA:** 2	K
User story breakdown into tasks			
Business: 3/7	**Engineers:** 6/7	**Educators:** 4/7	**Verdict:**
K: 1 | **KS:** 1 | **KSA:** 1	**K:** 1 | **KS:** 4 | **KSA:** 1	**K:** 0 | **KS:** 4 | **KSA:** 0	KS
Usage of feedback gathered at rituals			
Business: 6/7	**Engineers:** 6/7	**Educators:** 4/7	**Verdict:**
K: 0 | **KS:** 2 | **KSA:** 4	**K:** 2 | **KS:** 1 | **KSA:** 3	**K:** 0 | **KS:** 2 | **KSA:** 2	KSA
Working agile in a traditional enterprise context			
Business: 5/7	**Engineers:** 5/7	**Educators:** 5/7	**Verdict:**
K: 0 | **KS:** 1 | **KSA:** 4	**K:** 1 | **KS:** 0 | **KSA:** 4	**K:** 2 | **KS:** 1 | **KSA:** 2	KSA

Table K.1: Full results of the Learning Goals survey.

[1] Highest level chosen based on tie.
[2] Topic is rejected.

Appendix Bibliography

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