University of Twente

MSc. Business Information Technology
Master thesis

Assessing organizations' readiness for Agile at Scale adoption

Ruben G.R. Stam

Graduation committee

dr. M. Daneva
prof. dr. J. van Hillegersberg

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Abstract

Since the introduction of the Agile Manifesto, many organizations have adopted its methodology to develop software. However, as Agile was originally designed with small development teams in mind, organizations are struggling to apply Agile principles when many developers work on large products or projects at the same time. The so-called 'Agile at Scale' frameworks were invented to systematically help organizations in their journey of scaling the Agile principles.

The organizational change to adopt such a framework is a complex undertaking, requires significant resources, and is likely to fail if organizations are not properly prepared for it. Until now, the existing solutions to the organizational need for guidance in preparing for the adoption of Agile at Scale include a variety of maturity models. These models, however, focus on assessing the level of penetration of Agile practices in an organization, and not necessarily address preparation for the adoption of Agile at Scale and the level of organizational readiness to embark on it. Hence, how much preparation an organization needs and what preparation actions an organization must focus on and for how long, is hardly known. Currently, there is no model, assessment tool, and method for organizations to assess their readiness to adopt Agile at Scale. Hence, this master graduation project aims to design and evaluate a proposal for such a model, tool and method with the objective to provide organizations with the guidance they need to prepare and be prepared for the adoption of Agile at Scale.

To achieve this objective, the present research project adopted the design science research methodology of Peffers *et al.* and followed a research process including three major stages: (i) exploration and analysis of the problem space, (ii) artifact (i.e. solution) design and (iii) artifact evaluation. In line with this process, the research first focused on the types of readiness models from other related disciplines and their constructs, in order to select the proper readiness model type for the development of a dedicated Agile at Scale readiness model. Using systematic literature review techniques and qualitative research, a total of 45 Critical Success Factors for Agile at Scale adoption have been identified based on 122 publications and 5 expert interviews. To measure the presence of these Critical Success Factors in an organization, variables and indicators have been deduced from the Critical Success Factors. This work served as a *pre-step* for the design of the so-called Agile at Scale Readiness Model (ASRM), aimed at informing and assessing organizations' readiness to adopt Agile at Scale.

The second stage of this research focused on the design of the proposed readiness model ASRM which uses weighted Critical Success Factors, variables and indicators that when assessed, provide organizations with their level of readiness to adopt Agile at Scale. By collecting indicator data through specifically designed assessment questionnaires spread throughout the organizations, the proposed ASRM allows a readiness level to be calculated. In addition to these questionnaires, the design stage also included a 'proof of concept' of a digitalized ASRM's assessment tool and a step-by-step method for ASRM application.

Continuing on the second stage of this research, an important feature of the ASRM proposal in this thesis is that it includes multiple levels of granularity in the assessment: it reveals not only the overall readiness, but also the readiness level per Critical Success Factor, per variable, per indicator or per stakeholder group, participating in the assessment. The proof of concept of digitalizing ASRM's assessment tool and method has demonstrated how data can be collected digitally and different visualizations can be generated based on the needs of the specific organization. Moreover, ASRM is made available in two versions: (1) a full version with all Critical Success Factors, variables and indicators and (2) a lightweight version called ASRM Lite, in which only the top 15 weighted CSFs of all the 45 identified CSFs are included. The design of ASRM Lite reduced the number of variables from 70 to 27 and the number of indicators from 147 to 62, while still covering 68.7% of the weight of the full version of ASRM. ASRM Lite allows organizations to execute a quick scan assessment of ASRM with minimal resources, while still retaining an relative accurate assessment result.

The third stage was the evaluation of the proposed readiness model ASRM. It is important to note that the present project executed *two iterations* of the design cycle of the design science research methodology of Peffers *et al.*, in order to benefit from the evaluation of the initial ASRM proposal and in fact, come up with a more refined version. This is to say that the evaluation of the very first version of ASRM was deliberately used to design updates to ASRM based on the evaluation results. Each design cycle iteration concluded expert interviews with 5 experts from different organizations and with different levels of Agile (at Scale) experience. Two aspects were considered in the evaluation, namely the content of the model (e.g., is the model complete and are its constructs valid), and the use and acceptance of the model. Data for the former was gathered through semi-structured interviews while the questionnaires of the Universal Theory of Acceptance and Use of Technology (UTAUT) were utilized for the latter. The UTAUT data shows positive results and indicate that ASRM is likely to be adopted by practitioners. Furthermore, a senior executive of a leading software organization in the financial industry in the Netherlands has been interviewed to retrieve an executive's view on the use of ASRM, which complimented this project's evaluation efforts.

This thesis has some implications for research and for practice. The implications for research are mainly related to the limitations in the current research. Most notably, full validation of ASRM's accuracy and correctness can only be achieved by applying ASRM in many organizations and comparing its assessment results with the implementation results over the years. Therefore, the implications for research include follow-up evaluation case studies to understand if ASRM is also applicable for organizations coming from a plan-driven, waterfall approach, to benchmark ASRM to further calibrate its assessment scheme, and fully assess the utility of ASRM in real world scenarios.

The main practical implication of this research is that, with the introduction of ASRM, organizations now have the ability to assess their readiness prior to adopting Agile at Scale, reducing the risk of failure due to not being ready for the adoption. In particular, IT Professionals, high-level IT managers and decision makers involved in Agile at Scale

transformation initiatives could benefit from the results of applying ASRM in their organization.

Keywords: Agile at Scale, Scaled Agile, readiness, assessment, model

Preface

The past three years have revolved around finally finishing my studies, from starting with a pre-master, to conducting an extensive systematic literature review and to writing this master thesis. After graduating from a University of Applied Science, I knew I had not reached my ceiling and wanted to continue to grow and push myself. In doing so, I worked part-time during my masters to acquire working experience while also attempting to not just graduate, but graduate Cum Laude. Although I do not know if I will graduate Cum Laude at the time of writing, the thesis in front of you is my attempt in doing so.

Its topic originates from both a personal interest and an organization's interest. Personally, ever since taking an Organization Theory course during my pre-master, I have been interested in how to design an organization and how to let its employees cooperate. Putting this in a software development perspective quickly leads to Agile and its recent development of Agile at Scale. Topicus, my employer for over three years and my graduation organization, has implemented an Agile at Scale framework at one of its business lines in the past three years. I was personally involved in this process by selecting and implementing the tooling to support the Agile at Scale framework. A logical next step would be for other business lines to adopt SAFe, however it is not so clear if these business lines are ready to start the adoption. Thus, the topic of the thesis came to be.

The road to writing this thesis and completing my education would without doubt not have been possible without the extensive support that I have received from my friends, family and supervisors. It saddens me that my always supporting and dear grandmother, who suddenly passed away during the last months of my education, is not able to see the final result of the hard work. However, I know that she would have been proud and I want to thank her for all the support she has given me throughout my education and life.

I would also like to express my gratitude for all the support I have received from my supervisors at Topicus; Wietze Spijkerman and Stefan Hessels, with special thanks to Stefan who has been a mentor for the past four years where I wrote my bachelor thesis, started my professional career and now graduate my master.

Furthermore, I would also like to express my appreciation for the support and insights that my supervisors dr. Maya Daneva and prof.dr. Jos van Hillegersberg have provided me with. Without their insights, suggestions and critical evaluation, I would not have been able to deliver a thesis with the current level of quality.

Finally, I want to express my graduation for the general support I have received from my family. Special gratitude goes out my friend Alicia Ziser, who has motivated me to get the best out of myself and work and finish my thesis at times where my motivation experienced a drop.

Contents

List of figures

List of tables

List of equations

Introduction

This chapter serves as an introduction, where the relevance and goal of the thesis is provided.

1.1 Theoretical relevance & motivation

Since the introduction of Agile in 2001 [1], software organizations have changed the way they work and develop software. Instead of working in so-called pre-planned waterfall projects, organizations cut work down into smaller pieces for smaller teams that allow them to remain flexible and adapt to changing demands. However, as Agile methodologies such as Scrum and Kanban state that a development team should consist of less than 9 people, organizations struggle how to implement and work with Agile when the product being worked on requires many developers and other employees. Agile at Scale frameworks try to tackle this problem by scaling up Agile principles to be applied in larger organizations.

Interestingly, Agile at Scale is one of the few areas where practice seems to be ahead of theory. This is demonstrated by the findings of Dikert *et al.* [2], who in their systematic literature review (SLR) of challenges and success factors for large-scale agile transformations only found 6 academic studies, but 46 experience reports. These experience reports have led to many do's and don't's, as well as the development of Agile (at Scale) adoption and maturity models such as the Agile Adoption Framework [3], the Agile Maturity Model [4], the SAFe Maturity Model [5], and the Agile Transformation Model [6]. As the popularity of Agile at Scale adoption increases, the questions for organizations shifts from why to adopt, to how to adopt [5]. The required need to answer this question becomes evident when considering that adopting an Agile at Scale framework requires investments and has a significant effect on organizations, as it defines how organizations operate and deliver software. Failing in the adoption process would therefore have a big impact on organizations. However, researchers seem to have failed to address the first step in the adoption process of an Agile at Scale framework. Whereas many transformation and maturity models exist to evaluate the (ongoing) adoption of Agile at Scale, none of the published models evaluate the readiness of an organization to adopt such a framework. Yet, Agile at Scale readiness is important, because the organizational change to adopt an Agile at Scale framework is a complex undertaking that requires significant resources and is likely to fail if organizations are not properly prepared for it. This thesis sets out to fill this literature gap.

1.2 Research goal

The goal of this thesis is to address the missing step in Agile at Scale adoption, namely to assess whether an organization is ready for such an adoption an. To answer this question an Agile at Scale readiness model will be developed that helps organizations in answering this question. An essential part of this goal is to make the model applicable in practice. This means that the model should not only provide theoretical information about what defines organizations' Agile at Scale readiness, but should also provide the actual assessment tools to be useful for organizations.

1.3 Scope

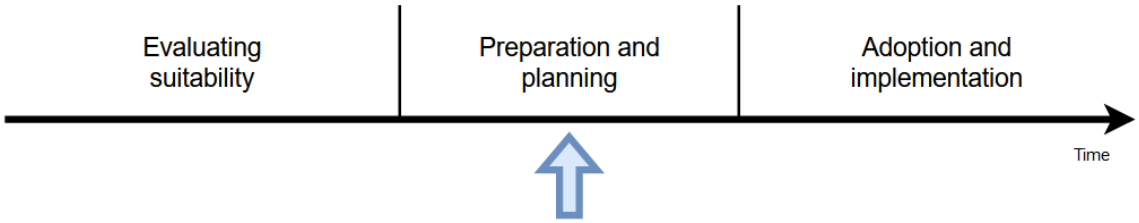


Figure 1: Model placement in Agile at Scale adoption timeline

The process of evaluating if an organization should adopt Agile at scale up till the actually adoption consists of a few stages. In the first stage, organizations should identify the problems and issues they are facing so that they can evaluate whether or not Agile at Scale would solve their issues or further improve their performance. This stage would also include assessing if Agile at Scale and its principles fit and suit an organization, e.g., does the organizational culture fit Agile at Scale, is the industry for which software is developed suitable for it, and will the software architecture support scaled development.

The scope and focus of this research is to develop a model that helps organization in the stage thereafter. That is, once an organization has decided that Agile at Scale is the route to take, organizations should then start to prepare and plan the change. It is in this stage that the Agile at Scale readiness assessment will be done and where the intended model will take its place. This is indicated by the blue arrow in Figure 1.

The last stage in adopting Agile at Scale would be the adoption and implementation phase. This would be the phase were maturity models take their place.

1.4 Research questions

Following the researcher goal, the main research question has been formulated as:

How can we assess the readiness of an organization that is interested in adopting an Agile at Scale framework?

Subsequently, the following sub questions have been formulated:

SQ1. What are relevant variables for the adoption of an Agile at Scale framework?
SQ2. What readiness model type fits best for assessing Agile at Scale readiness?
SQ3. How can the relevant variables and the model type be combined into a model with an assessment tool?
SQ4. Is the model with the assessment tool useable and useful for the assessment of Agile at Scale readiness?

1.5 Design requirements

To achieve the research goal and answer the research questions, a set of design requirements has been defined. These requirements aid in the design and creation of an Agile at Scale readiness model that is applicable in practice. The defined development requirements are:

- The model must offer an applicable assessment method to assess Agile at Scale readiness
- The model must provide means for indicating Agile at Scale readiness at different levels of granularity
- The model must be applicable in practice and have sufficient ease of use

1.6 Contribution to research and practice

As mentioned in the Introduction, scientific literature tends to focus mostly on the maturity of adopting frameworks and developments, specifically Agile at Scale. The contribution of this research is that it concentrates on a step before assessing maturity, namely readiness., filling this gap in the literature. To the author's best knowledge, readiness in the area of Agile of Scale has not yet been researched. Hence, this research is the first contribution to that area.

A valuable contribution is also made to practice by providing practitioners with a readiness assessment model with which their Agile at Scale readiness can be assessed. By applying the proposed model, organizations can increase their likelihood of adopting Agile at Scale successfully as the uncertainty if they are actually ready for such an adoption is taken away. Furthermore, the duration of such a complex evaluation is shortened by providing an easy to use assessment method and tool.

1.7 Definitions

Multiple terms of scaling Agile practices are used in the literature. To avoid confusion of these terms, the definitions used by the author are provided.

Large scale Agile – This term is found often in the literature, specifically often in case studies of organizations that make the transition from traditional development methods such as Waterfall to Agile. As the term implies, large scale Agile is defined as simply applying standard Agile to a project in which there is a large number of teams or to a large organization (horizontal scaling).

Agile at Scale – In contrast to large scale Agile, Agile at Scale applies scaling practices to enable better Agile and organizational performance. At Agile at Scale, an Agile scaling framework such as Less, SAFe or DAD, is used. These frameworks apply Agile scaling practices such as Scrum of Scrums in order to scale Agile not only horizontally, but also vertically. That means that Agile principles and events such as sprints and are not only practiced at the team level, but also on the levels above it. Developing a model for Agile at Scale readiness is the focus of this thesis.

Scaled Agile – Although this term fits the definition of Agile at Scale well, it is too closely associated with the Scaled Agile Framework (SAFe). Therefore, in this thesis, the decision is made to not adopt this term as the main thesis focus.

1.8 Thesis structure

The rest of this thesis is structured as follows. Firstly, the research methodology is provided. Next, relevant background and related work is discussed. This is followed by the development of the Agile at Scale readiness assessment model and its first evaluation. Finally, a discussion on the results, reflection on implications and conclusions are provided.

2 Research methodology

The Design Science Research Methodology (DSRM) of Peffers *et al.* [7] is adopted for this research. The choice for the DSRM over other design science research methodologies such as the DSR Process Model [8], Soft Design Science Methodology [9], or Action Design Research [10] was made based on the guidelines of Venable et al. [11] for choosing a design science research methodology. According to the guidelines, DSRM is suitable when the output of the research is not a IT system or a design theory.

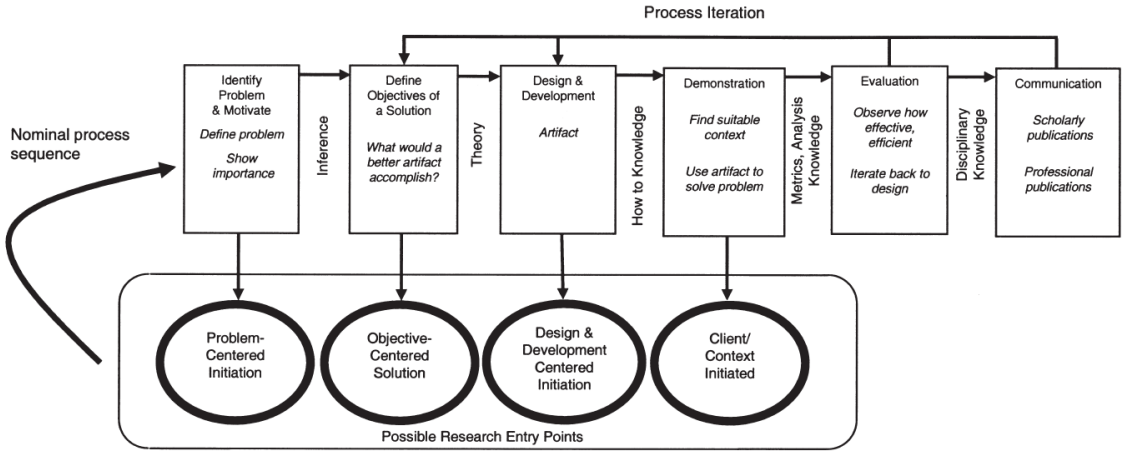


Figure 2: Design Science Research Methodology. Adopted from Peffers et al. [7]

As shown in Figure 2, the DSRM has six stages and four entry points. The Problem-Centered Initiation entry point is the logical starting point when the idea for a research is a result of an observation of a problem or from suggested future research in a publication [7]. For the current study this is the correct starting point as a clear gap in the literature has been identified that needs to be addressed, that being the lack of methods and tools to assess an organization's readiness for the adoption of Agile at Scale. The relevance and need to address this gap has already been demonstrated in the Introduction and thus that section covers the first stage of DSRM. The second phase of DSRM concerns defining objectives of a solution which, have been defined in the Research goal, Design requirements and Research questions sections. The following subsections will further elaborate on the implementation and application of the remaining stages of the DSRM with respect to the study design.

2.1 Design and development

The third step of the DSRM concerns the development of the artifact. As the defined objectives of the solutions show, the artifact will be a readiness model to assess the readiness for the adoption Agile at Scale. The design process of the initial model is shown in Figure 3. The first process step is to identify the relevant variables that need to be taken into consideration when adopting Agile at Scale (research question 1). The next step is to select a model type that suits the goals of an Agile at Scale readiness model (research question 2).

The findings of these two steps can then be combined into the initial model design (research question 3).

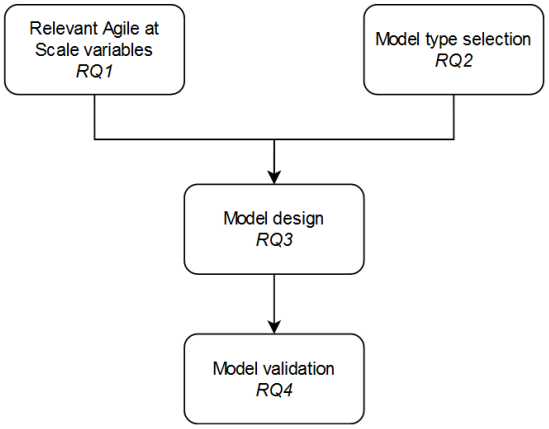


Figure 3: Initial artifact design process

2.2 Demonstration & Evaluation

Because of the nature of the model and its context, the demonstration and evaluation stages go hand in hand with each other. The focus of the model is to assess the readiness for the adoption of an Agile at Scale framework. Such an adoption can take a few years to complete, and hence it is not possible to try out and demonstrate the model by applying it to a real world case to then validate and evaluate the model afterwards and go for the next design cycle. Therefore the choice is made to use experts opinions to evaluate and validate the model. The model will be explained to the experts to make them understand how it would work in practice, to then start the evaluation and validation process. The validation answers research question 4 and is the fourth step in Figure 3.

The evaluation and validation of the model will be done through multiple means. The Universal Theory of Acceptance and use of Technology (UTAUT) [12] and its questionnaire will be employed to validate the usefulness of the proposed readiness model by asking Agile (at Scale) experts to fill in the questionnaire. Slight alterations will be made to UTAUT's questionnaire to tailor it to the proposed readiness model. Next to validating the usefulness and applicability of the proposed model, the content of the model will also be validated, e.g., is the model structure valid and are the selected variables correct. This part of the validation will be done through interviews with experts from the field. To ensure validity, a diverse set of practitioners is selected to participate in the evaluation cycles. This includes practitioners with different roles from different organizations to eliminate any organization specific biases.

2.3 Communication

When the final version of the model is ready, it will be published on essay.utwente.nl where the thesis and model are free to be downloaded and applied by anyone.

3 Background

This chapter serves as the foundation for the proposed readiness model. Relevant background information on Agile at Scale and important variables are provided and discussed. Furthermore, a systematic literature review on the design of readiness models is conducted, which provides the building blocks of readiness models.

3.1 Readiness models

As preparation for this thesis, a systematic literature review (SLR) was conducted with the goal to identify the building blocks, elements and internal constructs that make readiness models. This provides the ability for new readiness models to be tailor-build, selecting the best and most relevant elements, constructs and building blocks for the models' contexts. Furthermore, in the SLR special attention was paid to existing readiness model types, their goals and completeness, and their advantages and disadvantages.

The following subsections provide the results of the SLR. The used methodology can be found in Appendix A. Reviewing existing literature on readiness models has provided results in different aspects of the models. This section is structured in a way so that the previously mentioned aspects (model types, model elements, goals and completeness, and advantages and disadvantages) are discussed one by one.

Part of the literature review is to discuss the quality, usefulness and accuracy of different models and model types. An important remark to make is when discussing these aspects, the assumption is made that variables found in a model are accurate and relevant. The discussion and information about the quality, usefulness and accuracy of models is related to the model's constructs and structures. In other words, the content of the models is assumed to be accurate (i.e., the variables, dimensions, etc.), not the structures and constructs of the models.

3.1.1 Model types

The first goal of the SLR is to discover and identify the different model types that readiness models are made of. Table 1 provides an overview of the model types that have been identified. Two major model types were identified with a total of seven sub-types. Some models have borrowed elements and properties from other categories. However, the use of elements from other model types was found to be extensive enough to justify the identification of another model type than those identified. In fact, all models had a very clear main model type, with the use of only one or two elements from other model types. Therefore the models that used elements from multiple model types were mapped to the category that they use the most elements from.

The model types and categorization of models into these types has, to the best of the author's knowledge, not been done before. Hence, the model type taxonomy was created by the

author based on the readiness models found in the literature. The following sub-sections provide an overview of the different model types and how they differ from each other.

3.1.1.1 *Mathematical models*

One of the two main model types are the mathematical models. This model type is characterized by its use of mathematics as the foundation and main element of the model. Two subtypes have been identified, namely formula subtype and the fuzzy logic subtype. Just as any other model type identified, mathematical models and their subtypes work with variables. However, their approach and use of variables is mathematically oriented.

Equation 1 shows an example of a mathematical readiness model, specifically of the formula type. As the example shows, the variables are considered as mathematical variables on which (complex) calculations are done in order to calculate and assess readiness.

$$I - EDI_i = \beta_{0i} + \beta_1 \cdot WR_i + \beta_2 \cdot DRD_i + \beta_3 \cdot PERM_i + \beta_4 \cdot IOP_i + \beta_5 \cdot IOC_i + \beta_6 \cdot WR * IOP_i + \beta_7 \cdot WR * IOC_p + \beta_8 \cdot PRD * IOP_i + \beta_9 \cdot PRD * IOC_i + \beta_{10} \cdot C_i + \varepsilon_i$$

Equation 1: Example of a mathematical readiness model, adopted from [13]

The other mathematical subtype utilizes fuzzy logic as its main element of differentiation from the formula type. Fuzzy logic is a method of computation and interpretation which the objects that is reasoned and calculated about has unclear and fuzzy borders [14]. Its concepts allow the use of linguistical terms to evaluate variables and indicators in natural language expressions [14]. A common use case would be to apply fuzzy logic when applying questionnaires and Likert scales to assess variables.

3.1.1.2 *Dimensions, elements and variables models*

The other main type of model is the dimension, element and variable type (see type IDs 2.x in Table 1). The idea behind this model type is that there are dimensions, often further subdivided into elements and/or variables, that influence readiness. Although the identified subtypes vary in their approach of applying dimensions and variables and the extensiveness thereof, dimensions and variables are the underlying foundation of these models.

The simple dimensions subtype is considered to be the most basic subtype. This subtype is characterized by solely providing dimensions and variables that are relevant for readiness for a phenomena. A common way to present these types of models is through a table that provides the dimensions and variables, e.g. as in [15], [16] and [17]. A similar subtype is the type that utilizes enablers, critical success factors, motivators and barriers or a selection of these. Although at first these types might seem to be the same, there is a clear difference between the two. The former provides variables that can be measured and assessed. The latter, on the other hand, provides matters and affairs that should be in place (e.g. success factors) or not (e.g. barriers), but does provide the possibility to derive readiness throughout a measurable entity such as a variable. A more extensive subtype is the structured with

influences type. Like the before mentioned subtypes, this subtype also provides dimensions and variables or success factors and barriers. In addition, it also provides a visual structure and relationships between the variables such as influence relationships and causation relationships.

The two remaining subtypes are those that utilize grading and levels in their models. In contrast to the other dimensions, elements and variables subtypes identified, these last two subtypes also provide ways to asses readiness, either through grading or through identifying the readiness level. The grading subtype works through grading or scoring variables. Then, through a calculation or reaching specific thresholds it is assessed if readiness for the introduction of a phenomena or artifact is reached. Similarly, the subtype that utilizes (readiness) levels applies a method to asses readiness. In comparison with the grading subtype, this subtype additionally provides insight in how far one is away from reaching readiness or how ready one is. It does so by providing information about what is needed to reach a certain readiness level, e.g. by showing which variables should be satisfied to reach a certain readiness level.

Table 1: Identified Model Types

Type ID	Type	Subtype	Description	Literature
1.1	Mathematical	Fuzzy Logic	Apply Fuzzy logic to calculate readiness values	[14], [18]–[21]
1.2	Mathematical	Formula	Calculate readiness through applying Formula's	[13], [22]
2.1	Dimensions, elements, and variables	Simple dimensions	Provides relevant dimensions and variables	[15]–[17], [23]–[31]
2.2	Dimensions, elements, and variables	Structured with influences	Has a structure which includes relationships between variables such as influences and causations	[32]–[44]
2.3	Dimensions, elements, and variables	(Maturity) Levels	Provides levels of readiness	[45]–[52]
2.4	Dimensions, elements, and variables	Grading	Assess readiness by grading variables and overall readiness.	[53]–[57]
2.5	Dimensions, elements, and variables	Enablers, success factors, motivators and barriers	Provides Enablers, success factors, motivators and barriers that are relevant when becoming ready.	[58], [59]

3.1.2 Internal constructs and relationships

Analyzing and identifying the different model types also enabled the decomposition of the models into building blocks, internal constructs and relationships. Some constructs are found in multiple model types, while others are very specific to a sub-model type. The findings of this decomposition will be described in this subchapter.

3.1.2.1 *Use of hierarchy*

Among the readiness models included in this SLR, a form of hierarchy is present in 37 of the included models. One might conclude therefore that a hierarchy serves as the mechanism for the authors of the models to organize the structural elements of their models. Rather than just providing many variables that influence readiness, variables are often categorized by their overarching dimension. Researchers also realize that only providing dimensions (e.g. people and technology) is too general and generic to provide meaningful insights in factors that influence readiness, and thus break down dimensions into variables and/or elements. Different authors apply hierarchy differently. For instance, Akbar *et al.* [49] use two levels of hierarchy, where they provide 12 readiness categories with between 3 to 8 practices per category. On the other hand, Hamid & Mansor [26] use four levels of hierarchy by the use of internal and external factors, which both have underlying readiness dimensions, with underlying readiness factors, with underlying readiness elements. However, not every readiness model makes us of hierarchy. For example, Eskerod and Jepsen [40] only provide four variables that influence readiness in their model and make no use of a hierarchy.

3.1.2.2 *Use of measurable variables*

Identifying factors that influence readiness does not by definition result in the identification of measurable and assessable variables. A translation from such a factor to a measurable variable is sometimes needed, such as in [17]. In their model, Nortje and Grobbelaar [17] identified an Employee and Culture dimension with an underlying readiness element of Job security. This element is then assessed by the readiness variable of Employees' perception of job security with regards to AI. Also, in mathematical models there is often a derivation from criteria or elements to variables, such as in [14], [19] where attributes are derived from criteria. These attributes are then used in the calculation of the readiness level. In essence, there are cases where the factors, elements, criteria, dimensions, etc. are not directly measurable and measurable variables need to be derived from these factors, elements, criteria and dimensions in order to assess readiness.

3.1.2.3 *Relationships, influences and causations*

Influence and causal relationships are common in scientific models, and are also present in 20 of the included readiness models. These are most common to the structured with influence subtype, but not exclusive to. These relationships show how variables influence other variables and in the end readiness.

3.1.2.4 *Mechanisms to assess variables*

Out of the 47 included readiness models, 17 readiness models provide mechanisms to assess the variables that influence readiness. Such mechanisms are for example a calculation through a formula, or a list of requirements to achieve a specific readiness level. These mechanisms help the model's appliers and users to objectively and clearly understand and identify how ready they are.

3.1.2.5 *Mechanisms to gather data*

In order to assess relevant variables data needs to be collected. A method to collect quantitative or qualitative data is present in a number of the found models. For example, the model proposed in [51] provides sample questions per dimension to gather data to assess them and the models in [27], [52] provide questionnaires that can be used to assess the readiness variables. Other methods to gather the needed data are also imaginable, such as getting data out of IT systems (e.g. [22]).

3.1.2.6 *Visualization and representation*

Some models such as those in [50], [54] and [56] provide a visualization of the readiness level and the assessment of the readiness variables. Common ways to do this is through radar charts (e.g. [54], [56]), whilst others provide a (colored) table (e.g. [20], [46], [50]) or an image to illustrate how dimensions and variables are related (e.g. [23]).

3.1.3 Goals and completeness of readiness models

The approaches to the goals and completeness of readiness models in the 47 papers selected for inclusion in this SLR, vary widely across models and model types. Table 2 provides an overview and summary of the goals that the different model types have. Three main goals have been identified, that being (1) to inform, (2) to create understanding, and (3) to assess. An 'X' in one of the three central columns marks a model type to have the associated goal. The final column provides a summarized explanation of why and how a model type has its associated goals. The reasoning and explanation for the goals of each model type is provided in the remaining paragraphs of this section. It is argued that 'to assess' is the best goal as that enables practitioners to actually apply the model in practice.

Table 2: Goals and completeness of readiness model types

(Sub)type	To inform	To create understanding	To assess	Illustration
Enablers, success factors, motivators and barriers	**X**			Informs about aspects that are relevant for being ready. Does not provide ways to measure or asses those aspects.
Simple dimensions	**X**			Informs about relevant aspects and variables for readiness.
Structured with influences	**X**	**X**		By providing relationships and causations these models provide explanation of how readiness is influenced and by what.
Grading			**X**	By scoring and grading variables the readiness level gets assessed.
Mathematical			**X**	Uses mathematics to calculate a readiness score to asses readiness.
Levels	**X**		**X**	Readiness levels allow for the assessment of readiness. Also, because the requirements for the readiness levels are known, the user is informed on how to improve their readiness.

The simple dimensions subtype provides little more than just variables that are relevant for readiness. It informs about the relevance of certain variables for readiness, but does not provide ways to assess the readiness, nor does it inform how the variables impact readiness or how readiness can be improved through the variables. Success factors, barriers and such are in that sense the same. They provide relevant aspects and important factors for readiness, but the models and studies do not provide methods to assess these factors and thus readiness [60]. The goal and use case of these two types of models are then also to inform.

In a similar vein, models that incorporate a structure with influences or causations also inform, but they also explain. Through providing influences, relationships and causations, an understanding is generated of how the variables relate to each other and what variables should be changed to influence readiness.

In comparison to the before mentioned model types, the mathematical and grading types provide actual assessment of readiness. The grading models do so by grading variables in order to grade the overall readiness. Also, these models often provide a visual overview of the results, such as through (radar) charts (e.g. [53]–[56]) or through tables (e.g. [53], [54], [56]). In addition, Karandikar *et al.* [55] also provide a specific questionnaire tailored to the variables of their readiness model. By doing so they provide a way to gather the data needed for the assessment. The mathematical models provide assessment of readiness through their formulas and calculations, and thus give an answer to the question whether an entity is ready for a phenomenon. Instead of assessing and informing about readiness through graphs and charts, many mathematical models provide extensive tables to display the readiness calculations and assessment (e.g. [13], [18], [19]).

Models that provide readiness levels do not only assess readiness through their levels, they also inform how to reach specific levels. In doing so, most of these models also provide ways how to gather the data and assess is in order to determine the readiness level. Nekvasil & Svátek [52] provide a questionnaire to gather the data and show which requirements should be met to reach a certain readiness level. Kelly *et al.* [51] provide example questionnaire questions and give an extensive description of the different readiness stages. Alruwaili & Gulliver [50] provide a method to assess readiness and a decision methodology composed of four steps to assess which of the six readiness stages an organization is in.

An important remark to make is that the elements of completeness as described in the previous paragraphs are not exclusive to the corresponding model types. To illustrate, Alruwaili & Gulliver [50] propose a readiness model of the level subtype in which they provide a visual representation of the readiness assessment results through a color-coded table to visualize the level of readiness, whilst it are the mathematical and grading models that most frequently provide visual overviews of the readiness assessment results.

3.1.4 Advantages and disadvantages

As noted in previous subsections, there is a broad difference in model types, their goals and their completeness. Accompanying these differences are different advantages and disadvantages of the different model types. It is acknowledged that the advantages and disadvantages may vary depending on the setting where a model type would be deployed (e.g. in IT, in health care, in the banking sector, etc.). For this SLR, the focus lies on the IT domain and thus the advantages and disadvantages are evaluated with regards to the IT domain. Table 3 shows the advantages and disadvantages of the different model types for different areas on a 1-4 scale. The advantages and disadvantages of the model types and scoring of the evaluation elements (columns) were created based on the findings in the previous sub sections of section 3.1. Subsequently, the scoring has been done by the author based on those same findings. The motivation for the scoring is found in the remaining paragraphs of this section, where the advantages and disadvantages of every model type is discussed.

Table 3: Advantages and disadvantages of readiness models

Model type	Ease of understanding	Ease of execution	Ease of data collection	Assessment accuracy	Completeness
Enabler, success factors, motivators and barriers	4	1	1	1	1
Simple dimensions	3	1	2	2	1
Structured with influences	3	1	2	2	1
Grading	3	3	3	3	3
Mathematical	1	1	3	4	3
Levels	4	4	3	3	3

It is argued by the author that the main advantage of success factors, enablers, motivators and barriers is that they are easy to understand. They provide in clear words what is beneficial and what is not for the adoption and readiness of an artifact or change. However, this is also its biggest downside. Although it is clear what is beneficial for and will contribute to readiness, it is not clear how to measure these things. The success factors, enablers,

motivators and barriers need to be translated into measurable variables and these need to be assessed. Subsequently, it is also not provided how to collect the data for the assessment, nor how to do the actual readiness assessment. This also makes it hard to assess readiness accurately, because there is no prescribed way on how to collect data to assess readiness, let alone that the model provides measurable variables. Because of this, this model type scores high on ease of understanding, but very low on all the other criteria.

Many of the above mentioned advantages and disadvantages also apply to the simple dimensions category. By providing just relevant dimensions and variables, the models stay simple and are easy to understand. In contrast to success factors, enablers, motivators and barriers models, these models do provide measurable variables which makes it easier to gather the required data, while also making them more accurate because the model's appliers do not have to deduce measurable variables themselves as is the case with success factors, enablers, motivators and barriers models. However, these models are not extensive in the way that they provide a comprehensive method to also gather and assess data to determine readiness. As a result, the execution of the readiness assessment is not easy, as the model's appliers have to come up with ways to do the assessment themselves. As this type, just like the of success factors, enablers, motivators and barriers type, does have the goal to inform rather than to assess (see Table 2), it scores low on completeness.

The influences model type expands on the simple dimensions category by adding relationships, influences and causations. The main benefit of adding these elements is that it provides a better understanding of how variables are related to each other. It provides understanding of how changing one variable may influence a different one and how all of these variables eventually influence readiness. However, this model type retains the same shortcomings as the simple dimensions type. That is, appliers of the model need themselves to come up with ways to assess readiness and gather data for the assessment.

A clear advantage of the grading model type is that it provides assessment tools to assess readiness whilst staying easy to understand. Many of these models provide a guiding tool on how to gather and assess the data, without being overly (mathematically) complex. By providing the tools to assess readiness, the model is able to accurately provide readiness assessment, assuming that the variables applied in the model are correct. Assessment of readiness through grading requires quantified data and analysis. However, the downside is that qualitative-based quantitative analysis is a time-consuming task [61]. As a result, this type scores high on all aspects, but not the highest as there are still disadvantages.

Mathematical models share many of the advantages and disadvantages of grading models. These models are accurate in their readiness assessment as they provide a quantitative way to objectively assess readiness. By expressing readiness in a numerical way, models of this type present a very clear answer to the question whether one is ready or not. This comes at a cost however. To be able to calculate the readiness level, numerical data is needed that can be used in the mathematical formulas. Fuzzy logic models tackle this by quantifying data so that it can be used for mathematical calculations. However, to tackle it this way requires

knowledge of Fuzzy logic or possibly other mathematical techniques. In general, the mathematical knowledge required to apply and more importantly to understand how readiness is assessed, is a downside of these mathematical models. It can be hard to explain to your average manager how a, to them, complex model works and how it calculates readiness. As transparency and understanding of an algorithm influence trust [62], it is important for mathematical model appliers and managers to understand how a model works in order to trust its assessment. Given the relative complexity of some mathematical models and their techniques, mathematical models can be hard to apply in practice .

Just as the grading and mathematical models, the level models provide a clear assessment of readiness. By providing different levels of readiness, it informs appliers how ready they are, e.g. not ready at all, almost ready or very ready. It is often the case that the model provides requirements or criteria to be met to achieve a specific readiness level. This helps model appliers what is needed to get to the required readiness level and thus improves ease of use. In addition, it also makes the model type easy to understand while still providing adequate and accurate readiness assessment. This results in the type scoring high on all criteria.

3.2 Agile at Scale

A frequent question found in the literature is how to define "large scale" when scaling agile. Although Agile methodologies prescribe 7-9 team members per team, there is no clear guideline for the number of teams and when it is considered large scale. Multiple researchers and Agile at Scale frameworks provide definitions of what is considered large scale Agile. For example, Dingsøyr *et al.* [63] consider 2-9 teams being large scale Agile and 10+ teams very large scale Agile, while, based on a small literature review, Dikert *et al.* [2] define large scale Agile as having 50 or more people or at least 6 teams.

Various frameworks exist nowadays that guide the scaling of Agile process in organizations [64], such as Scaled Agile Framework (SAFe), Scrum of Scrums (SoS), Disciplined Agile Delivery (DAD), Large-Scale Scrum (LeSS), Nexus, and Recipes for Agile Governance in the Enterprise (RAGE). SAFe, SoS and LeSS are considered the more mature frameworks [64]. Table 4 provides an overview of the suggested amount of teams for a specific framework.

Table 4: Suggested team size to adopt Agile at Scale frameworks. Adapted from [64]

Framework	Team Size
SAFe	50-120 people in release trains
SoS	5-10 teams
LeSS	10 Scrum teams, 7 members per team
DAD	200 people or more
Nexus	3-9 Scrum teams
RAGE	No specific size

A question to ask is what defines an Agile at Scale framework. In an attempt to answer that question, [64] identified 8 common scaling practices:

1. **Scrum of Scrums**: An approach to scale Scrum to large groups.
2. **Communities of practice:** groups of people that share a common concern or passion and have the goal to share their knowledge and learn how to improve.
3. **Scaled sprint demo: a** meeting in which teams show the features that they delivered.
4. **Scaled requirements management:** A team of people concerned with structuring hierarchical requirement management, hierarchical structure of product owners, hierarchical structure of the backlog and its management.
5. **Scaled sprint planning:** A meeting in which the planning for the coming period (months) is discussed.
6. **Scaled retrospective:** A scaled version of the retrospective at a level above that of a single team.
7. **Feature teams:** Cross-functional, cross-component and self-organized teams that design, plan and implement features in a sprint.

8. **Undone department:** a group of teams that support development teams in achieving shippable increments at the end of a sprint.

For a detailed overview of common scaling Agile practices and a comparison of different Agile at Scale frameworks, see [64]–[67].

3.2.1 Agile at scale variables

Multiple SLRs have been conducted to identify (Critical) Success Factors (CSFs) and challenges for large scale agile transformations. Dikert *et al.* [2] identified 29 Success Factors grouped into 11 categories and 35 challenges grouped into 9 categories, and Abrar *et al.* [68] identified 21 Success Factors and motivators for Large-Scale Agile adoption. Shameen *et al.* [69] report 11 human related challenges that can negatively impact Agile practices in large-scale software development [70]. Next to examining Agile at Scale practices, Kalenda *et al.* [64] have identified 9 Success Factors and 10 Challenges in a literature review and a case study.

To derive variables that indicate an organization's readiness for the adoption of Agile at Scale, CSFs and challenges of such an adoption could be used as starting points. Challenges are the things that need to be overcome to be successful. CSFs, on the other hand, are the few key areas in which favorable results are absolutely necessary ensure success for an organization or a manager [71], [72]. It is argued that focusing on achieving CSFs over tackling challenges is the better approach. After all, CSFs need to be achieved in order to reach goals [72], whereas challenges are problems and difficulties that may need to be overcome. Furthermore, when looking at the identified challenges and CSFs in [2], [64], [68], it is often the case that there is a relation between the identified challenges and the identified CSFs. To put it more specifically, the CSFs often encapsulate covering the identified challenges. Table 5 demonstrates this by providing examples of CSFs covering challenges. Hence, CSFs are used as the starting point to identify relevant variables for Agile at Scale readiness.

Table 5: Examples of challenges covered by CSFs. Adapted from Dikert *et al.* [2]

Challenges	Success factors
Agile customized poorly	Customize the agile approach carefully
Lack of coaching	Coach teams as they learn by doing
Lack of training	Provide training on Agile methods
Management unwilling to change	Ensure management support
Interpretation of agile differs between teams	Conform to a single approach

3.2.2 Critical Success Factors

Table 6 shows a merge of the Success Factors identified in [2], [64] and [68]. The categorization of Dikert *et al.* [2] is adopted as the main categorization, where the found success factors by [64] and [68] were added. This led to three new categories, namely Technological support, Customer, and Other.

Table 6: Success Factors

Success Factors		
Management support		
	Ensure management support	[2], [64], [68]
	Make management support visible	[2]
	Educate management on agile	[2], [64], [68]
Commitment to change		
	Communicate that change is non-negotiable	[2]
	Show strong commitment	[2], [68]
Leadership		
	Recognize the importance of change leaders	[2], [68]
	Engage change leaders without baggage of the past	[2]
	Dedicated management	[68]
Choosing and customizing the agile approach		
	Customize the agile approach carefully	[2]
	Conform to a single approach	[2], [64]
	Map to old way of working to ease adaptation	[2]
	Keep it simple	[2]
Piloting		
	Start with a pilot to gain acceptance	[2], [68]
	Gather insights from a pilot	[2], [68]
	Careful transformation and sustainable planning	[64], [68]
Training and coaching		
	Provide training on agile methods	[2], [64], [68]
	Coach teams as they learn by doing	[2], [64], [68]
	Knowledge sharing management	[68]
Engaging people		
	Start with agile supporters	[2]
	Include persons with previous agile experience	[2], [64]
	Engage everyone in the organization	[2]
	Team encouragement	[68]
Communication and transparency		
	Communicate the change intensively	[2]

	Make the change transparent	[2], [64]
	Create and communicate positive experiences in the beginning	[2]
	Strong collaboration and communication between teams and team members	[64], [68]
Mindset and alignment		
	Concentrate on agile values	[2], [64]
	Arrange social events	[2], [64]
	Cherish agile communities	[2]
	Align the organization	[2]
	Cooperative organizational culture	[68]
	Face to Face meetings	[68]
Team autonomy		
	Allow teams to self-organize	[2], [68]
	Allow grass roots level empowerment	[2], [68]
Requirements management		
	Recognize the importance of the Product Owner role	[2]
	Invest in learning to refine the requirements	[2], [68]
Technological support		
	(Automated) tools and infrastructure	[64], [68]
	Solid engineering practices	[64]
	Quality production using pair programming	[68]
Customer		
	Customer satisfaction	[68]
	Strong collaboration with customer	[68]
Other		
	Risk management	[68]

In total, 122 publications were included in the SLRs of [2], [64], [68] combined. Table 7 provides an overview of the publications per SLR. Unfortunately, it was not possible to filter out duplicates between the three SLRs due to the way that the included publications were presented by the authors of [2], [64], [68], and due to the fact that a significant amount of the included publications were classified and anonymous. Nonetheless, having 122 publications included, possibly including duplicates, provides a representative overview of the found CSFs and challenges in Agile at Scale adoptions.

Table 7: SLRs on Critical Success Factors

SLR	Focus	Included publications
[2]	Success Factors and Challenges	52
[68]	Motivators and Success Factors	58
[64]	Practices, Challenges and Success Factors	12

3.2.3 Variables and indicators

As concluded in the systematic literature review on readiness models, (Critical) Success Factors are in itself not sufficient enough to be directly applied in a readiness model. Rather, measurable variables should be derived from the Success Factors. Inspired by the method of Sidky *et al.* [3] to create the Agile Measurement Index, the Goal Question Metric approach [73] influenced the approach to devise measurable variables from the identified Success Factors. In this approach, the goal is to assess the degree of presence of the Success Factors in the organization and then determine whether this degree is sufficient to adopt Agile at Scale. This is done by deriving variables that measure a particular Success Factor. For example, to assess the Success Factor 'Ensure management support', it is needed to ascertain if management understands the value of adopting Agile at Scale. Hence, a variable to assess the degree of presence of 'Ensure management support' is *management value understanding*. The variable can then be measured by indicators, which are essentially questions to be graded on a Likert scale.

There are two ways to identify the relevant variables and indicators, namely (1) common sense and (2) experience and technical literature [3]. The latter are based on the consultants' experience [3]. For determining the relevant variables and indicators, both methods are used. To elaborate, the author and the thesis supervisors have experience with Agile at Scale transformations and will apply this knowledge to develop the indicators and variables. Additionally, the detailed description of the CSFs found in the used SLRs served as inspiration for deriving the variables and indicators. Furthermore, knowledge and experience of external experts will be incorporated through the use of design cycles.

Based on this approach, 68 variables and 158 accompanying indicators have been derived from the CSFs. Table 8 serves as an example of the breakdown of the CSFs into variables into indicators. The table shows the 4 CSFs in the Engaging People group with their respective variables and indicators. Furthermore, a column 'Who' is added which displays who should answer the indicator question, where

- M = Manager
- E = Employee
- L = Change Leader
- T = Trainer.

The total of 68 variables and 158 indicators can be found in Appendix C.

Table 8: Breakdown of CSF – variable – indicator for the Engaging People CSF group

Success Factor	Variable	Indicator	Who
Start with agile supporters			
	Identifying agile supporters		
		We know who are agile supporters	M/L
	Identifying people with the right personality for change		
		We know who are willing to try something new	M/L
		We know who are collaborative and understanding persons	M/L
Include persons with previous agile experience			
	Ensure Agile experience in every team		
		We have someone with Agile experience in every (development) team	M
Engage everyone in the organization			
	Be inclusive		
		We did a stakeholder analysis	L
		We included all stakeholders in feedback meetings	L
		We gained acceptance from all stakeholders	L
Team encouragement			
	Understand how to encourage		
		Management knows how to encourage us	E

4 Model design

Following the finding of the SLR on readiness models and the development of variables and indicators to assess Agile at Scale readiness, the initial version of the model itself can be developed. The first step in this development is to choose and select one of the identified model types that fits an Agile at Scale readiness model best. Following is the design of the model according to the model type chosen.

4.1 Selecting the model type

Deciding which model type to adopt for an Agile at Scale readiness model depends on what purpose the model serves. As noted in the Research goal and in the Design requirements, important aspects of the model are that it is (1) applicable in practice, (2) relatively easy to use and (3) that it provides gradations of Agile at Scale readiness. Based on these requirements, the model types simple dimensions, structured with influences, and enablers, success factors, motivators and barriers are dropped. Reasoning for this is that these options, although scoring high on ease of understanding, score low on ease of execution, ease of data collection, assessment accuracy and completeness (Table 3). This is also shown in the goals of these model types, that being to inform rather than to assess (Table 2). Hence these model types do not provide the necessary tools for the model to actually access readiness in practice.

At glance it might seem contradictory that the model type enablers, success factors, motivators and barriers is dropped, since the starting point for identifying relevant variables and indicators in section 3.2 are CSFs. Yet, as already stated clearly in that section as well as in section 3.1.4, enablers, success factors, motivators and barriers themselves are not suitable to be used directly to assess readiness. However, also in these sections, it is argued that measurable variables should be deduced from enablers, success factors, motivators and barriers in order to be applied in readiness models. Exactly this approach is taken in the development of the Agile at Scale readiness model. That being said, CSFs are not directly used in the model, but variables and indicators are deduced from the CSFs in order to be applied in the model. Hence the model type of enablers, success factors, motivators and barriers is dropped, but CSFs still play a role in the models design.

This leaves the grading, mathematical and levels types. The mathematical type is also dropped, as its ease of use suffers due to the knowledge of mathematical techniques, such as Fuzzy Logic, that are required for applying this model type successfully. Hence, the choice of the model type to-use is between the grading type and the levels type.

Both types are very similar in their approach and goal. Both types provide methods to assess readiness in practice and do so accurately. Furthermore, they are not over-technical in their approach and thus have good ease of use characteristics. This is also shown in Table 3 where both model types score average or high on all criteria. However, the levels type has an important advantage over the grading type that is especially relevant for an Agile at Scale

readiness model, namely that next to assessing readiness, it also provides understanding of readiness and how to improve it. Rather than only providing numbers, presenting levels of readiness and plotting the result of the assessment on those levels creates a visual representation for the users, which provides a context for evaluating information. This may improve decision making [74]. Furthermore, having readiness levels allows the assessment result of specific indicators or variables to be plotted on those levels, showing how the result came to be. Additionally, this shows which areas mostly need to be improved on to increase readiness. Finally, having levels also enables the use of knock-out criteria for different levels, e.g., not having a very important criteria at a specific minimum level will result in 'unready' the assessment results of the other criteria. As will be discussed in further detail in sections 4.4.2 and 6, knock-out criteria can be an important aspect of a performant model. All in all, these advantages of the levels make it possible to better meet the Design requirements than the grading type. Hence, the levels type is chosen as the model type of choice for an Agile at Scale readiness model.

4.2 High-over readiness model design

The Agile at Scale Readiness Model (ASRM) consists of a few major parts, namely (1) the breakdown of CSFs into variables into indicators, (2) the assessment through the questionnaire based on the indicators, and (3) the assessment result through readiness levels. Figure 4 visually shows these parts. The first part of the model was already designed in previous section, where variables and indicators were derived from CSFs, of which an example is given in Table 8 and the full list is provided in Appendix C.

The set of indicators results into four questionnaires; one for each respondent type (see Appendix D). The respondents are asked if they agree or disagree with the indicators on a Likert scale, where 1 equals disagree and 5 equals agree. Averaging the responses to all indicators results in a number between 1 and 5. This number indicates the level of readiness, where a higher number indicates higher readiness.

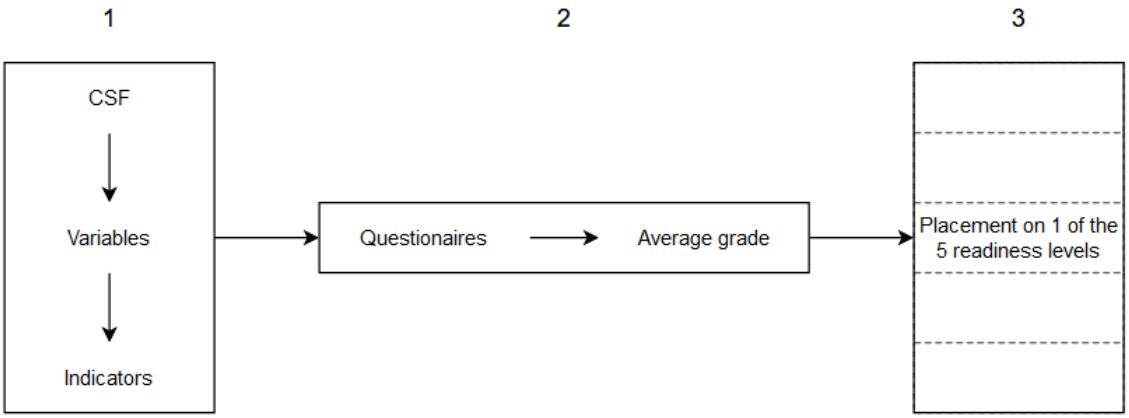


Figure 4: High-over design of ASRM

In line with the choice for the levels model type as described in the previous subsection, readiness levels are defined of which there are five. Based on the average of grade as a result of the questionnaires, an organization ends up in one of the five readiness levels. Further, detailed explanation of the calculation of the readiness level and the definition and design of the readiness levels is given in the coming subsections.

4.3 Integrating variables and indicators

An important aspect to consider is that some CSFs might be more important than others. This is contradicting to the idea of CSFs, that being that those are key areas that an organization must be successful in [72] and thus an organization should succeed in all CSFs. Yet, it is imaginable that some CSFs are more key than others, for example when one CSF needs to be met first in order for the others to be met. Furthermore, some CSFs might just have a bigger impact than others in contributing to achieving an organizational goal, since it is not uncommon to rank CFS (e.g., [75]–[77]). Also interesting to note is that [2], [64], [68] all report the number of times a CSF was reported in the publications included in their SLR, implying that this may be valuable information. As their SLRs show, there is a wide spread of times different CSFs are reported; from 2 times up to 46 times distributed over [2], [64], [68]. Understandably, what may be a CSF for one organization to succeed in adopting Agile at Scale, it may not necessarily be the case for a different organization given the different nature of different organizations. However, when specific CSFs are reported by many organizations relative to other CSFs, it is arguable that these specific CSFs are more important than others. Hence, a weighting factor has been assigned to the CSFs, variables and indicators.

4.3.1 Weighting of CSFs

The weighting is done based on the number of times a CSF is reported, spread over the three included SLRs of [2], [64], [68]. The numberof times a CSF is reported is then divided by the sum of all reports of every CSF. That is:

$$Weight\ of\ CSF\ z = \frac{x_{az} + x_{bz} + x_{cz}}{\sum_{i=1}^{42}(x_{ai} + x_{bi} + x_{ci})}$$

Equation 2: Weighting of CSFs

where

- x = the amount of times a CSF is reported in a SLR
- a = SLR of [2]
- b = SLR of [64]
- c = SLR of [68]
- i = the list of all found CSFs, with a total number of 42 CSFs.

An overview with all mentions and weights of the CSFs can be found in Appendix B.

4.3.2 Weighting of variables and indicators

A major part of the model are the indicators and the accompanied questionnaire. Following up on the previous section, the weight is also assigned to the indicators. More specifically, no special further weighting is applied to in the individual indicators, but rather the weight of the CSFs is carried through to the indicators. For example, should an CSF have 2 associated variables with a total of 6 indicators, then the weight of the indicator is the weight of the CSF divided by the 6 since there are 6 indicators. In formula form that is:

$$Weight\ of\ indicator\ y\ of\ z = \frac{Weight\ of\ CSF\ z}{Number\ of\ indicators\ of\ z}$$

Equation 3: Weighting of indicators

As Equation 3 shows, the amount of indicators per CSF is not taken into account. How the weighting of CSFs can be done based on available literature, this is not the case for the indicators as they are a creation of the author based on reasoning and detailed descriptions of the CSFs in [2], [64], [68]. Hence, giving weight to the indicators would be a subjective undertaking. Therefore no weight is applied to the indicators. The same reasoning is carried through for the indicators. In essence, as already noticed in the previous paragraph, the weight of a CSF is simply carried over onto the indicators by dividing the weight of a CSF by the number of associated indicators.

4.4 Designing readiness levels

Oddly, there seem to be no guidelines available in the literature on the design of readiness levels. Although the SLR conducted in Section 3.1 was focused on existing readiness models and their constructs, its search query was broad enough to incorporate everything readiness model related, including the design of readiness levels. Yet, no existing guidelines were found. When looking at the model development methodologies in [45]–[52], all of them being of the levels model type, it is noted that none of the authors follow a specific development guideline either. Rather, they develop the levels based on their own reasoning and validated the models through expert opinions (e.g., [45], [46]) or base the models on existing models and test them in practice (e.g., [51], [52]), validated it through experts opinions (e.g., [49]), or not validate them at all (e.g., [47], [48], [50]). Hence, there seem two approaches that can be taken to come to the readiness levels: either develop the readiness levels based on reasoning and validate it in practice, or base the model on an existing model. The following paragraph will discuss the choice of approach.

In order to base the readiness levels of ASRM on existing models, suitable models have to be identified. The model that comes to mind is the Agile Readiness Index [3]. Rather than measuring readiness for Agile at Scale as is the goal of ASRM, the Agile Readiness Index [3] measures an organization's readiness for 'regular' Agile. Furthermore, it helps organizations in guiding them to adopt key Agile principles. This results in the model utilizing 5 readiness

levels, even though these levels are in essence also describing how far an organization is in adopting Agile. This makes the model lean towards being a maturity model, although it is noted that in this case it is a very thin line between being classified as a readiness or a maturity model. The Agile Readiness Index [3] seems to be a bit of both. This consideration and the fact that the readiness levels are based on Agile principles, for which there is no clear Agile at Scale equivalent, makes basing ASRM's readiness levels on the Agile Readiness Index [3] not a valid approach. To the best of the author's knowledge, there also seems to be no other Agile (at Scale) readiness model that the readiness levels of ASRM could be based on. Therefore, the approach is taken to develop the readiness models based on reasoning and validate the levels through experts opinions of which more details are provided in Section 5.

4.4.1 Readiness levels of ASRM

ASRM has five readiness levels, that being (1) not ready, (2) immature and unexperienced, (3) trial and prepare, (4) ready, and (5) fully ready. The description of the levels is as follows.

- **Not ready** – The organization is far from ready for Agile at Scale. The organization is still in de adoption phase of 'regular' Agile, its principles, and Agile thinking.
- **Immature and unexperienced** – Many Agile principles are adopted on a basic level, but many improvements can still be made and the organization is too inexperienced and immature in Agile to take the next step.
- **Pilot and prepare** – The organization is almost ready for the next step, but there are still improvements to make. It is likely that some key CSFs are not present enough yet. Piloting will be a good way to go and prepare for the change.
- **Ready** – The organization is ready for the change and it's a logical next step in its development. Not every CSFs is at its most optimal level yet, but it is sufficient to start the adoption.
- **Prepared and fully ready –** the organization has many, if not all, of the CSFs at its highest level and is very prepared to start the adoption of Agile at Scale.

As noted before, the assessment through the questionnaires will result in a readiness score by adding all the scores for the individual indicators (multiplied by their respective weight). This readiness score will be a grade between 1 and 5, which will result in a readiness level according to the range as shown in Table 9.

Table 9: ASRM levels

Color code	Readiness level	Range
	Prepared and fully ready	4.5 – 5
	Ready	3.5 – 4.5
	Pilot and prepare	2.5 – 3.5
	Immature and unexperienced	1.5 – 2.5
	Not ready	1 – 1.5

4.4.2 Knock-out criteria and level requirements

A common element seen in many of the levels model type models that certain requirements need to be met in order to reach a specific level. For example, specific Agile practices are required to reach specific levels of the Agile Readiness Index [3] and specific CSFs need to be met in order to meet specific readiness levels in the Organizational Readiness Model (ORM) for Manufacturing Execution Systems (MES) [48]. Such knock-out criteria may also be relevant for ASRM. For example, it is imaginable that certain, crucial CSFs need to be at least at readiness level x in order for the organization to be deemed ready, because without having this specific CSF at a well enough level, the adoption will be guaranteed to fail. Another approach that can be taken for example, is that, in order to reach a certain readiness level, no CSF may be more than one level lower than the readiness score, which in essence is the weighted average of all CSFs. Clearly, there are multiple approaches that can be taken in case such knockout criteria and/or level requirements are required. The question remains, however, if they are required for ASRM and, if so, in what way they should be implemented.

As there is no clear indication which CSFs are crucial or much more important than others, except for maybe the frequency that a CSF is reported, it is a risky undertaking to define these knock-out criteria. Not only would the relative importance of CSFs be an educated guess, so would the implementation be (e.g., what is the required minimum level). Therefore the decision was made to not implement knock-out criteria in the initial version of ASRM, but wait for the expert opinion sessions to gain their insights into what the knockout criteria should be. Thus, revised versions of ASRM based on the evaluation sessions are likely to include knock-out criteria.

4.5 General remarks and assumptions

There are a few remarks and assumptions that are made for the development of ASRM that need to be noted to properly apply ASRM in practice. Although some of these remarks have already been mentioned before, they are repeated as a reminder.

The first assumption is that organizations that apply ASRM already adopted Agile and thus (basic) Agile principles are already in place.

Second, ASRM is not a model to assess how well Agile at Scale fits an organization. In the author's opinion, assessing how well an Agile at Scale framework fits an organization is a different subject that assessing readiness for the adoption. Different factors such as organizational size, corporate culture, and the industry in which the organization is active would be relevant for assessing how well (specific) Agile at Scale (frameworks) fit organizations opposed to how ready an organization is to start the adoption. In other words, the evaluation of fitness of Agile at Scale should have been conducted before applying ASRM.

A final remark to make is that, although there are four different questionnaires for four different roles, the questionnaire is not limited to four persons. On the contrary, it is advised to let the questionaries be answered by as many people as possible, as this generates more data and therefore will increase the assessment's accuracy. When conducting the questionnaires over more than four people, the result per indicator should be the average result for that indicator of all respondents.

5 Evaluation methodology

Following the design of ASRM, this chapter describes its empirical evaluation methodology. In the next section, the outcomes of the design cycles and the improved model versions are presented.

As noted in section 2, the Design Science Research Methodology (DSRM) of Peffers *et al.* [7] is adopted for the research design. As for any design science research, the idea is that through design cycles artifacts can be evaluated, validated and improved [9]. Given the scope of the artifact, that being a model and an assessment tool for an organizational change, validation of the artifact is a long term undertaking considering the time organizational change takes. To make it explicit, (fully) validating ASRM would take a few years since, to validate if a readiness assessment by ASRM was correct, an organization has to go through the organizational change of adopting Agile at Scale to validate, which can take a few years. Given the timeframe of this thesis, validation of the ASRM is therefore not in scope. Evaluation is, however, in scope. In fact, two iterations of the design cycles of DSRM are applied. An initial version of ASRM is developed that will then be validated and updated accordingly to the received feedback. This cycle is then repeated once more.

Two aspects will be considered for the evaluation of ASRM, namely the content of the model and the acceptance and use of the model. The former refers to the correctness, completeness, approach validity and accuracy of ASRM. That is:

- Is the model correct, i.e., are the included CSFs, variables, indicators, weights, and readiness levels correct?
- Is the model complete, i.e., is the set of included elements, CSFs, variables, indicators and readiness levels complete?
- Is the approach valid, i.e., are the constructs of the model, such as breaking down CSFs into variables into indicators, a valid approach to assess Agile at Scale readiness from the perspective of practitioners?
- How accurate is the model, i.e., how accurate will ASRM predict readiness for Agile at Scale from the perspective of practitioners?

Evaluation of ASRM on the two aspects is done through different means. While the evaluation of the content of ASRM was done through expert interviews, the acceptance and use of the model will be validated by applying the Unified Theory of Acceptance and Use of Technology's [12] questionnaire. The following subsections will go into further detail on the validation of these aspects.

5.1 Expert interviews

Semi-structured interviews are used to validate ASRM. When there is objective knowledge, semi-structured interviews may be used to acquire subjective knowledge about a phenomenon [78]. McIntosh and Morse's [79] taxonomy recognizes four types of semi-structured interviews, of which one is the descriptive & corrective type. This type lends itself well for the validation of ASRM, as its purpose is evaluation and its outcome is refutation, elaboration and/or correction [79].

A set of five Agile (at Scale) experts were interviewed, with a focus on diversity among the experts (see Table 10). That is, not only did the experts have different levels of experience with Agile and Agile at Scale, but their organizations were also in different stages of Agile (at Scale) adoption and maturity. For example, Topicus (Finance Mortgages unit) has been adopting and executing the SAFe framework for around two years, while it will likely take a few more years until Topicus (the Finance Pension & Wealth unit) will start to consider such a framework. On the other hand, Topicus (Finance Business Lending unit) is closer towards such an adoption, but is still evaluating if they should adopt. Having such a variety of experiences and organization's perspectives on ASRM is valuable as it increases ASRM's validity through incorporating both mature experiences (i.e., those who have already adopted an Agile at Scale framework) and less mature experiences (i.e. those that are looking to adopt an Agile at Scale framework).

Table 10: Experts

Organization	Function	Agile experience	Agile at Scale experience
Topicus - Finance Mortgages	Senior Scrum Master	5	2
Topicus - Finance Business Lending	Agile coach	7	4
Topicus - Finance Pension & Wealth	Scrum Master / Operational Manager	4	0
De Volksbank	Agile coach	4	4
SAP	Engineering manager	10	5

Although the experts will provide valuable insights for the design of ASRM, they might not be the ones who take the final decision to (start to) adopt Agile at Scale. Such a final decision is often in the hands of senior executives, who in the end, decide over the direction the organization is going and have a major say in organizational changes with the size such as adopting Agile at Scale. Therefore, the third and final iteration of ASRM will be demonstrated to the General Manager of Topicus Finance to validate the model's usefulness and acceptance for those who take the final decision to adopt Agile at Scale.

The interviews were conducted individually through Microsoft Teams due to the covid restrictions. Firstly, the author gave an introduction of the goal of ASRM and the reasoning for it being an important contribution to the literature and practice. Then the model was explained in detail where the author shared his screen so that the interviewees could see the various elements of the model and how they are woven together. The author then continued by asking open-ended questions about the various elements of ASRM. The questions were categorized into different theme's that either focused on specific constructs of the model or on specific content of the model. The list of interview questions can be found in Appendix E.

5.2 UTAUT

The Unified Theory of Acceptance and Use of Technology (UTAUT) [12] distilled critical factors and contingencies from eight theories and models of technology use for the prediction of behavioral intention to use technology in an organizational context [80]. UTAUT outperformed these eight models by explaining about 50% of technology use and about 70% of variance in behavioral intention [81]. Furthermore, UTAUT has been applied to study a variety of technologies in different contexts and has served as a baseline model since its publication [80], [82]. One of the contexts it has been applied to, is the application of Decision Support Systems (e.g. [83]–[85]). In essence, ASRM is a DSS; it provides organizations and practitioners with the information needed to decide if they are ready to adopt Agile at Scale. Although the initial versions of ASRM provided to the experts were not digital yet, the latest version, including the proof of concept, included digital visualizations and interfaces. Hence, UTAUT is considered suitable for the assessment of the acceptance and use of ASRM.

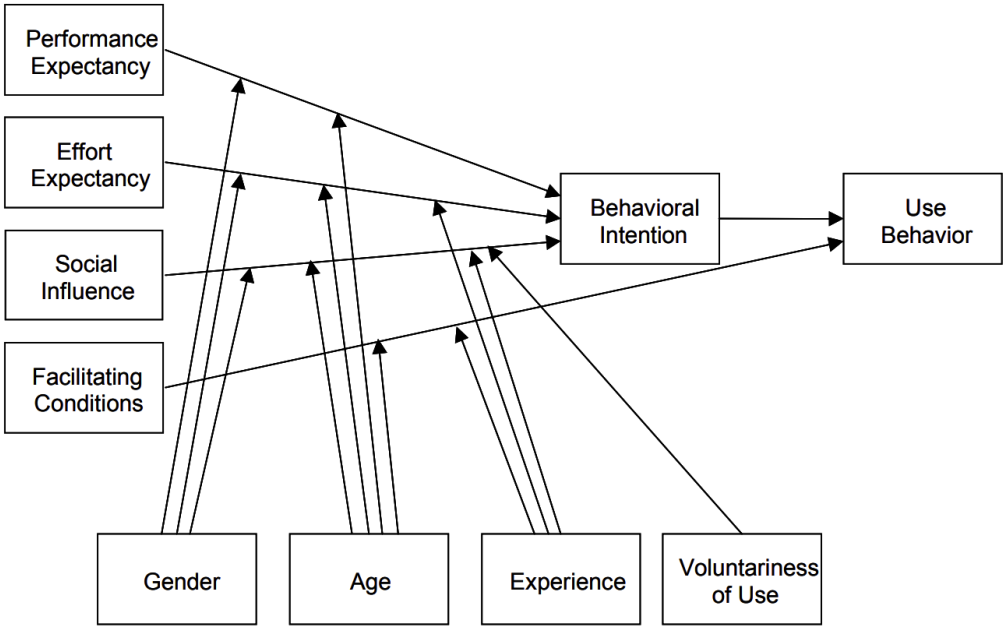


Figure 5: Unified Theory of Acceptance and Use of Technology. Adopted from [12].

Slight alterations to UTAUT's questions and statements were made to better fit ASRM, shown in Appendix F. Some statements were dropped as they are not relevant, as they are not relevant for a model or an assessment tool. Deviations from the standard UTAUT questions are marked in *italics.*

Furthermore, a set of control questions were added due to the four moderators of UTAUT, that being gender, age, experience and voluntariness of use. However, since ASRM is an DSS and a model, it is argued that gender and age are not relevant moderators since age nor gender should influence the capabilities to adopt and apply a model; applying models and theories is done constantly by academic researchers and to a good degree also by professionals, regardless of their age or gender. The moderator questions can also be found in Appendix F.

6 First design cycle

This subsection describes the results of the first validation round ASRM and the subsequent updated version of ASRM. First, the feedback received during the expert interviews is discussed, followed by the results of the UTAUT questionnaire. Afterwards, the second iteration of ASRM is provided.

6.1 Expert interview results

Overall the initial version of ASRM was well received by the experts. The main constructs were considered strong and logical, but understandably there is some need for sharpening the model. Furthermore, some elements might be added to the model, such as visualization of the results. As the feedback touched on a diverse range of aspects of ASRM, the feedback is grouped into categories that are discussed one by one.

Model constructs

The experts acknowledged that it is difficult to get from something very qualitative, that being readiness for Agile at Scale, to a quantitative measurement for it. Hence they noticed that the used approach to get from CSFs to variables to indicators is a solid and clever approach. An expert also noticed that due to this approach, results of indicators can be linked back well to the CSFs and the literature. Furthermore the choice and reasoning for choosing CSFs over challenges as the starting point of the model was agreed with.

CSFs

Overall the found CSFs made sense to the experts. However, according to the experts different CSFs were still missing from the list. Interesting to note is that the experts named different missing CSFs, with little overlapping missing CSFs. The list of missing CSFs as per participating experts, is shown below:

1. Keep reminding why the adoption and change is taking place;
2. Have goals, milestones and KPIs of the change defined;
3. Have strategic alignment by making the change part of your organizational strategy;
4. Have the right organization size for the change;
5. Face the complexity that requires you to change;
6. Have the proper software and team architecture that allows you to scale;
7. Have cohesion between teams.

Although CSFs 4 and 5 make sense, they could also be considered as factors that an organization should include when evaluating if Agile at Scale fits their organization. As discussed before in section 4.5, evaluating if Agile at Scale fits an organization is not part of ASRM.

Next to missing CSFs, there are also CSFs that the experts had some doubts about. Multiple experts had their reservations on CSF *having quality production using pair programming*. They argue that there is no one right type of Agile methodology to apply (e.g., pair programming, Scrum, Kanban, XP, etc.) and thus this was not a CSF in their view. Similar reasoning was provided for CSF *solid engineering practices*, but it was also acknowledged that this is relevant when having distributed development, which is not unlikely when applying Agile at Scale.

One of the participating experts also noted that CSF *Communicate that the change is non-negotiable* may work at times, but could also provide the opposite of the desired effect. The effect of executing this CSF would depend on the organization and organizational culture. Furthermore, this expert also expected the Scrum Master role to get more attention as the Product Owner role did.

The experts noticed that among the CSFs there seems to be a big emphasis on leadership and getting management support. However, one expert argued that although strong and dedicated leadership is required to start the change, more focus should be on the teams as you need evangelists and support from out of the teams in order to be successful in the change. The expert did recognize that the focus of the literature is often not on the teams but more on leadership and management.

Some other interesting remark that was made by the experts is that the order that the CSFs grouping is provided in actually seems to be a chronical order. In other words, achieving the CSFs could very well be done in the order that they are provided in Table 6.

Variables and indicators

An important remark that an expert made is that many of the indicators are in essence self-assessments. Because of this, it is important to ask the questions to multiple people with multiple roles. By doing so one can check if the self-assessment is actually correct. To provide an example; the answer to asking management if they communicate openly will likely be yes, however employees might experience this very differently. For some of the variables and indicators these double-check questions have been part of the initial version of ASRM, but this should be extended to more variables and indicators.

A topic of conversation is how to validate the found indicators. An approach that may be taken is to validate it through expert interviews, as is the approach taken for this thesis. However, given the time limit only a small group of experts can be interviewed. Preferably, a statistically valid sample size should be used. Moreover, construct validity [86] for Likert scales and construct factor analysis [87] would be applied to statically validate that the indicators assess readiness correctly.

Weighting

The views on the weighting were diverse among the interviewed experts. While some experts supported the idea and the way it was implemented, others had their reservations. First the views and opinions of those who support the weighting is provided, followed by views of those against.

Three experts agreed with the idea of weighting, while one was neutral and one was against. Those agreeing argued that it is smart to apply the weighting to emphasize the importance of certain CSFs over others, implying that they support the idea that some CSFs might be more important than others. Two experts argued that some CSFs might be dropped because they have such a low weight assigned that their impact will be negligible. Furthermore, multiple experts noted that some CSFs might be combined to make the model more simple. Additionally, they also provided the idea to weigh and provide the readiness assessment at the CSF group level rather than at the CSFs level.

The neutral expert expressed the feeling that it's hard to give an opinion on the weighting of the CSFs, but that the reasoning for the applied weights was logical. However, the expert also noted that there is not necessarily a scientific base for one CSF being more important than the other; a CSF being mentioned more might only be an indicator for that. After all, if they are CSFs, then they should all be achieved anyway due to the nature of CSFs. Yet, the expert also suggested the idea to place the CSFs in three groups of different importance to the readiness assessment.

The expert against the weighting argued that CSFs being mentioned more does not provide a scientific basis for certain CSFs being more important than others and applying weights to them. Although the idea is nice, it lacks the proper foundation.

Readiness levels and knock-out criteria

The feedback regarding the readiness levels was positive. Only for one expert who was wondering if the bar was maybe set a bit low for the *pilot & prepare* level, no other improvement feedback was given.

All of the experts agreed that there should be knock-out criteria, be it with different visions on which and how to implement them. For example, one expert argued that the CSFs out of the groups *Management support, Commitment to change,* and *Leadership* should all be at minimum be at the second highest level. Another expert stated that everything should be at least at the third level, with some CSFs at, at least, the second or first level. Another expert argued that at least all CSFs should score at least a 3.5 as a result of the survey assessment. Finally, one expert noted that there are very likely knock-out criteria, but that there is no way to decide what they are. The expert argued that a much bigger sample size than currently employed in this should would be needed to decide on any knock-out criteria.

Goal and visualization

A subject that came back in most of the expert interviews was the question what the goal was of the model. The experts were of the opinion that this ties into the visualization options. One expert argued that figuring this out is the central question to decide which types of visualization should be applied. According to multiple experts, visualization is really important for the value of the model and its use and acceptance. A recurring theme was that it is important to identify and show the gaps that come out of ASRM's assessment. With regards to what the goal is of the model, is this to only provide an assessment or to also show how the result came into being. The former would only need a readiness level as the outcome, while the latter would require more information about the performance of different elements of the model and how they add up to the overall assessment. Such an outcome would show ASRMs appliers information about the areas that they are performing well in, as well as the areas in which they still need to improve, which is what the experts argued to be valuable to be added to ASRM. Many of the experts could see radar charts per CSF or CSF group as a way to provide such insight.

Some experts also noted that it would be valuable to see the difference between different roles' and people's scoring on ASRM's questionnaire, as it is interesting and valuable to see if, for example, management says that the teams are self-steering, but that the team members say that they are not.

New insights

An expert noted that some of the CSFs seem to be aimed more at the implementation phase of Agile at Scale, rather than at pre-conditions that are needed to be ready for adopting such a change. Hence, the expert suggested that a deviation may be made between CSFs focused on the implementation phase and those pre-conditions. A non-exhaustive list of the CSF groups that could be selected for the pre-conditions group would be

- Management support
- Commitment to change
- Leadership
- Engaging people
- Mindset and alignment (although this should be in both groups)
- Team autonomy
- Customer.

Different experts also argued that, even when an organization is not fully ready yet, the organization could start with the adoption as long as they keep working on the CSFs that are not at a proper level yet.

Furthermore, some experts also pointed out that a valuable aspect of ASRM lies in the fact that it asks questions about an organization and its employee's performance. Sometimes asking the question itself invokes the necessary change and thus increases readiness.

Other remarks

Here, some other, general remarks are provided that do not necessarily fit any of the categories above, but that are worth mentioning.

One expert noticed that the amount of indicators and thus the length of the questionnaire is quite substantial. Initially the author argued that it might be a bit too much as it could take some time to answer the questionnaire. However, the expert agreed with the counterargument provided that, although the questionnaire is quite substantial, it is not so relative to the size and impact of the decision and assessment if an organization is ready to adopt Agile at Scale.

Another remark that some experts had was that there are very likely situations possible where an organization needs to and is forced to change, e.g., by external forces, even when they are not ready for the change. Although this feedback was not necessarily targeted at ASRM or its validity, it is an important consideration to keep in mind when applying ASRM.

Furthermore, three experts suggested that it could be valuable to test ASRM in a set of organizations with the goal of benchmarking. This could prove valuable information in determining what readiness levels and CSF levels organizations should reach in order to successfully adopt Agile at Scale.

6.2 UTAUT results

The results of the UTAUT questionnaire can be seen in the four figures below and the results are overall positive. The numbers displayed are the averages of the scorings of the individual experts. Positive results are the expected usefulness, ease of learning and use, management support for applying the model, and having the relevant resources and knowledge to apply the model.

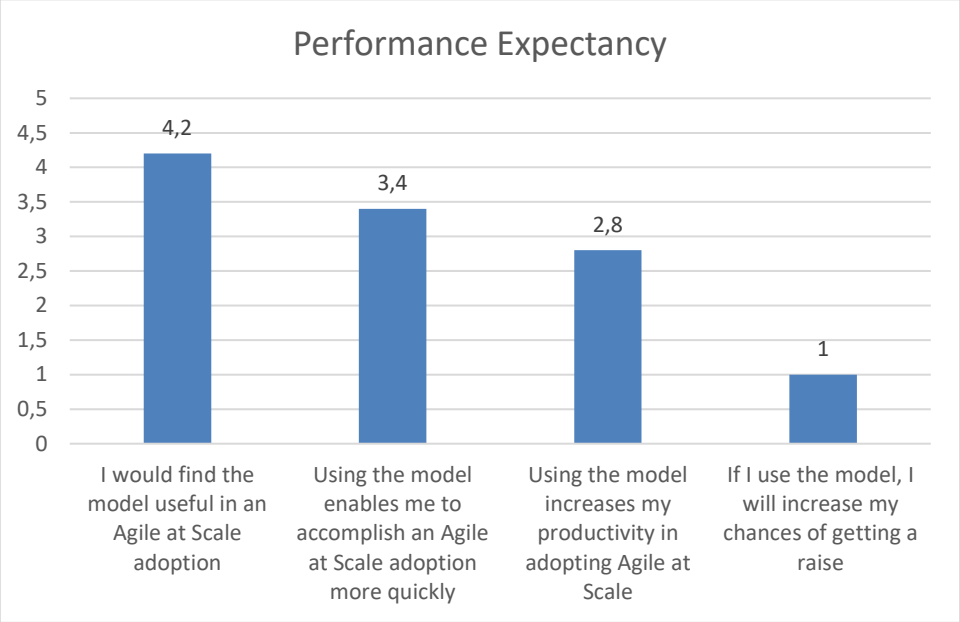


Figure 6: UTAUT results round 1: Performance Expectancy

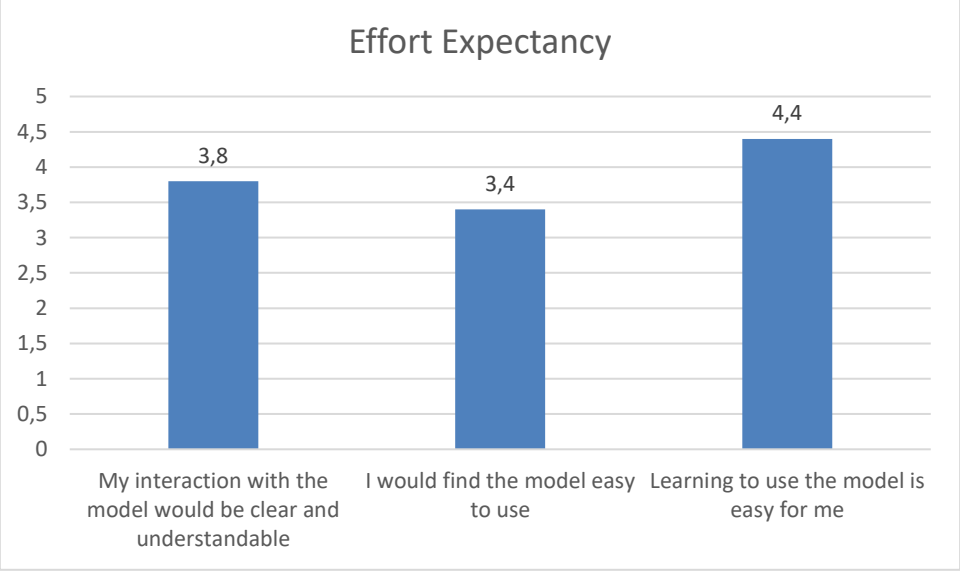


Figure 7: UTAUT results round 1: Effort Expectancy

Notably, there are a few outliers such as the *increasing chances to getting a raise* and *people who influence or are important to me think that I should use the model* questions. Important to note is that many experts contacted the author about relevance of the former question, as they found it a strange question and doubted its relevance, explaining the low score on that question.

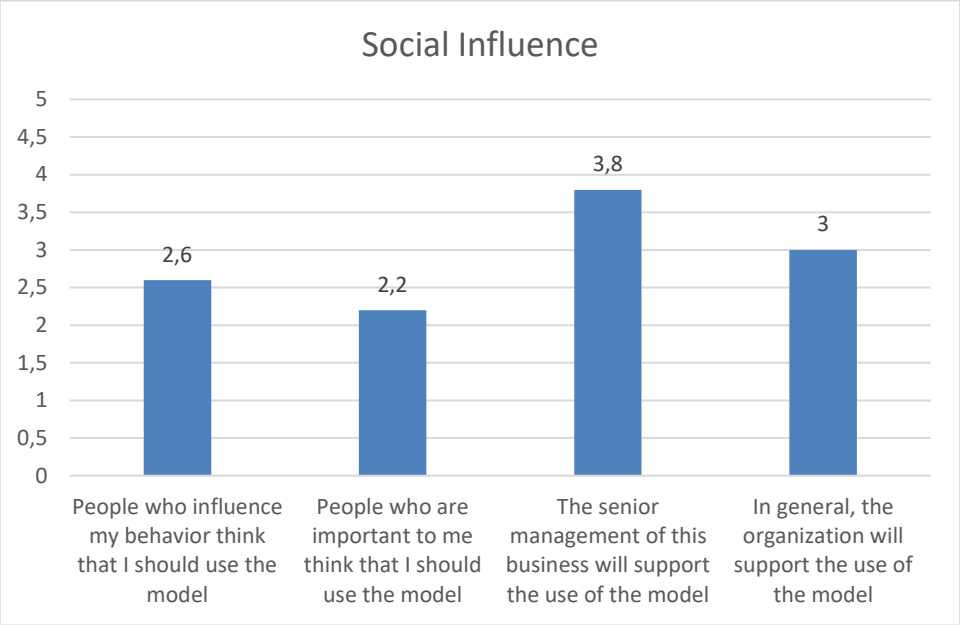


Figure 8: UTAUT results round 1: Social Influence

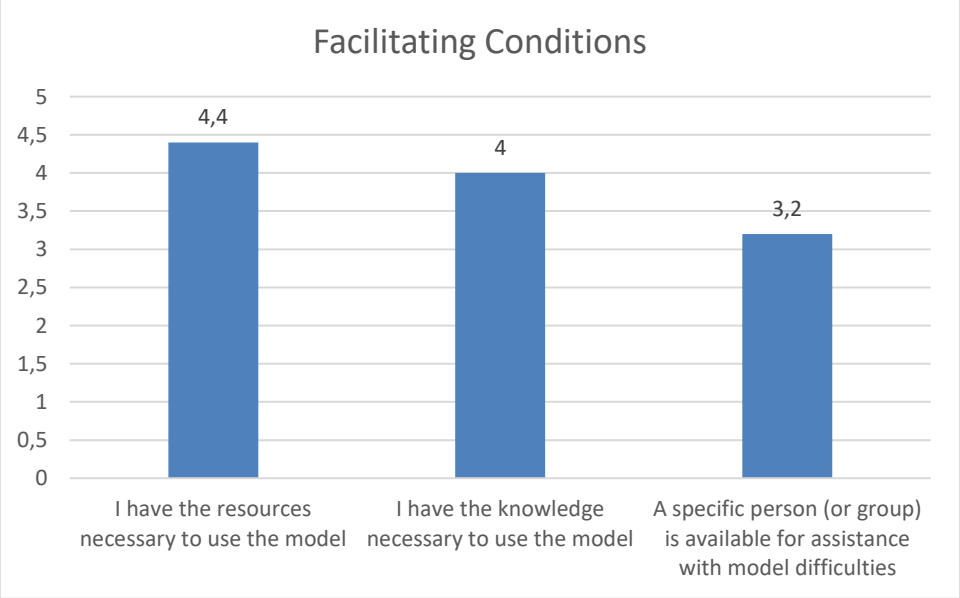


Figure 9: UTAUT results round 1: Facilitating Conditions

Performance Expectancy, Effort Expectancy, and Social Influence all influence Behavioral intention to use the model [12]. Together with the Facilitating Conditions, the Use Behavior is influenced. As Figure 10 shows, the intention to use ASRM is scored average or above. Although these results are not poor, improvements should be made to ASRM to improve these scores. The results of this improvement will be discussed in section 7.2.

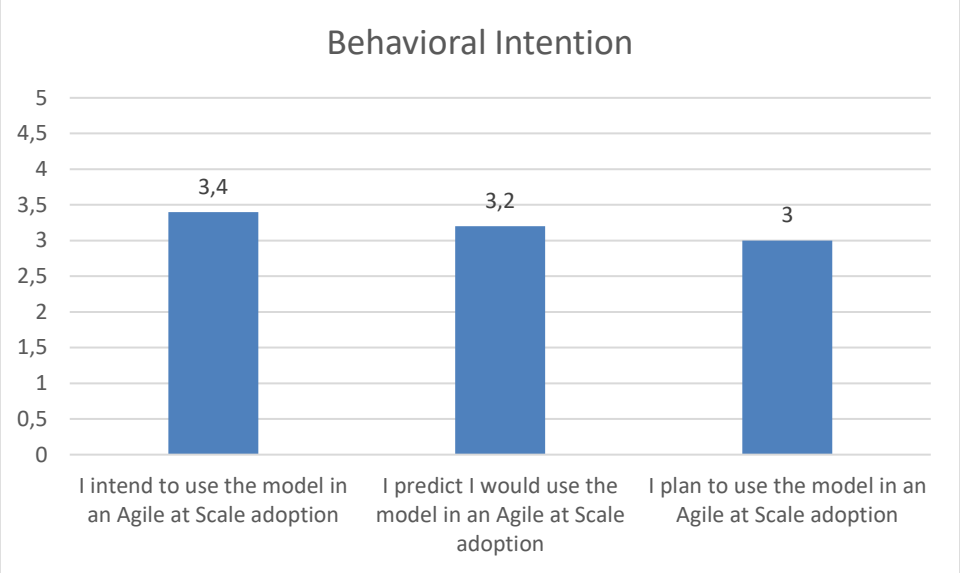


Figure 10: UTAUT results round 1: Behavioral Intention

6.2.1 Moderators

UTAUT states that there is a set of moderators which influence the use behavior [12]. The answers provided on the moderator questions are displayed in Figure 11 and Figure 12. As the figures show, the experts are experienced and often adopt new models and technologies on their own initiative.

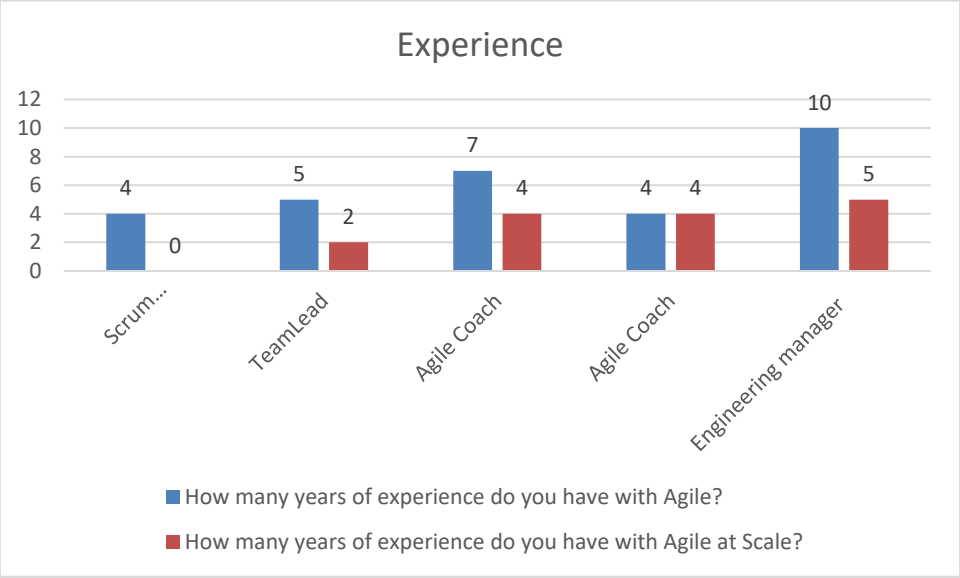


Figure 11: UTAUT moderator: Experience

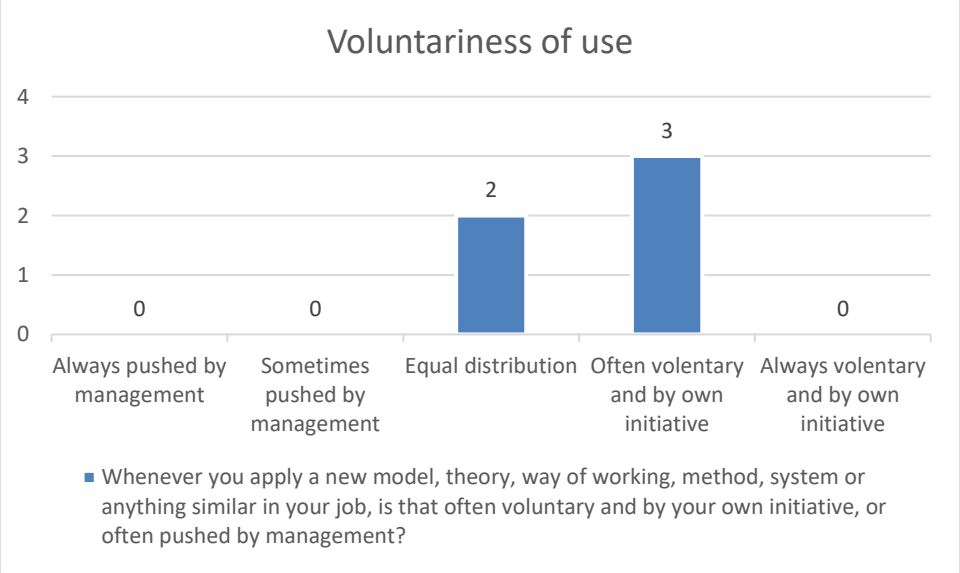


Figure 12: UTAUT moderator: Voluntariness of use

6.3 Second iteration of ASRM

Based on the feedback provided by the experts, ASRM has been revised to its second iteration. Multiple aspects of the model have been updated, which will be discussed one by one.

Given the extensiveness of the model (Appendix C and Appendix D together take up 20 pages), it was decided to only provide the initial iteration of ASRM (Appendix C and Appendix D) and the final (third) iteration of ASRM (4, Appendix I, Appendix J, and Appendix K), thus leaving the second iteration out. Hence, the revision and changes described in this sub-section together with those of the next validation round described in section 7 will be found in the final version of ASRM.

CSFs

The CSFs *Communicate that the change is non-negotiable* and *Quality production using pair programming* have been dropped from the model. The reason is that both are very organization specific and might well not be a CSF for every organization. The experts agreed that *Quality production using pair programming* is not necessarily a CSF, as there are many other ways to achieve quality production through other Agile methods such as Scrum, Kanban, and Extreme Programming. The effect of *communicate that the change is non-negotiable* can be different depending on the organization, its employees and its culture. If an organization is very resistant to change, then forcing a change will likely increase resistance [88]. Hence, this CSF is argued to not be applicable to every organization and thus dropped.

New CSFs have also been added to the model based on expert feedback, bringing the total number of variables up 70 and indicators to 152. A relevant question to ask when adding CSFs based on expert feedback is how valid it is to add them based on the small sample size; is one expert mentioning a CSF enough to add it to the model? On other hand, many of the publications included in the SLRs of [2], [64], [68] are experience reports and thus academics or practitioners reporting their experiences. Hence, it could be argued that a mention of a CSF by an expert is the same as an experience report, albeit not published. Surely, one could argue that a CSF should be mentioned at least more than once to be included. On the other hand, given the low weighting that such a low-mentioned CSF would have compared to others, its impact is not completely going to change the readiness assessment results. With that in mind, it might be better to include it as an extra point of attention than to leave it out.

Five CSFs have been added, namely *Have strategic alignment, Have goals, milestones and KPIs of the change defined, Keep reminding why the adoption and change is taking place, Have cohesion between teams,* and *Have the proper software and teach architecture that allows you to scale.*

Knock-out criteria

Although all experts agreed that there should be knock-out criteria, there was no exact agreement on what the knock-out criteria should be, while their suggestions were all

decently similar. As a result, an attempt was made to incorporate all suggestions by finding the middle ground. This resulted in selecting the top 15 CSFs as candidates to have knock-out criteria applied to them. As a baseline, all of these 15 CSFs should be scored at least a 2,5, resulting in them being at the *Pilot and prepare* level. Furthermore, based on the feedback of some experts, a subset of the top 15 CSFs was deemed to be needed to be scored at least a 3,5, resulting in them in being in the *ready* level. Finally, given the proportional weight of 2 CSFs compared to others, it was decided that this CSF should be in the *prepared and fully ready* level and thus be scored at least a 4.5.

Table 11: Knock-out criteria

CSF	Weight	Knock-out level
Coach teams as they learn by doing	13,15%	4,5
Educate management on agile	10,80%	4,5
Allow teams to self-organize	7,98%	3,5
Show strong commitment	7,98%	3,5
Ensure management support	7,04%	3,5
Allow grass roots level empowerment	6,81%	3,5
Careful transformation and sustainable planning	6,81%	3,5
Cooperative organizational culture	5,87%	2,5
Invest in learning to refine the requirements	5,87%	2,5
Customer satisfaction	5,16%	2,5
Strong collaboration with customer	4,93%	2,5
(Automated) tools and infrastructure	4,93%	2,5
Strong collaboration and communication between teams and team members	4,69%	2,5
Provide training on agile methods	4,46%	2,5
Recognize the importance of change leaders	3,52%	2,5

Table 11 displays the knock-out criteria, as well as the top 15 CSFs selected for ASRM Lite. Important to note is that the values 'Weight' column are the weights of the CSFs in ASRM Lite, representing the relative weight among the top 15 CSFs and not that of all CSFs of ASRM. Presenting the weights in this manner allows to emphasize the relative weight and the reasoning for the assigned knock-out levels.

ASRM Lite

Two subjects that came back in the expert interviews were that (1) the model might be too extensive, i.e., the questionnaire might be too lengthy and (2) the impact that some CSFs make on the overall result can be very underwhelming due to the (big) difference in weight. In light of this feedback, a 'light' version of ASRM has been developed. In ASRM Lite, the number of CSFs has been brought back from 45 to 15 by cutting any CSF mentioned less than 15 times. Furthermore, the number of variables was reduced from 70 to 27 and the number

of indicators from 152 to 62. Together, these top 15 CSFs are still responsible for 68.7% of the weight of the full version of ASRM and thus, ASRM Lite still provides a relative accurate readiness assessment.

The reduction in CSFs and thus indicators makes ASRM Lite quicker to apply, as the accompanied questionnaires are much shorter. This allows practitioners to get a quick indication of their readiness by applying ASRM Lite, while ASRM can be used to get the full extensive assessment. The variables and indicators of ASRM Lite can be found in Appendix J and the questionnaires are available in Appendix K.

Visualization

Visualizations are a new addition this version of ASRM. The starting point to create the proper visualizations was asking the question what the goal of the visualizations is and what is aimed to be achieved by them. As mentioned in the previous sub-section, the goal is to (1) demonstrate an organization's readiness for Agile at Scale and (2) to create insight in how a readiness assessment came to be so that organizations can understand how they can become more ready. With this in mind and based on suggestions of the experts, different variations of radar charts were created to visualize the 'scoring' of the CSFs that together make up for the overall readiness assessment.

An issue that was identified was that, with the full version of ASRM, there are so many CSFs (45) that, regardless of the visualization method (e.g., different types of charts), it is hard to create a visualization that remains uncluttered, comprehensible and insightful when providing so many data points and variables. A solution would be to consolidate the amount of CSFs, e.g., by making a radar chart of the CSF groups and displaying those in a graph, but then the issue comes up on how to determine the score of the group; should this be the average score of all CSFs in that group or should it be a weighted average? Or should it maybe display the lowest score so that it is still clear where the biggest improvements may be made? As there is an argument to be made for any of the options, the decision was made to not choose a specific approach but to present the options to the experts and hear their opinions about it.

Despite the just discussed issue, different visualization suggestions were developed for ASRM Lite as these with the amount of CSFs included in ASRM Lite these issues do not exist. In general, as also argued by the experts, radar charts are able to very clearly display where the 'gaps' are and where improvement can and should be made. More interesting are the enhancements that can be added to radar charts. For example, another line may be added in the graph to display the knock-out criteria in the model. This allows to quickly see whether or not organizations comply with the levels required for certain CSFs. Another valuable visualization may be combining a radar chart with a pie chart, where the filling in of the planes displays the scoring (just as with normal radar charts) and the width of the plane visualizes the respective weight of that CSF. Mock-up examples are provided in Figure 13.

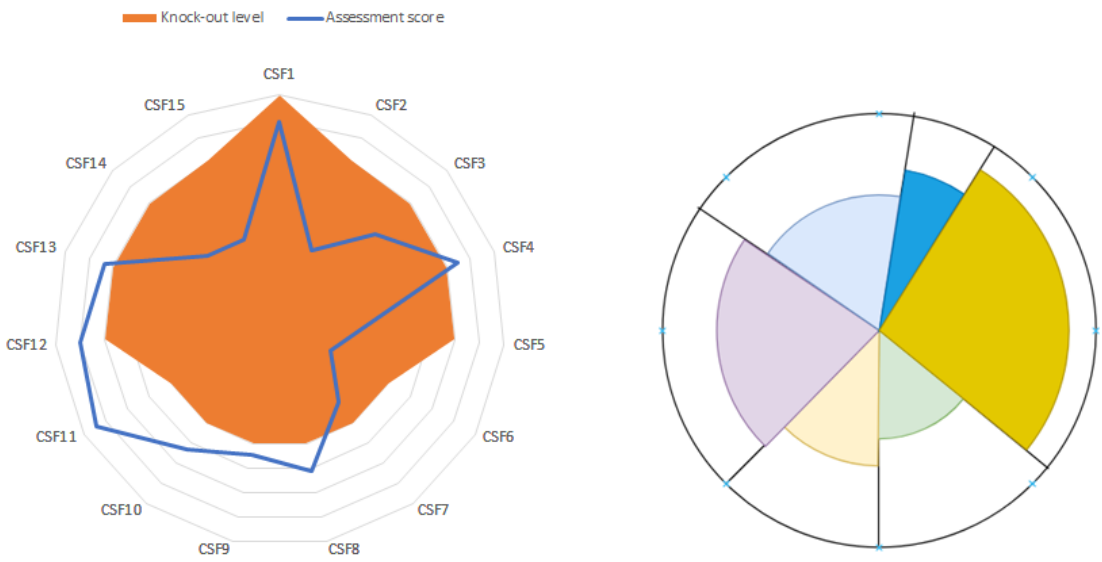


Figure 13: Example visualizations. Left: Radar chart with knock-out criteria. Right: Radar and Pie chart combined displaying weights and scores.

Updated indicators

Two somewhat contradicting feedback topics provided by the experts were that on one hand, there were maybe too many indicators and thus questionnaire questions in terms of useability, while on the other hand many variables and indicators should be checked with multiple roles (e.g., management and employees), which could result in more questions. To mitigate this contradiction, the amount of indicators is slightly reduced while adapting many indicators so that the question can be answered by more roles. Furthermore, ASRM Lite was introduced to provide a quicker analysis.

In comparison, the previous version of ASRM included indicators specified to be answered by a specific role, which were derived from a 'general' indicator. In the updated version, these indicators are brought back to the 'general' indicator so that they can be answered by multiple roles. This reduced the number of indicators, while more were added due to the newly introduced CSFs. In the end, the number of indicators was brought back slightly from 158 to 152, while the questionnaires per role tend to be more extensive due to indicators now being assigned to more roles for a more accurate assessment. Concluding, the biggest reduction in application time comes from applying ASRM Lite, while improvements to ASRM should result in a more accurate assessment.

7 Second design cycle

This sub-section describes the results of the second design cycle, that being the feedback received by the experts on the second iteration of ASRM, the UTAUT results for this iteration, and the third and final iteration of ASRM. Furthermore, a validation session with the General Manager of Topicus Finance about the third iteration of ASRM is described. Unfortunately, due to health circumstances, one of the original experts was unavailable for the second design cycle, bringing the total experts to 4 for this cycle.

7.1 Expert interview results

Understandably, the amount of feedback received for the second iteration of ASRM was much less than that of the first iteration. After all, with the first iteration, ASRM was firstly introduced to the experts to receive feedback, while all that feedback was processed into the second iteration. Hence, the main goal of the second feedback round was to verify if all feedback was processed correctly and if there were any points of attention left.

CSF

All the experts had few remarks on the removal of the two aforementioned CSFs, as the reasoning provided for the removal was conceived as valid. The same applies for the addition of the five CSFs mentioned by the experts, with the exception that one expert noted that the CSF *keep reminding why the adoption and change is taking place* is very similar to, and likely included in, the CSF *communicate the change intensively*.

ASRM Lite

ASRM Lite was very well received by the experts. Its function as a 'quick scan', consisting of 66% less CSFs and 58% less indicators, while maintaining 68.7% of the total weight was considered very useful and a welcome development. Having both ASRM as well as ASRM Lite available was considered useful and the proper approach.

A topic of discussion was if it is an issue that some groups of CSFs are disregarded in ASRM Lite as a result of only including CSFs with 15 or more mentions. While one expert suggested to include only CSFs with at least 15 mentions and in case a CSF group does not have such a CSF, then also include the highest mentioned CSF of that group, all other experts were of the opinion that losing CSF groups was not necessarily an issue. Their reasoning was that, although it might go against 'gut feelings' to disregard certain groups, the numbers do not lie and thus excluding those less mentioned CSFs and groups should be accepted.

Knock-out criteria

As with the CSFs, little feedback was provided on the knock-out criteria as all experts found the proposed knock-out criteria solid. One expert confirmed again that it is important to

apply knock-out criteria to certain CSFs as they might be detrimental to a successful Agile at Scale adoption and thus readiness.

Visualizations

The visualizations of the second iteration of ASRM was the main conversation topic, as this was a new addition to ASRM. The suggested radar charts were well received, with special praise for the radar and pie chart combined. A suggestion made by an expert is to also include the knock-out criteria in that chart to enhance it further. Furthermore, the addition of the knock-out criteria values added to other radar charts were well received by most experts, while there was one expert who found it distracting.

As mentioned in 6.3, it is hard to provide clear visual representations of many variables and thus it is was hard to develop a way to represent the overview of the readiness assessment of all individual CSFs. Hence the experts were asked about their opinion on this issue. Most experts suggested to provide an overview (e.g. pie chart) of the CSF grouping level. The values would then be the averages of the scorings of the CSFs inside the groups. Furthermore, some experts suggested that it would be valuable if the overview could then be expanded into more detail, i.e., then show the results of the CSFs in a group.

A different visualization proposed by an expert was not necessarily a chart, but actually a table form with different colors representing the result per CSF. The CSFs could then also be grouped per CSF group. Furthermore, the knock-out criteria could be visually added as a bar that needs to be reached.

Also, an expert suggested that it might be valuable to color code the results in some way in the chart. For example, by having green, orange and red results depending on the assessment scores. This would aim the attention to the points that need it, that being the CSFs that are not on the proper level yet. An additional thought provided was that a pie chart could be added with the percentage of CSFs having a 'green', 'orange' and 'red' score.

The proposal to visualize the differences in answers on the questionnaires between different the groups (i.e., managers, employees, change leaders, and trainers) was well received by all experts, as they argued that that information is valuable and important for the change and its readiness.

The author reasons that, although there are general useful visualizations that can be provided by default for ASRM (e.g., the radar charts for the scoring on CSFs), the deeper one goes into the data, the more specific the wishes and requirements for certain visualizations become for different organizations. For example, one organization might want to know the different answers on specific CSFs from different groups, while others are interested in the lowest scored variables spread over all CSFs. Hence, it is reasoned that the best solution would be to provide a software tool for the appliers of ASRM that allow them to generate their needed visualizations next to the default visualizations provided with ASRM, which

are considered to be valuable for every organization. This reasoning was agreed on by all experts, who underwrote that different situations and organizations require different visualizations.

7.2 UTAUT results

Compared to the previous iteration, all results for the Performance Expectancy and Effort Expectancy have increased positively. Notably, the *increasing chances to getting a raise* keeps being scored low as the experts found the question irrelevant. Moreover, the overall results are very positive, with every element scoring over 3 (disregarding said question) and most over 4.

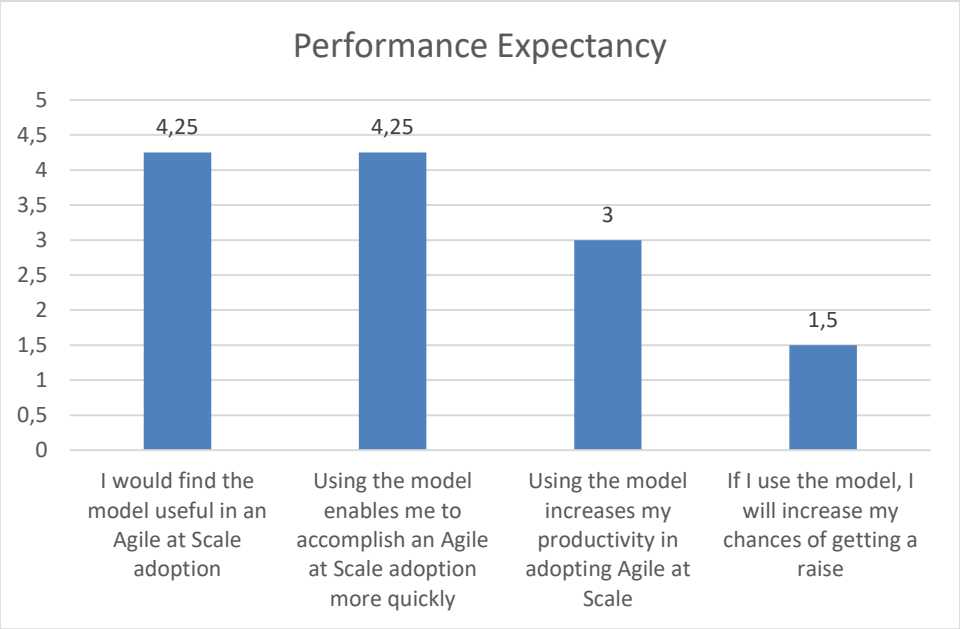


Figure 14: UTAUT results round 2: Performance Expectancy

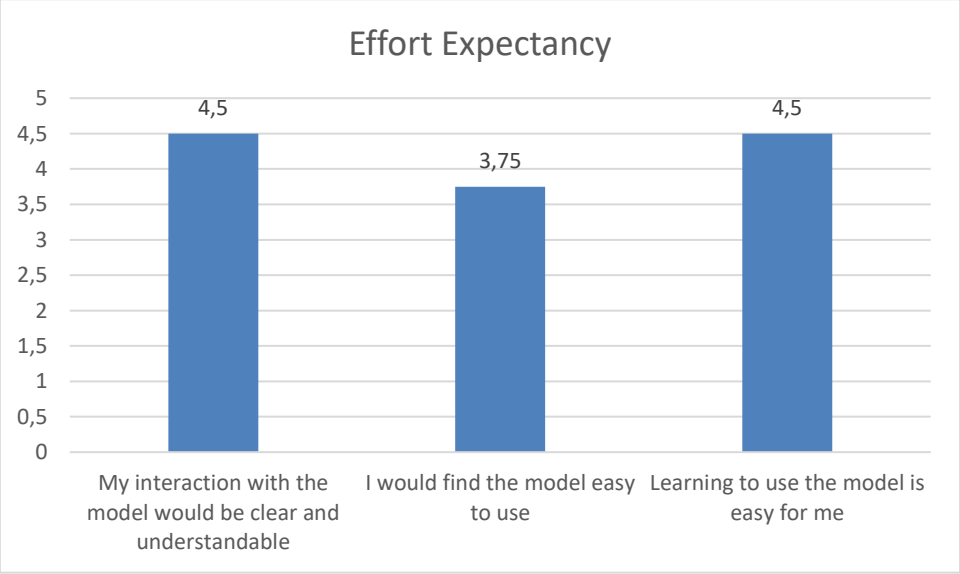


Figure 15: UTAUT results round 2: Effort Expectancy

All elements in Social Influence and Facilitating Conditions show improved results, with the exception of *People who influence my behavior think that I should use the model* and *I have the resources necessary to use the model*, which saw a minor decline.

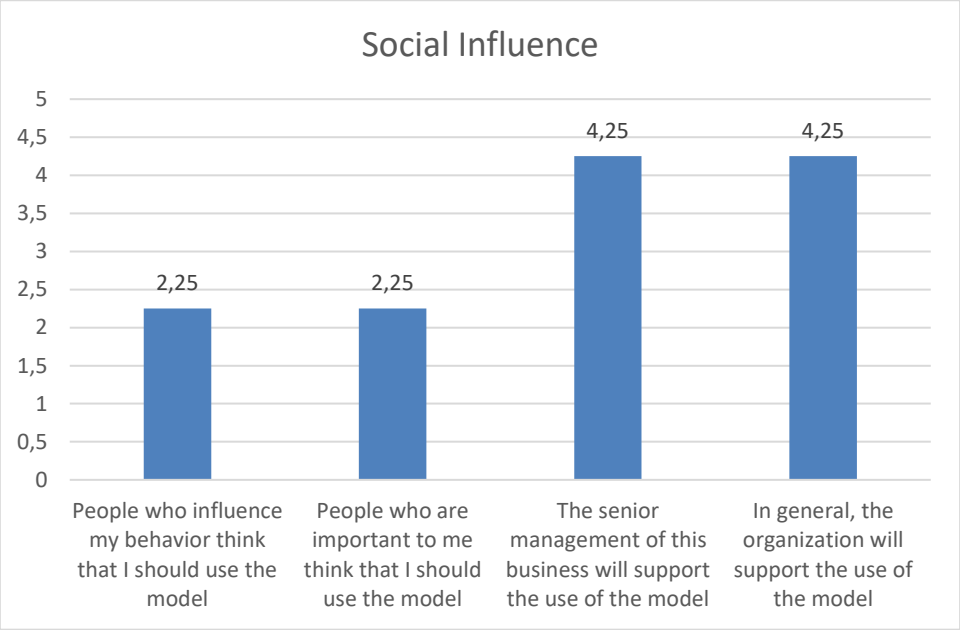


Figure 16: UTAUT results round 2: Social Influence

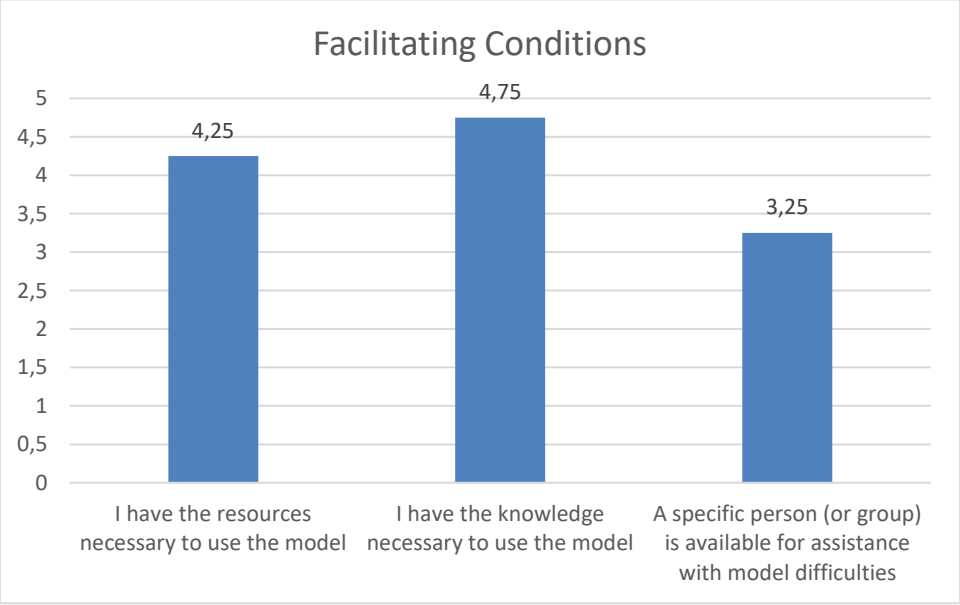


Figure 17: UTAUT results round 2: Facilitating Conditions

Two out of the three elements of Behavioral intention saw a minor increase, while one saw a minor decrease. Interesting to note is that the experts noted that they found it hard to answer these questions, as they are not currently in a close-to Agile at Scale adoption phase. The results of the UTAUT questionnaire will be discussed further in section 8.3.

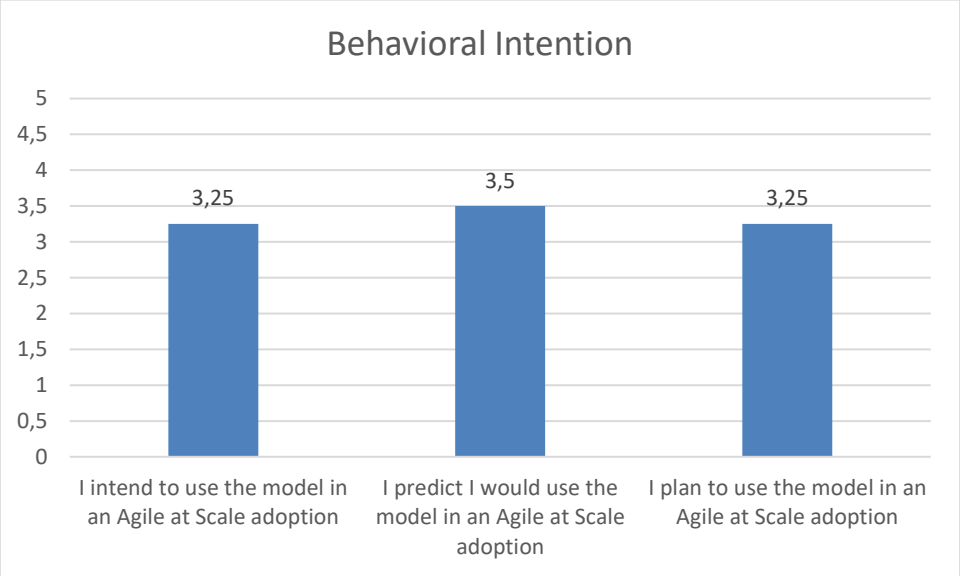


Figure 18: UTAUT results round 2: Behavioral Intention

7.3 Third iteration of ASRM

Based on the second feedback round, the third and final iteration of ASRM has been developed. Its changes compared to the previous version will be discussed, and the full model can be found in 4, Appendix I, Appendix J, and Appendix K. Furthermore, a visualization proof of concept is provided.

CSFs, variables, and indicators

Compared to the previous version, no changes have been made to the included CSFs, variables, and indicators. Although one expert noted that the CSF *keep reminding why the adoption and change is taking place* is very similar to, and likely included in, the CSF *communicate the change intensively*, it was decided to not incorporate this suggestion as only one expert suggested it and as it is argued that there is a difference between communication *why* a change is taking place and *how* a change is taking place and progressing.

ASRM Lite

The main topic of discussion regarding ASRM Lite was whether or not it is an issue to drop certain CSF groups as a result of only including CSFs mentioned 15 times or more. While one expert proposed to introduce a rule that would allow for at least one CSF in every group to not lose any groups, all other experts were against this idea. They argued that the numbers do not lie, and apparently, those groups that would be dropped, be it against 'gut feelings', are dropped legitimately and based on numbers and facts. Including them 'to include them' is something that should be avoided. Therefore the CSFs included in ASRM Lite remained the same.

Knock-out criteria

As described before, all experts agreed with the suggested knock-out criteria and thus no changes were proposed and thus made to the knock-out criteria.

7.3.1 Visualization and automation Proof of Concept

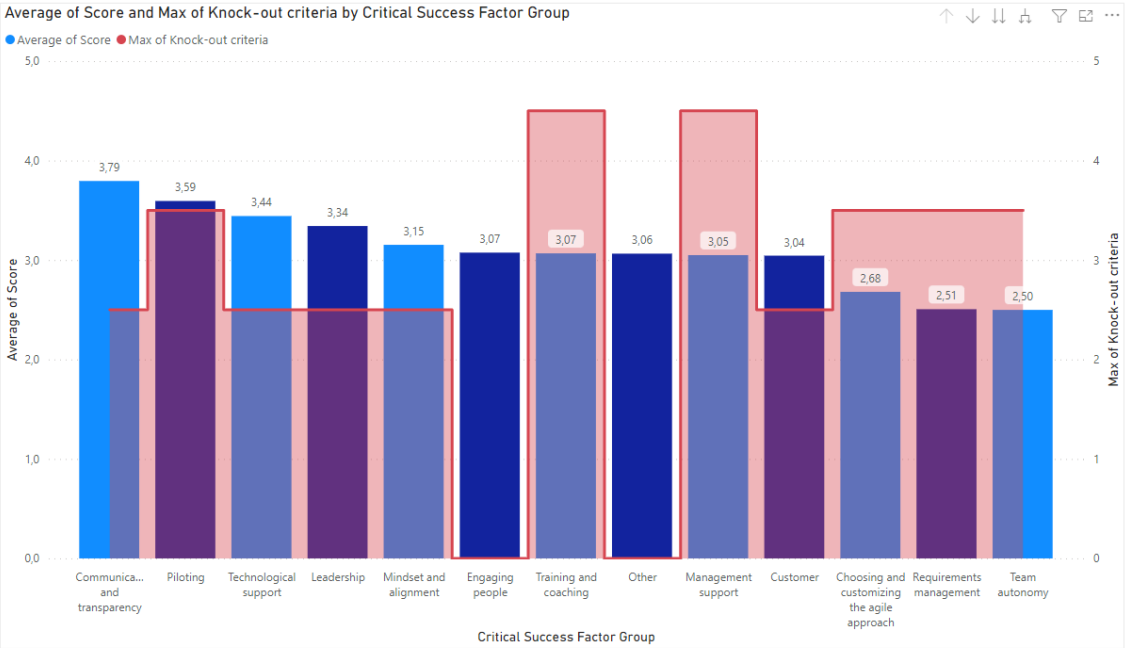
A major addition and improvement of ASRM is making the model available through a digital tool. To demonstrate its value, a proof of concept has been made in Microsoft Power BI. Power BI can automatically process data that is being generated through digital sources, such as Google Forms. Organizations would be able to share the link to the questionnaires, which the correct employees could then fill in. The data from the questionnaire would then automatically be available in Power BI, assuming that it is configured correctly.

Power BI's strength lies in its ability to generate tables and graphs based on the users needs, and its ability to drill down into more detailed information. Exactly these two strengths are sought after when digitalizing ASRM. To demonstrate, a drillable dashboard has been made for ASRM's assessment, based on test questionnaire data.

ID	Questionnaire	MS1-M1	MS1-M2	MS1-M3	MS1-M4	MS1-M5	MS1-M6	MS2-M1	MS2-M2	MS2-E1	MS3-M1	MS3-M2	MS3-X1	MS4-M1	CC1-X1	CC1-X2	CC1-X3	CC1-E1
45	Employee									2					5	4	5	4
46	Employee									5					4	5	4	5
47	Employee									3					3	5	4	3
48	Employee									3					4	4	5	4
49	Employee									1					3	4	4	5
50	Employee									4					5	5	3	5
51	Employee									4					5	4	3	5
52	Employee									5					4	3	4	4
53	Employee									1					4	4	5	3
54	Employee									4					4	3	5	4
55	Employee									3					4	3	4	3
56	Employee									1					3	5	3	3
57	Employee									1					3	4	3	3
58	Employee									5					4	5	4	3
59	Management	5	5	2	2	1	2	5	1		3	5	1	1	4	3	5	
60	Management	2	3	5	1	3	4	5	2		4	2	3	1	3	4	5	
61	Management	2	5	2	1	4	2	4	4		1	2	5	5	5	5	4	
62	Management	3	5	5	4	5	2	5	2		2	3	5	1	3	3	5	
63	Management	2	3	5	2	1	2	5	1		2	1	5	2	5	5	5	
64	Management	1	5	4	2	3	4	4	2		1	4	4	5	3	4	5	
65	Management	1	5	3	4	1	5	1	4		2	2	4	1	3	3	4	
66	Management	2	3	3	1	4	4	3	4		2	2	5	5	5	5	5	

Figure 19: Example questionnaire data

Figure 19 shows a set of the fake data results as it would come through questionnaire tools such as Google Forms. Figure 20 shows a digital dashboard of the average scores over the CSF groups. The red line shows the knock-out criteria for various CSFs in their respective groups. Furthermore, a table is provided which shows the average score per CSF, as well as the average score per questionnaire group.



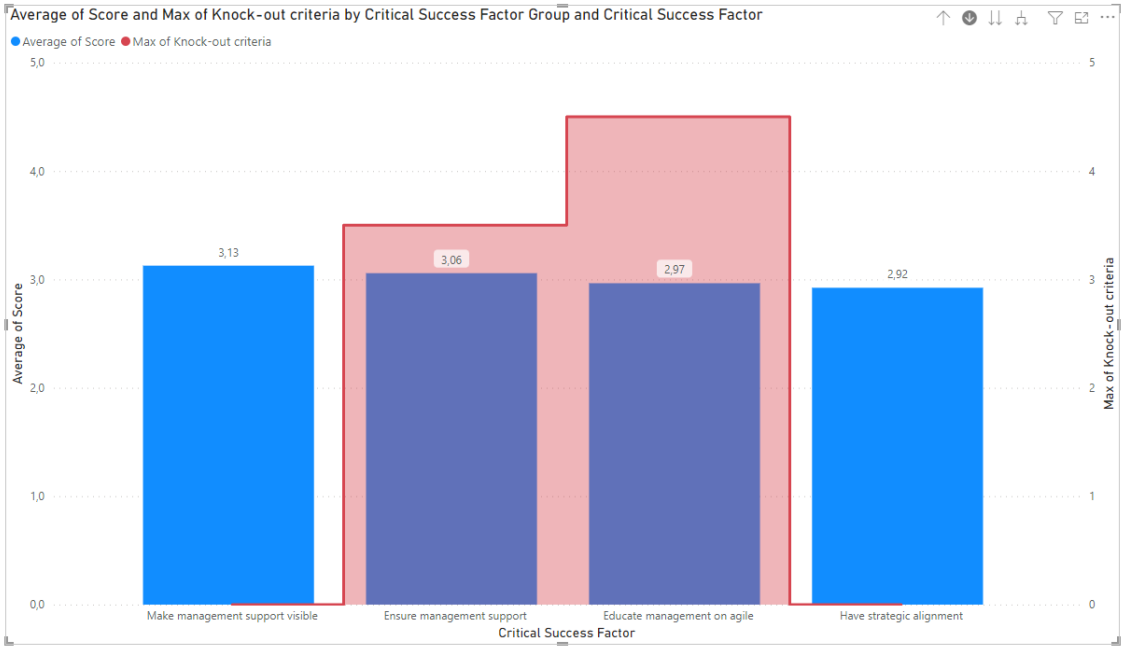
Critical Success Factor Group	Change Leader	Employee	Management	Trainer	Total
Choosing and customizing the agile approach	1,33	2,78	2,49		**2,68**
Communication and transparency	4,33	3,73	3,97		**3,79**
Customer			3,04		**3,04**
Engaging people	3,33	3,03	3,06		**3,07**
Leadership		3,29	3,40		**3,34**
Management support	2,33	3,05	3,06	3,00	**3,05**
Mindset and alignment	3,89	3,06	3,26	3,47	**3,15**
Other			3,06		**3,06**
Piloting	3,11	3,41	3,74		**3,59**
Requirements management			2,52	2,40	**2,51**
Team autonomy	2,33	2,55	2,45		**2,50**
Technological support		3,39	3,55		**3,44**
Training and coaching	3,11	3,00	3,14	3,00	**3,07**
Total	**3,40**	**3,24**	**3,20**	**2,92**	**3,22**

Figure 20: CSF group results dashboard

If one would be interested in more details about the assessment, one could drill down into one of the CSF groups. Figure 21 shows an example of drilling down into the Management Support group, showing the score per CSF in that group. Furthermore, the red bars indicate that the knock-out criteria for 2 CSFs that are in that group, are not reached. When we drill down further, we can see the score per indicator for a specific CSF, as shown in Figure 22. Finally, displayed in Figure 23, when drilling down even further, the average answers for a specific indicator spread over different respondent groups are shown.

It is important to note that the drill-downs and dimensions can be changed per level. For example, if one would want to see the scoring for all CSFs per responded group, then that is possible. The end user is free to generate any visuals and insights that are valuable to them for their organization and situation.

Unfortunately, some of the more advanced visualizations (such as those suggested in Figure 13) need to be bought separately, hence those visualizations were not able to be created in the proof of concept.



Critical Success Factor Group	Change Leader	Employee	Management	Trainer	Total
Management support	**2,33**	**3,05**	**3,06**	**3,00**	**3,05**
Educate management on agile	2,33		2,99	3,00	**2,97**
Ensure management support			3,06		**3,06**
Have strategic alignment			2,92		**2,92**
Make management support visible		3,05	3,23		**3,13**
Total	**2,33**	**3,05**	**3,06**	**3,00**	**3,05**

Figure 21: Example drill down example dashboard

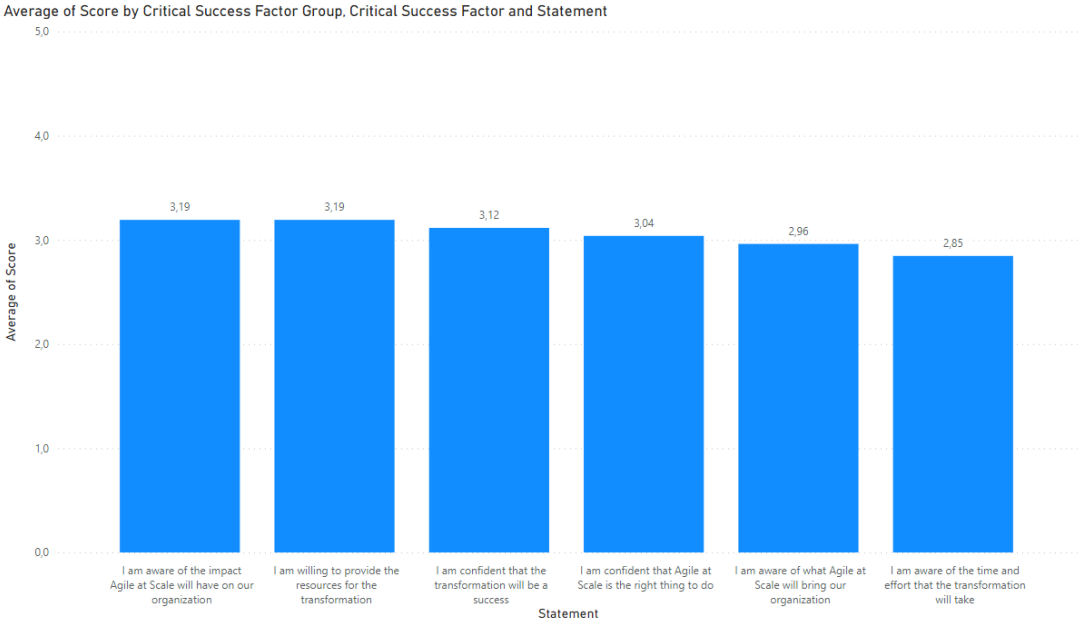


Figure 22: Example drill down indicators

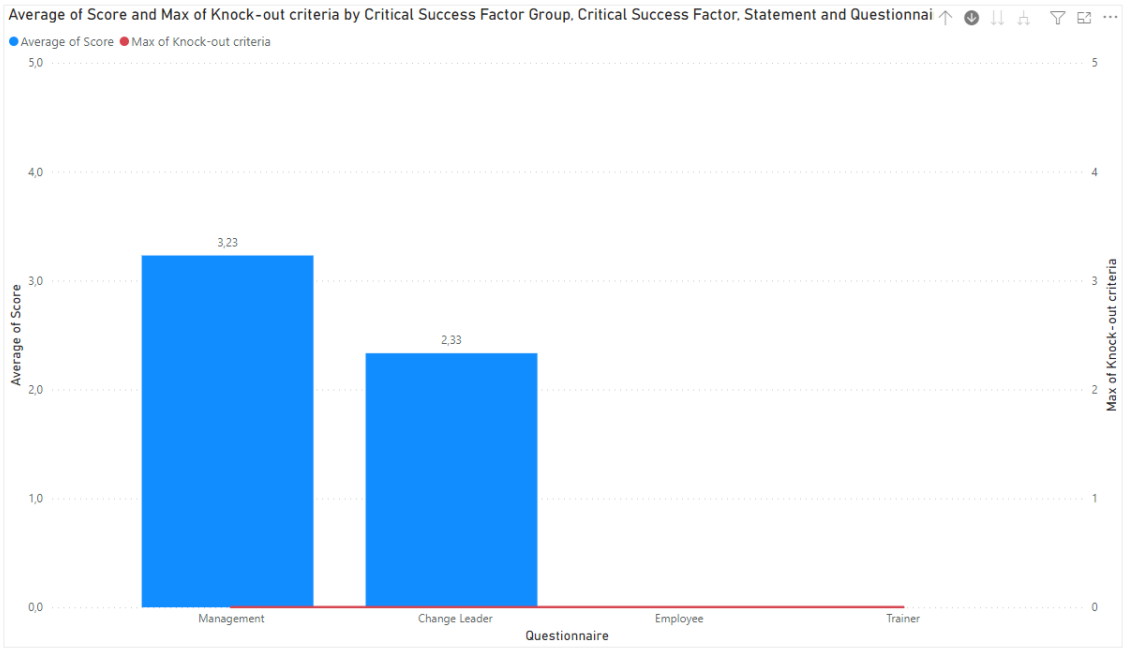


Figure 23: Example drill down into answers per respondent group

7.4 ASRM demonstration session with a senior executive

Following the development of the proof of concept, a demonstration session with the General Manager (GM) of Topicus Finance was held, who also is part of the Board of Directors of Topicus. The goal of this session was to demonstrate the proof of concept and to gather insights in how an executive views ASRM. Executives such as the GM are often responsible for making the final decision to start an organizational change and therefore their view on ASRM is important for the acceptance and adoption of ASRM.

The session was set in an interactive setting, where discussions, remarks and sharing of insights were encouraged throughout the length of the session. Firstly, the context and goal of ASRM was briefly provided, followed by an overview of the model and the design process. Thereafter, the proof of concept was shown and demonstrated. After the demonstration, the GM was asked to provide answers and views on a set of questions (see Appendix G), which he did at a later point in time through email.

7.4.1 Results

As was encouraged, the session was very interactive with discussions and dialogs taking place throughout the meeting. Furthermore, the GM confirmed that he was responsible for the final decision of the business line Mortgages of Topicus Finance to adopt the SAFe framework. Moreover, the GM was excited to learn about ASRM since he was aware that a model to assess readiness for Agile at Scale did not exist yet as he had looked extensively for such a model when Topicus Finance Mortgages was about to start its SAFe adoption. This demonstrates the need of practitioners to have an Agile at Scale readiness assessment model at their disposal, thus underwriting the contribution and importance of ASRM. Additionally, the GM noted that assessing fitness and suitability is different from assessing readiness, thus underwriting Figure 1.

While explaining ASRM's design and design process, the GM expressed his appreciation for the approach to get from soft, qualitative topics to measurable indicators, as such an approach could possibly be applied for many other different organizational transformations that involve soft aspects. By applying a model like ASRM, organizations could come to a well-considered and more factual decision and development that is in line with what is currently needed by the organization, according to the GM.

When asked what the GM's view is on using models like ASRM, he stated that he is a supporter of applying such models, as many organizations characterize themselves by executing organizational changes including change plans without first determining their current maturity level and whether the organization is at all ready to start the adoption and implementation of their chosen path and change, or whether there still are a number of other steps that first need to be taken before commencing with the adoption of the envisioned change. The pitfall is that, because this assessment would never take place, the

implementation of the change will never become successful with the painful consequence that the change is not supported within the organization.

However, when asked if ASRM would make it easier to make decisions, the GM responded that ASRM does not necessarily make making decisions easier as knowledge about an organization is also part of one's experience and of the ability to identify the needs of the organization and the market it operates in. However, the decision process would be sped up, and its shape and required additional steps would become more specific. This would result in a more factual evaluated decision and argumentation, which could then be used to make the communication to the organization more explicit.

Nonetheless, the GM stated clearly that ASRM will be applied and used when the next business line of Topicus would want to adopt Agile at Scale. Furthermore, ASRM Lite would be suitable to be used as a quick scan to discover what areas need further attention to become ready to adopt Agile at Scale. Additionally, the GM sees the value of quick scan versions of organizational change models, as those could quickly show an organization's readiness or maturity in a specific organizational change area, where then a prioritization could be made on which area to improve first based on the results of the quick scans.

Finally, the GM was enthusiastic about the proof of concept and the possibilities it creates to generate more insights and views depending on the need, as the GM was of the opinion that models like ASRM and its visualizations are ongoing, continuously evolving concepts.

8 Discussion

The previous chapter reported the empirical evaluation efforts of this thesis which revealed the validity and acceptance of ASRM. To follow up, different aspects of the design process of ASRM and ASRM itself are discussed and reflected upon. As the chapter will show, the discussion leads to many options for further research. A summary of possible future research will be provided at the end of the section (8.6.2).

8.1 Scope of ASRM

An important distinction for the correct application and focus on ASRM is the distinction between (1) the fit of Agile at Scale for an organization and (2) assessing the readiness for the adoption. Despite there being a distinction as described in section 1.3, both topics show overlapping elements. A prime example would be the organization's structure, culture and design. Not every organization with any culture can adopt Agile (at Scale) successfully, as certain organizational cultures are more suitable than others [89]. Furthermore, combining traditional Agile methodologies with more traditional plan driven approaches into hybrid Agile methods is a common practice, with 66% of nearly 700 projects surveyed applying a hybrid method [90]. It could be argued that Agile at Scale is a hybrid Agile method, as frameworks such as SAFe attempt to combine short iterations with longer term planning. While identifying the correct organizational culture is part of assessing the fit of Agile at Scale, assessing if that culture is actually present at time of the adoption would be part of assessing readiness. Nonetheless, both topics remain closely related and one could argue that both should be included in one, holistic model. Such a model would incorporate all the aspects to assess whether Agile at Scale would solve the issues an organization is facing, whether it would fit their work area, if their organizational culture would work well with Agile at Scale, etc. On the other hand, one should consider the feedback provided by the experts on the size and extensiveness of ASRM and the fact that ASRM Lite was very welcomed by the experts because it's size was reduced compared to ASRM. With this in mind, it is questionable to further extend ASRM by including aspects to assess the fit of Agile at Scale, instead of keeping those aspects in a separate model.

A similar discussion is that of adopting Agile at Scale when coming from traditional plan driven, waterfall methods versus coming from 'regular' Agile. Currently, ASRM is designed with the latter in mind, i.e., for organizations that are already familiar with Agile and thus its people do not need to be trained and educated on regular Agile and its principles, but only in Agile at Scale depending on the selected framework. The question is also whether it is wise to go straight to Agile at Scale while not even having experience with regular Agile. Since an adoption of Agile or Agile at Scale can take a few years, demonstrating its size, impact and challenge, it could be desirable to take one step at a time. On the other hand, since Agile at Scale frameworks do seem to combine some elements of traditional plan driven development, the change might not be as impactful as going full, regular Agile. Gaining

more insights in which of the reasonings is true would be a valuable addition to the adoption process of Agile at Scale.

8.2 Readiness models

The results of the SLR presented in section 3.1 shows that there is a wide variety in the completeness and goals of different readiness models. On one hand, some researchers (e.g. [16], [23], [24], [31]) provide just the dimensions and variables that are relevant for readiness. On the other hand, some other researchers (e.g. [18], [20], [50], [56]) provide the dimensions and variables, but additionally provide the different levels of readiness, tools and instructions how to assess the readiness and guidance on how to collect the data for the readiness assessment. One could argue that the former is less useful and less valuable, specifically for practitioners, because only knowing relevant variables, but not knowing how to or being able to assess them, is impractical. The models of the latter category provide more extensive guidance and help practitioners to actually assess their readiness. Models that provide variables and influences to explain how certain phenomena work and interact are of great value to create a better understanding of a phenomena, and are thus not to be regarded useless. In fact, dimensions and variables are the base of any readiness model included in the SLR, demonstrating that the authors of the included readiness models chose to utilize dimensions and variables in order to make sure that the findings of the models are understandable. However, for such a specific type of model that is focused mainly on being applied in practice – that being readiness models – its applicability and usefulness in practice should be accounted for. Therefore it is argued that readiness models should not only consist of the measurable variables, but also the tools and guidance on how to gather the data for the assessment and the assessment method itself. This specific approach was taken when developing ASRM; measurable indicators and variables were deduced from CSFs, ways to gather the data through questionnaires were provided, and assessment methods and visualizations are supplied. The models that only provide relevant dimensions and variables are not sufficient enough to assess readiness, however they can be used as the base and foundation of more comprehensive models that also provide assessment tools.

Apart from the fact that there is a gap in the completeness and comprehensiveness of different readiness models as shown in Table 2 and the previous paragraph, an important question is why there is such a gap and why researchers provide and develop models with such a variation in completeness. Interestingly, the models that provide a comprehensive approach including both assessment and data gathering tools and methods are few ([18], [20], [27], [49]–[52], [55], [56]), meaning that most authors that made model proposals did not continue their research to include methods and tools for the practical application of their models by other researchers and practitioners. Based on the executed SLR, we could conclude that their reasons to not provide the needed methods and tools are unknown and can only be speculated about; is it because the value of these tools is not clear? Is it because providing applicable data collection and assessment tools is a tedious undertaking? Regardless of what the reasons may be, researchers should understand and recognize the value of these parts of their models, especially for models whose use case lies mainly in

practice as is the case with readiness models. In other words, when researchers propose a model type whose purpose mainly lies in being applied in practice rather than in an academic setting, the model authors should consider the completeness of the model and evaluate whether enough tools and information is provided for practitioners to utilize the model in practice. This was confirmed by feedback from the experts for ASRM, who after being introduced to the CSFs, variables and indicators soon asked for the methods to gather and visualize the data and results.

8.3 Design of ASRM

One of the design requirements was that the model should be applicable in practice and have sufficient *ease of use*. Although 'sufficient' is hard to quantify, the results of UTAUT show that the experts on average score ease of use as 3.75 out of 5, which is considered a solid result. Furthermore, ease of learning to use the ASRM is also considered a strength, with a score of 4.5 out of 5. Although it is acknowledged that the full version of ASRM is quite extensive and can take some effort to be applied, the actual practice of applying the model is not considered hard by the experts. It is also likely that ASRM Lite contributed strongly to the ease of use and ease of learning, as ASRM Lite is much smaller and therefore less overwhelming.

An interesting interaction would be how different Agile at Scale frameworks, such as SAFe, DAD and LeSS, would interact with ASRM. In the design of ASMR, no framework specific elements were included with the idea that the model should be applicable for all Agile at Scale frameworks. As a result, it might be the case that specific CSFs are not relevant for certain frameworks, or the other way around. Furthermore, the weighting may also prove to be different for specific CSFs. These framework specific variations could potentially lead to differences in accuracy of ASRM for different frameworks. On the other hand, ASRM was validated and designed to be generally applicable and include all relevant CSFs with their respective weights based on mentions in 122 publications.

The way that the weights of the CSFs are calculated remains an interesting topic. On one hand, one could apply the reasoning that if a CSF is mentioned by many organizations, then it can be assumed that that CSF is very likely to be an actual CSF for most organizations. Similarly, if an CSF is mentioned very little, then it might not actually be a CSF or only for specific organizations. Therefore, higher weights should be applied to CSFs that are mentioned more often as those are most likely to be of importance. In that sense, it is more of an 'confidence of importance' weight and thus indicates the importance to being ready. On other hand, it can be argued that the amount of mentions does not say anything about the relative importance of a CSF for the success of adoption. Hence it could be argued that one CSF would not contribute more to being ready than another based on being identified more often as a CSF. Ultimately, applying weights to the CSFs is logical as the weights would indicate confidence of importance, and possibly also indicate its relative contribution to being ready to adopt Agile at Scale.

8.4 Reflection on the ASRM evaluation effort in this thesis

Following Peffers *et al.* [7], evaluating ASRM was a major element in the design process of the model. Opting for expert opinion interviews was a fitting choice, as it provided important insights from practitioners that otherwise would have been neglected. A valuable discovery was that the there were very few CSFs that the experts disagreed with and that, thus, the experts experience and opinions were very much in line with the literature.

However, fully validating the accurate predictability of ASRM will only be achievable in a few years, given the nature and length of Agile at Scale adoptions, and once many organizations have applied the model. It will take a few years to gather the necessary data to do a full validation. Ideally, one would apply ASRM in organizations that are on the brink of adopting Agile at Scale. ASRM would assess the organization's readiness, the organization would start the adoption regardless if they are considered ready or not, and when the transformation is ought to be complete, the results of the adoption, that being whether it was successful or not, would be compared with the assessment result of ASRM. Unfortunately, such validation takes much effort and many (time) investments, however it is required to

A subject related to the evaluation work discussed in the previous paragraphs is that of sample size. Clearly, a bigger sample size would lead to more accurate results and possibly better supported answers. However, given the time available for the present study, the sample size was limited to a set of five experts and one end-user which is deemed sufficient for scope of the study.

Another, interesting topic would be to benchmark ASRM in different organizations. By evaluating how different organizations score on different elements of ASRM, organizations could be compared and standards could be set. Furthermore, the impact and weights of CSFs could be adjusted based on gathered data on the readiness levels that organizations are on at the moment that they adopt Agile at Scale successfully. For example, if practice would learn that many organizations that are deemed unready by ASRMs calculation end up adopting Agile at Scale successfully nonetheless, the levels and weights might have to be adjusted. Although such scenarios are unlikely since that would mean that organizations who do not have the CSFs in place would still be able to transform successfully, it cannot be ruled out until researched.

A topic that remains difficult is to assess the extent in which the proposed indicators assess the variables correctly and thoroughly. Although the method of Sidky *et al.* [3] was adopted to generate the indicators, full thorough validation of the indicators through construct validity [86] and construct factor analysis [87] would be a valuable addition to ASRMs validation. It would ensure further validation that the indicators actually assess what they are designed for and that they do so with enough confidence.

A question that one could raise would be if ASRM and its validity would change when one would apply the model in a different organization or field than in which it was validated.

When answering this question, it is important to consider that a variety of experts from different organizations were incorporated in the validation. Moreover, the SLRs covering 122 publications that were used to extract the relevant CSFs for adopting Agile at Scale did not focus on specific industries, resulting in CSFs that are relevant for a wide spread of organizations in different industries. In essence, the CSFs and validation of ASRM have been kept general. Hence, there should be no difference in the useability of ASRM from one organization to another. Yet, it is imaginable that certain CSFs might be more important for certain organizations than others (e.g., management support might be more important in hierarchical organizations than in flat organizations), given different cultures, current readiness levels, different industries, or different types of software. However, following the reasoning of Seddon and Scheepers [91] and Ghaisas *et al.* [92], it is reasonable to believe that it might well be possible that ASRM would be applicable to organizational contexts that are similar to the context in which the evaluation work was accrued out. For example, Agile companies that share a national and organizational culture similar to the cultural context of the interviewed experts.

8.5 Reflection related to the usefulness of ASRM in practice and its timelines

An unanticipated finding of this research was that the interviewed General Manager had been looking for a model exactly like ASRM approximately two years ago, when one of the business lines of his organization decided that they should adopt Agile at Scale. As a result, the model was received with much enthusiasm. Although the author never validated with practitioners that there was a need for a model such as ASRM, it turned out there was as this is a perfect example of the need for a model like ASRM. Not only did the General Manager see value in ASRM, but also in the approach to come from soft aspects of the organization to measurable quantitative results, indicating that there is a wider need to make such aspects quantifiable and measurable.

As the popularity of Agile at Scale adoption increases, the questions for organizations shift from why to adopt, to how to adopt [5] and inherently if an organization is ready to adopt. Given this and the response from the General Manager, it is assumable that other organizations face the same issues and have the same need to assess their readiness before starting to adopt Agile at Scale, indicating the relevance of ASRM for practitioners and organizations.

8.6 Implications

This study provides a number of implications for research and practice, which will be now be discussed.

8.6.1 Implications for practice

With the introduction of ASRM, practitioners and organizations now have a tool deemed fit and usable by interviewed experts in the field, to assess their readiness before starting to adopt Agile at Scale. By applying ASRM before starting the adoption, organizations can now get information on whether starting the adoption in their current state is a good idea. This will make them being less at risk when starting the adoption and it will increase their chances of a successful adoption as they are ready for the change.

Organizations will also have the choice to apply ASRM, ASRM Lite, or both depending on their needs. ASRM Lite can be quickly applied and will give organizations a quick, relatively accurate assessment of their readiness. With the help of the customizable visualizations, organizations can now get insight in the areas in which they still need to improve in order to become ready to adopt Agile at Scale. This should help change leaders to focus on the areas in which the organization still needs to improve to become ready for the change. Additionally, the initiative takers and sponsors for the adoption of Agile at Scale now have a scientific model at their disposal with which they can prove that they are ready for the change, which should convince management and employees to start the adoption. With that in mind, ASRM can be used to communicate if and why an organization is ready to adopt Agile at Scale.

The introduction of ASRM does not only have implications for organizations that aim to adopt Agile at Scale. ASRM will have implications for Agile at Scale consultants as well. With ASRM, consultants can now also provide a quantitative assessment in addition to their experience-based qualitative results. However, with ASRM being publicly available, nothing stops organizations from applying ASRM without the help of (expensive) consultants. In fact, ASRM was designed with the design requirement of being easy to use, which should enable this approach. This could result in a decrease in value of Agile at Scale consultants, as organizations might now decide to not hire (expensive) consultants and do the assessment themselves. On the other hand, it is arguable that the qualitative knowledge and expertise of Agile at Scale experts and consultants can never be fully replaced by a quantitative tool such as ASRM, but that they could only enhance each other. Time will have to tell which of the possible outcomes will become reality.

Although not all organization's employees will be involved in the decision making to adopt Agile at Scale, the adoption will impact them. Agile at Scale is an organizational change that will introduce new ways of working for development teams and employees. As a stakeholder of such an impactful change, employees will likely appreciate the fact that management is now able to not only make the decision to start the adoption based on

experience and 'gut feeling', but also on a quantitative model that underwrites the aspects in which an organization is ready and not, and to what extent.

Furthermore, not only can ASRM be considered an assessment tool, it can also be considered as a guideline to what is essential for successfully adopting Agile at Scale and how to make sure that those essentials are in place. As one of the interviewed experts noted, sometimes only asking if one is ready (in a specific area) makes them become more ready, as people will start to realize the importance of the topic and therefore look to improve it. By providing CSFs for a successful adoption, organizations will get an overview of the important aspects that need to considered. This realization can arise without having to go into the deeper details of ASRM, such as the variables, indicators, readiness levels and knockout criteria.

Finally, the specific professional in an organization who might benefit from the proposed ASRM model is reflected upon. Usually, according to literature on Agile transformations, if an organization wants to embark on Agile at Scale, a team is formed by multiple specialists and senior managers who together engage in strategic thinking regarding the Agile transformation. Such a team would attempt to answer a variety of questions, such as if the organization should adopt Agile at Scale, when the most suitable moment is to start the adoption, and if it should be done with consultants on board or with the resources already available inside the organization. The newly proposed ASRM model and tool would be worthwhile considering by the team searching answers to such questions. Usually, these questions require expert opinions based on past observations and experiences. However, with ASRM, the team could gain insights into the Agile at Scale readiness level by consolidating evaluative data collected systematically by using the pre-set questionnaires of ASRM (see Appendix I and Appendix K).

8.6.2 Implications for further research

This study is a first step in providing practitioners with a model and method to assess their readiness for adopting Agile at Scale. As a result, many new research opportunities have arisen. First of all, a valuable contribution would be to evaluate if ASRM would be able to be applied when an organization is coming from a plan driven, waterfall approach instead of Agile. Possible outcomes could be that it is applicable, that it needs to be adapted, or possibly even a new model would have to be developed. In the same vein, understanding the influence of specific Agile at Scale frameworks on ASRM would be valuable knowledge.

Furthermore, further validation of the variables and indicators of ASRM can be a valuable contribution. Construct validity [86] and construct factor analysis [87] could be applied to further analyze and validate the current variables and indicators. Moreover, researching possible dependencies between CSFs could enhance the understanding of ASRM's constructs and relations. Also, extending the expert validation with more experts would further add to the validity of ASRM. Interestingly, the experts provided CSFs that were not found in the literature. This would imply that there are possibly more relevant CSFs for

adopting Agile at Scale than science is aware of. Hence, further researching CSFs for Agile at Scale adoption would be a valuable undertaking.

Another interesting research direction would be to benchmark ASRM in different organizations. Through benchmarking, ASRM's readiness levels and knock-out criteria could be further calibrated. Not only would it contribute to the ability to calibrate ASRM, it would also create insight in how ready organizations on average are at the time they plan to start the adoption. As one of the experts noted, asking questions about readiness may implicitly contribute to becoming ready. The question would be if organizations would naturally become more ready to adopt Agile at Scale once they have decided that they want to adopt it. Hence, comparing the readiness of those organizations with those that do not plan to adopt Agile at Scale may yield valuable insights and implications.

As was stated before, assessing the fitness and suitability of Agile at Scale for an organization is not in scope for the current research. However, to the author's knowledge, such research has not yet been conducted. That is, there seems to be no model or assessment tool that helps organizations evaluate if Agile at Scale would solve the problems and issues they face, or bring their organization to the next level. Addressing this gap in the literature would be a valuable contribution, both for the academic knowledge as well as for practitioners who would benefit from such a model.

Finally, fully evaluating and validating ASRM in real world scenarios would be a worthwhile undertaking. Applying ASRM in organizations that are at the point to start the adoption of Agile at Scale and tracking their success or failure over time of the implementation to then compare it with the assessment verdict would create invaluable insights in the accuracy of ASRM.

9 Conclusions

The goal of this research is to develop an Agile at Scale readiness model with the design requirements that it (1) must have a readiness assessment method, (2) that it has gradations of Agile at Scale readiness, and (3) that it is applicable in practice with sufficient ease of use. To achieve this goal, the main research question was *How can the readiness of an organization to adopt an Agile at Scale framework be assessed?* To answer this question, the answers to the sub-questions will first be given. Finally, the answer to the main research question will be provided.

SQ1. What are relevant variables for the adoption of an Agile at Scale framework?

After evaluating three SLRs covering a total of 122 publications, 42 CSFs were identified of which 2 were eliminated based on expert feedback and reasoning. Additionally, 5 more CSFs were added based on experts feedback, bringing the total to 45 CSFs. These CSFs were further broken down into 70 variables and 152 indicators. The full list of CSFs, variables and indicators can be found in Appendix H.

SQ2. What readiness model type is best fit for assessing Agile at Scale readiness?

Multiple readiness model types have been identified, of which the *levels* type is argued to be the best fit for an Agile at Scale readiness assessment model. This type (1) provides methods to accurately assess readiness, (2) it is not over-technical and thus it (3) has good ease of use characteristics. Contrary to its main competitor the *grading* type, *levels* models provide visual levels of readiness. These levels and their visual components may help the model's appliers understand how ready they are and how to improve their readiness.

SQ3. How can the relevant variables and the model type be combined into an assessment tool?

Combining the CSFs found in the literature and through expert interviews, the derived variables, and the derived indicators with the constructed Agile at Scale readiness level for the levels model type laid the foundation of Agile at Scale Readiness Model (ASRM). ASRM is further expanded by adding weights to the critical CSFs and associated indicators, adding knock-out criteria that further increase accuracy, and visualizations of the assessment through different charts and diagrams. Finally, ASRM Lite was created to act as a light version and a quick scan of ASRM. The final result of this development process can be found in Appendix H, Appendix I, Appendix J, and Appendix K.

SQ4. Is the assessment tool useable and useful for the assessment of Agile at Scale readiness?

According to expert-based evaluation and UTAUT results (Chapter 5), ASRM is useable and useful for the assessment of Agile at Scale readiness. Few points of improvement were suggested by the experts in the second evaluation round, suggesting that the experts deemed ASRM as a correct and useable model. This was further confirmed through an interview with the General Manager of a leading software organization in the financial market in the Netherlands. Furthermore, the UTAUT results show that the experts find ASRM useful for the adoption of Agile at Scale and expect it to achieve the adoption more quickly. Furthermore, they state that ASRM is easy to use and learn, and that senior management and their organizations will support the use of ASRM.

RQ. How can the readiness of an organization to adopt an Agile at Scale framework be assessed?

The collective empirical evidence through this master thesis concerning the Agile at Scale Readiness Model (ASRM) let me conclude that the model can be used to assess the readiness of an organization to adopt Agile at Scale. ASRM provides questionnaires that organizations can fill in and the results can be digitalized to be visually displayed. Organizations are rated on one of five readiness levels and drilling down options on the results and visualizations allow organizations to gain further understanding of the assessment result. ASRM Lite can be used as a quick scan when time is too limited to apply ASRM or to quickly gain an initial assessment.

9.1 Limitations

Finally, it is acknowledged that the research presented in this thesis has some limitations. Not unexpectedly, some limitations have already been mentioned in the implications for further research and thus some limitations might therefore be repeated.

First of all, only five experts were interviewed and included for UTAUT, spread over three organizations. Additionally, only one executive manager was consulted to gather information on the insights of those who are in the end responsible for starting the adoption of Agile at Scale. This limitation is mitigated by having made two cycles through the design Science process of Peffers *et al.* [7]. As Wieringa and Daneva [93] indicate, collecting feedback from practitioners, even if these are small in number, is very important to evaluate the applicability and suitability of the ideas behind the early design of an artifact – and this was the goal of the evaluation.

Secondly, only two design cycles were applied. Although the second design cycle provided little feedback and points of attention – which obviously is a good sign – further validation and evaluation regarding the created visualizations and the proof of concept would be welcome.

Finally, ASRM has not yet been tested and validated in practice. Hence, its usefulness and accuracy are currently only based on literature, theorization and user expert opinions. It is acknowledged that such a work would take multiple years and this forms a line for research in the future.

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Appendix A. Readiness model SLR methodology

This SLR is based on the methodological guidelines of Kitchenham [94]. Kitchenham [94] provides three phases in her guidelines: the planning phase, the conducting phase, and the reporting phase. The planning phase consists of the identification and reasoning why there is a need for a SLR and with the development of the review protocol. The conducting phase is, over multiple sub-stages, concerned with the study selection and data extraction and synthesis. The final phase is to report the review and its findings.

Data sources

The Scopus database was chosen to be used to perform the search. Scopus indexes other databases and thus provides a comprehensive selection of search results. Furthermore, Scopus has advanced search options that are useful applying the inclusion criteria for this literature review. A common practice is to consult different databases to make sure that all relevant literature is found. As the next subchapter will show, many (useful) publications were found in Scopus alone. Because of the extensive amount of results, it was chosen not to consult a second database because the (amount of) results are deemed to be sufficient to come to well-founded results and conclusions.

Search queries

The goal of this SLR is to understand how in general readiness models are build up and what their internal structure is. Therefore the search body of the search query is quite simple, namely "readiness model". This query resulted in 324 hits. However, these results also included hits from unrelated subject areas. Scopus has some advanced search capabilities that allowed the results to be filtered to the subject areas of computer science, business management and accounting, engineering, and decision sciences. Applying these filters resulted in the full search string: *TITLE-ABS-KEY ("readiness model") AND (LIMIT-TO (SUBJAREA , "COMP") OR LIMIT-TO (SUBJAREA , "ENGI") OR LIMIT-TO (SUBJAREA , "BUSI") OR LIMIT-TO (SUBJAREA , "DECI"))*. Applying this query narrowed the amount of hits to 168.

The question can be raised why the search query wasn't specified towards IT. The answer to this question is twofold. Firstly, extending the search query to include 'information technology' or 'agile' provided very little hits; 30 and 2 respectively. This amount of publications would be too little to confidently provide all the building blocks of readiness model, as the sample type is simply too slim. Secondly, useful and relevant model elements might be excluded by only looking at IT related readiness models. Therefore it is argued that it is important to also look at models and their elements from similar fields and to learn from those fields.

Inclusion and exclusion criteria

Following the proposal of Kitchenham [94], a set of inclusion and exclusion criteria has been applied to the literature found via the search queries. The criteria are found in Table 12.

Table 12: Inclusion and exclusion criteria

Inclusion Criteria (IC)	Exclusion Criteria (EC)
IC1: The research field of the paper is related to Computer Science, Business and Management, Decision Sciences, or Engineering.	**EC1:** The paper is not written in English.
IC2: The paper is a peer reviewed journal, a scientific book chapter or a conference publication.	**EC2:** The paper is a preliminary paper, for example a doctoral paper, a research summary or an editorial.
IC3: The paper is available for download through the University of Twente's libraries.	**EC3:** The paper misuses the term of readiness for maturity or acceptance.
IC4: The essential topic of the paper is a readiness model.	**EC4:** There is a more comprehensive follow-up paper of the paper.
	EC5: The paper treats readiness and readiness models only as a side topic.
	EC6: The paper has poor readability to the extent where the content of the paper cannot be validated.

Study selection

Figure 24 shows the study selection steps. The initial search query provided 324 hits, which was narrowed down to 168 after applying domain-relevant filters provided by the Scopus database. The next round of filtering was done by reading the abstract and title to assess whether the paper would be relevant and should be further inspected. The assessment was done based on the inclusion and exclusion criteria (Table 12). In the last selection step, the decision to include or exclude the paper was done by reading the full text, where once again the inclusion and exclusion criteria were applied in order to select the final set of papers that are included in the review.

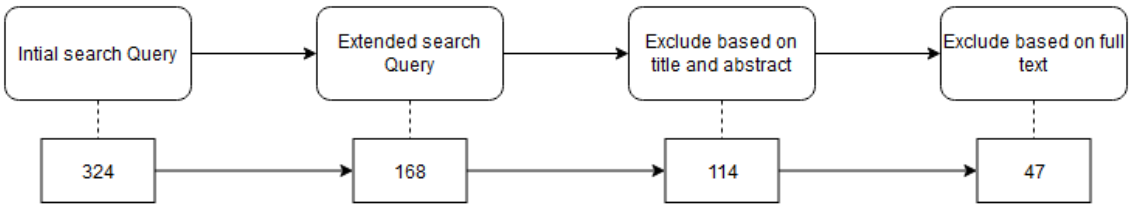

Figure 24: Study selection

Data extraction

In some cases two versions of the same article was found, for example a conference proceeding that is also published as a journal article. In such a case, the most extensive version of the article was included and the less extensive version excluded. The following list presents the data that was extracted from the included studies:

1. Group
2. Subgroup
3. Hierarchy
4. Measurable variable generation
5. Relationships, influences and causations
6. Assessment tools and methods
7. Data gathering
8. Visualisation

Qualitive analysis was performed on the selected studies to form categories of concepts. It is important to note that the list was not completely predefined before the data extraction began, but rather formed through the data extraction process. As stated before, the goal of this SLR is to identify the building blocks and elements of readiness models. Thus, when an element was identified in a study, it was added to the data extraction list and the element was looked for in the other studies as well. As an additional result of this study goal, the focus was on qualitative analysis over quantitative analysis as the goal is not to identity the amount of models per group or category or the frequency that an building block was found

in readiness models, but rather what model types exist and what building blocks and elements.

Appendix B. CSF mentions and weights

Success Factors	Mentions	Weight
Management support		
Ensure management support	29	0,046
Make management support visible	4	0,006
Educate management on agile	34	0,054
Commitment to change		
Communicate that change is non-negotiable	4	0,006
Show strong commitment	30	0,048
Leadership		
Recognize the importance of change leaders	15	0,024
Engage change leaders without baggage of the past	2	0,003
Dedicated management	6	0,010
Choosing and customizing the agile approach		
Customize the agile approach carefully	11	0,018
Conform to a single approach	12	0,019
Map to old way of working to ease adaptation	6	0,010
Keep it simple	4	0,006
Piloting		
Start with a pilot to gain acceptance	14	0,022
Gather insights from a pilot	10	0,016
Careful transformation and sustainable planning	25	0,040
Training and coaching		
Provide training on agile methods	18	0,089
Coach teams as they learn by doing	46	0,073
Knowledge sharing management	7	0,011
Engaging people		
Start with agile supporters	3	0,005
Include persons with previous agile experience	14	0,022
Engage everyone in the organization	5	0,008
Team encouragement	3	0,005
Communication and transparency		
Communicate the change intensively	5	0,008
Make the change transparent	10	0,016
Create and communicate positive experiences in the beginning	6	0,010
Strong collaboration and communication between teams and team members	19	0,030
Mindset and alignment		

	Concentrate on agile values	11	0,018
	Arrange social events	11	0,018
	Cherish agile communities	5	0,008
	Align the organization	6	0,010
	Cooperative organizational culture	25	0,040
	Face to Face meetings	13	0,021
Team autonomy			
	Allow teams to self-organize	34	0,054
	Allow grass roots level empowerment	29	0,046
Requirements management			
	Recognize the importance of the Product Owner role	7	0,011
	Invest in learning to refine the requirements	22	0,035
Technological support			
	(Automated) tools and infrastructure	20	0,032
	Solid engineering practices	2	0,003
	Quality production using pair programming	7	0,011
Customer			
	Customer satisfaction	21	0,034
	Strong collaboration with customer	21	0,034
Other			
	Risk management	12	0,019
Total		626	1,000

Appendix C. Initial ASRM variables and indicators

Management support

Success Factor	Variable	Indicator	Identifier	Who
Ensure management support				
	Management understands value			
		I am aware of what Agile at Scale will bring our organization	MS1-M1	M
		I am aware of the impact Agile at Scale will have on our organization	MS1-M2	M
		I am confident that Agile at Scale is the right thing to do	MS1-M3	M
		I am confident that the transformation will be a success	MS1-M4	M
	Management provides resources			
		I am aware of the time and effort that the transformation will take	MS1-M5	M
		I am willing to provide the resources for the transformation	MS1-M6	M
Make management support visible				
	Management communicates support			
		I support the transformation openly	MS2-M1	M
		I have communicated management support clearly to our employees	MS2-M2	M

	Employees experience management support		
	Management is supporting of the transformation to Agile at Scale	MS2-E1	E
Educate management on agile			
	Management has had Agile (at Scale) training		
	I have had agile training	MS3-M1	M
	I know the agile principles	MS3-M2	M

Commitment to change

Success Factor	Variable	Indicator	Identifier	Who
Communicate that the change is non-negotiable				
	There is outgoing communication			
		The change is non-negotiable	CC1-M1	M
		I have communicated that the change is non-negotiable	CC1-M2	M
	Understandable incoming communication			
		I am aware that the change is non-negotiable	CC1-E1	E
Show strong commitment				
	The change is necessary			
		I think that the change is necessary	MS2-M1	M/E
		I am committed to make the change a success	MS2-M2	M/E
	The change is achievable			
		The change is manageable	CC2-X3	M/E
		I trust that management is making the right decision	CC2-E2	E

Leadership

Success Factor	Variable	Indicator	Identifier	Who
Recognize the importance of change leaders				
	Understanding the impact of the change			
		We need someone that leads the change	Le1-M1	M
		Change requires expertise	Le1-M2	M
	Understanding the value of organized change			
		We have a dedicated change leader	Le1-X1	M/E
		We have a motivated change leader	Le1-X2	M/E
Engage change leaders without baggage of the past				
	Adopting change leaders with a fresh view			
		We have an external/freshly hired change leader	Le2-X1	M/E
Dedicated Leadership				
	Being responsible for the change			
		We have a leadership team responsible for the change	Le3-M1	M
		The dedicated leadership team is motivated	Le3-M2	M

Choosing and customizing the Agile approach

Success Factor	Variable	Indicator	Identifier	Who
Customize the agile approach carefully				
	Team customization			
		Will you allow teams to customize agile to their fit?	CCA1-M1	M
		Do you allow a pragmatic way to adopt Agile at Scale?	CCA1-M2	M
	Project/train customization			
		Customization per project might be needed	CCA1-M3	M
		Different types of project and software might need different types of customization	CCA1-M4	M
	Evolutionary process			
		Adopting and customizing Agile at Scale is an evolutionary process	CCA1-X1	M/E
		Adopting Agile and Scale is an ongoing process	CCA1-X2	M/E
Conform to a single approach				
	Having common vocabulary			
		We have defined our vocabulary	CCA2-M1	M
		We have shared and communicated our vocabulary	CCA2-M2	M
	Having common event definitions			
		We have defined the expectations and goals for different Agile at Scale meetings	CCA2-M3	M
		We have shared the expectations and goals for different Agile at Scale meetings	CCA2-M4	M

Map to old way of working to ease adaptation			
	Creating recognizable patterns		
	We have mapped high level management practices to the Agile approach	CCA3-X1	M/L
Keep it simple			
	Avoiding complex organizational structures		
	Our organizational structure is not very complex	CCA4-M1	M

Piloting

Success Factor	Variable	Indicator	Identifier	Who
Start with a pilot to gain acceptance				
	A pilot was conducted			
		We have conducted a successful pilot	Pi1-X1	M/L
	Acceptance and confidence was created			
		The pilot led to acceptance of Agile at Scale	Pi1-X2	M/L/E
		The pilot showed the potential of Agile at Scale	Pi1-X3	M/L/E
	Convince management			
		I am eager to use Agile at Scale	Pi1-M1	M
		I give approval for the use of Agile at Scale	Pi1-M2	M
Gather insights from a pilot				
	Identifying challenges that have to be tackled			
		We have identified relevant challenges	Pi2-L1	L
		We know how to mitigate identified challenges	Pi2-L2	L
		We have learned how to best introduce teams and managers to Agile at Scale	Pi3-L3	L
Careful transformation and sustainable planning				
	Understand the length of an organizational transformation			
		Adopting Agile is a long-term organizational change	Pi3-M1	M
		I understand that there might be a drop in velocity while going through the change	Pi3-M2	M
		We have a sustainable planning for gradual adoption	Pi3-M3	M

Training and coaching

Success Factor	Variable	Indicator	Identifier	Who
Provide training on agile methods				
	Plan professional training			
		I want to provide training for my employees	TC1-M1	M
		I want to provide all managers with training	TC1-M2	M
		We understand the value of training	TC1-X1	M/E
	Conduct training			
		Managers have had training on Agile at Scale	TC1-X2	M/T/L
		Employees have had training on Agile at Scale	TC1-X3	M/T/L
Coach teams as they learn by doing				
	Acceptance the time that it takes to learn			
		We have coaches ready for ongoing training and coaching	TC2-M1	M
		We allow teams to learn and improve	TC2-M2	M
		We don't expect teams to instantly succeed	TC2-M3	M
	Learning the right things			
		We focus on the principles of Agile at Scale, not the tools	TC2-T1	T
		We watch from a sideline and correct if necessary	TC2-T2	T
	Providing coaches			
		We make use of internal coaches	TC2-X1	M/T/L
		We make use of external coaches	TC2-X2	M/T/L

Knowledge sharing management			
Understanding the importance of knowledge sharing			
	Knowledge sharing is important for organizational change	TC3-M1	M
	Knowledge sharing is important for an Agile transformation	TC3-M2	M
	Knowledge sharing increases organizational success	TC3-M3	M
Enabling knowledge sharing			
	We provide knowledge sharing platforms	TC3-M4	M
	We encourage knowledge sharing	TC3-M5	M
	People have time to spend on knowledge sharing	TC3-X1	M/E
	We facilitate knowledge sharing	TC3-M6	M

Engaging people

Success Factor	Variable	Indicator	Identifier	Who
Start with agile supporters				
	Identifying agile supporters			
		We know who are Agile supporters	EP1-X1	M/L
	Identifying people with the right personality for change			
		We know who are willing to try something new	EP1-X2	M/L
		We know who are collaborative and understanding persons	EP1-X3	M/L
Include persons with previous agile experience				
	Ensure Agile experience in every team			
		We have someone with Agile experience in every (development) team	EP2-M1	M
Engage everyone in the organization				
	Be inclusive			
		We did a stakeholder analysis	EP3-L1	L
		We included all stakeholders in feedback meetings	EP3-L2	L
		We gained acceptance from all stakeholders	EP3-L3	L
Team encouragement				
	Understand how to encourage			
		Management knows how to encourage us	EP4-E1	E

Communication and transparency

Success Factor	Variable	Indicator	Identifier	Who
Communicate the change intensively				
	Reaching as many people as possible			
		We have communicated the change extensively over multiple channels	CT1-M1	M
		The change has been communicated intensively	CT1-E1	E
		I am very aware of the change	CT1-E2	E
		Many of my colleagues are aware of the change	CT1-E3	E
	Making it visible			
		We have communicated the change extensively over multiple channels	CT1-M2	M
		We have (almost) overcommunicated the change	CT1-M3	M
		The change has been communicated intensively	CT1-E4	E
	Communicating the goals			
		We know our expectations	CT1-M4	M
		We have communicated our expectations	CT1-M5	M
		I know what is expected from me	CT1-E5	E
		We are able to motivate the change	CT1-M6	M
		We have communicated the motivation to change	CT1-M7	M
		I know the motivation for the change	CT1-E6	E
		I agree with the motivation to change	CT1-E7	E
Make the change transparent				
	Sharing of information			
		We show and share successes	CT2-X1	M/L
		We show and share challenges	CT2-X2	M/L

	We display the status publicly	CT2-X3	M/L
Create and communicate positive experiences in the beginning			
	Generate positive word-of-mouth		
	We encourage word-of-mouth communication	CT3-M1	M
	We have a strategy to enable word-of-mouth communication	CT3-M2	M
	Celebrate (small) victories		
	We free up time to celebrate victories	CT3-M3	M
	We provide budget for celebrations	CT3-M4	M
	We value informal celebrations	CT3-X1	M/E
	Publicly compare Agile and agile at Scale		
	We have plans to compare benefits clearly	CT3-M5	M
Strong collaboration and communication between teams and team members			
	Creating an open and transparent environment		
	I can be openly critical about things	CT4-E1	E
	I can talk about problems without fear of repercussions	CT4-E2	E
	Working together and sharing knowledge		
	We hold cross-team meetings to exchange knowledge	CT4-X1	M/E
	We hold cross-team meetings to communicate progress	CT4-X2	M/E
	We have a Scrum of Scrums	CT4-M1	M
	We have Communities of Practice	CT4-X3	M/E

Mindset and Alignment

Success Factor	Variable	Indicator	Identifier	Who
Concentrate on agile values				
	Emphasizing Agile principles over practices and simple mechanics			
		We concentrate on Agile (at Scale) principles	MA1-X1	M/E/L
		Agile at Scale principles are more valuable than Agile practices	MA1-X2	M/E/L
Arrange social events				
	Understanding the goal and purpose of social events			
		Social events are there for people to help shape the new way of working	MA2-X1	M/L
		Social events can create enthusiasm for Agile	MA2-X2	M/L
		Social events can create more bonding	MA2-X3	M/L
Cherish Agile communities				
	Understanding value of Agile communities			
		Agile communities can raise awareness for Agile methods	MA3-X1	M/L
Align the organization				
	Acceptance of the change across all levels of the organization			
		The change is good for the organization	MA4-X1	Diff. layers
		I am confident in the change	MA4-X2	Diff. layers
		Higher ups have made a good decision to change	MA4-X3	Diff. layers

Cooperative organizational culture				
	Value cooperation			
		We encourage collaboration	MA5-X1	M/E
		We encourage collaboration between different hierarchy levels	MA5-X2	M/E
		Collaboration will get me further than going for my own successes	MA5-X3	M/E
Face to Face meetings				
	Enable face to face meetings			
		We encourage people to have face to face meetings	MA6-M1	M
		Face to face meetings are common	MA6-X1	M/E
		Face to face meetings are beneficial for cooperation	MA6-X2	M/E

Team autonomy

Success Factor	Variable	Indicator	Identifier	Who
Allow teams to self-organize				
	Understanding value of self-organization			
		Teams need to self-organize to properly apply Agile	TA1-X1	M/L
		Self-organization will provide voluntary improvement	TA1-M1	M
		Self-organization will ease acceptance of Agile methods	TA1-M2	M
		Teams know how to prioritize work items most efficient	TA1-X2	M/E
	Willingness to trust self-organization			
		I trust my teams with prioritizing their work properly	TA1-M3	M
		I trust my teams to apply Agile methods most effective for them	TA1-M4	M
Allow grass roots level empowerment				
	Management's understanding that top-down mandate can be ineffective			
		Change works best when it is not forced	TA2-M1	M

Requirements management

Success Factor	Variable	Indicator	Identifier	Who
Recognize the importance of the Product Owner role				
	Understanding the Product owners value and impact			
		Being a product owner is a dedicated role that someone should fulfill	RM1-X1	M/T
		The quality of the implementation of the PO role effects team performance	RM1-X2	M/T
	Providing training to ensure proper implementation			
		We will provide dedicated Agile at Scale training	RM1-X3	M/T
Invest in learning to refine the requirements				
	Understand the difficulty of requirement engineering			
		It can be hard to go from high level requirements to user stories	RM2-M1	M
		Adding multiple layers of requirements is beneficial	RM2-M2	M
		Training on requirements engineering is needed	RM2-X1	M/T

Technology support

Success Factor	Variable	Indicator	Identifier	Who
(Automated) tools and infrastructure				
	Development			
		We have automated tests	TS1-X1	M/E
		We have continuous integration	TS1-X2	M/E
		Our development environment supports distributed development	TS1-X3	M/E
		The organization shares these tools	TS1-X4	M/E
		Different parts of the organization use different tools	TS1-X5	M/E
	Communication			
		A good communication infrastructure is needed for succesful change	TS1-M1	M
		Videoconferencing infrastructure is needed for distributed development	TS1-M2	M
		I am willing to invest into better communication	TS1-M3	M
Solid engineering practices				
	Awareness			
		I understand that there might be a drop in velocity while going through the change	TS2-M1	M
	Mitigation			
		We have methods in place for technical debt management	TS2-X1	M/E
		We have plans to deal with the drop in velocity	TS2-M2	M
		QA is necessary to be added to teams	TS2-M3	M

	We have clearly defined tolerance levels for quality	TS2-X2	M/E
	We have clearly defined tolerance levels for velocity	TS2-X3	M/E
	We have visual indicators to keep an eye on tolerance levels	TS2-X4	M/E
Quality production using pair programming			
	Applying pair programming		
	We do pair programming	TS3-X1	M/E

Customer

Success Factor	Variable	Indicator	Identifier	Who
Customer satisfaction				
	Making sure the customer is feeling heard			
		Our customers are stakeholders in our project	Cu1-M1	M
	Making the customer understand that the change is good			
		We intent to convince our customers of the upcoming change	Cu1-M2	M
		We intent to convince our customers that the upcoming change is good for them	Cu1-M3	M
Strong collaboration with customer				
	Communicating change with customers			
		We intent to tell our customers of the upcoming change	CU2-M1	M
	Incorporating customers in the change			
		We intent to continuously keep our customers involved in the change	CU2-M2	M
		We understand that the change will impact the customer	CU2-M3	M
		We need to figure out how to shape the change so that it works for both us as our customers	CU2-M4	M

Other

Success Factor	Variable	Indicator	Identifier	Who
Risk management				
	Executing risk management			
		The change is complex and brings risks	Ot1-M1	M
		We intent to do dedicated risk management	Ot1-M2	M
		Proper risk management will decide the success of the change	Ot1-M3	M

Appendix D. Initial ASRM questionnaires

Management questionnaire

Code	Indicator	Score				
		1	2	3	4	5
MS1-M1	I am aware of what Agile at Scale will bring our organization					
MS1-M2	I am aware of the impact Agile at Scale will have on our organization					
MS1-M3	I am confident that Agile at Scale is the right thing to do					
MS1-M4	I am confident that the transformation will be a success					
MS1-M5	I am aware of the time and effort that the transformation will take					
MS1-M6	I am willing to provide the resources for the transformation					
MS2-M1	I support the transformation openly					
MS2-M2	I have communicated management support clearly to our employees					
MS3-M1	I have had agile training					
MS3-M2	I know the agile principles					
CC1-M1	The change is non-negotiable					
CC1-M2	I have communicated that the change is non-negotiable					
CC2-X1	I think that the change is necessary					
CC2-X2	I am committed to make the change a success					
CC2-X3	The change is manageable					
Le1-M1	We need someone that leads the change					
Le1-M2	Change requires expertise					
Le1-X1	We have a dedicated change leader					
Le1-X2	We have a motivated change leader					
Le2-X1	We have an external/freshly hired change leader					

Le3-M1	We have a leadership team responsible for the change					
Le3-M2	The dedicated leadership team is motivated					
CCA1-M1	Will you allow teams to customize agile to their fit?					
CCA1-M2	Do you allow a pragmatic way to adopt Agile at Scale?					
CCA1-M3	Customization per project might be needed					
CCA1-M4	Different types of project and software might need different types of customization					
CCA1-X1	Adopting and customizing Agile at Scale is an evolutionary process					
CCA1-X2	Adopting Agile and Scale is an ongoing process					
CCA2-M1	We have defined our vocabulary					
CCA2-M2	We have shared and communicated our vocabulary					
CCA2-M3	We have defined the expectations and goals for different Agile at Scale meetings					
CCA2-M4	We have shared the expectations and goals for different Agile at Scale meetings					
CCA3-X1	We have mapped high level management practices to the Agile approach					
CCA4-M1	Our organizational structure is not very complex					
Pi1-X1	We have conducted a successful pilot					
Pi1-X2	The pilot led to acceptance of Agile at Scale					
Pi1-X3	The pilot showed the potential of Agile at Scale					
Pi1-M1	I am eager to use Agile at Scale					
Pi1-M2	I give approval for the use of Agile at Scale					
Pi3-M1	Adopting Agile is a long-term organizational change					
Pi3-M2	I understand that there might be a drop in velocity while going through the change					
Pi3-M3	We have a sustainable planning for gradual adoption					
TC1-M1	I want to provide training for my employees					
TC1-M2	I want to provide all managers with training					
TC1-X1	We understand the value of training					

TC1-X2	Managers have had training on Agile at Scale					
TC1-X3	Employees have had training on Agile at Scale					
TC2-M1	We have coaches ready for ongoing training and coaching					
TC2-M2	We allow teams to learn and improve					
TC2-M3	We don't expect teams to instantly succeed					
TC2-X1	We make use of internal coaches					
TC2-X2	We make use of external coaches					
TC3-M1	Knowledge sharing is important for organizational change					
TC3-M2	Knowledge sharing is important for an Agile transformation					
TC3-M3	Knowledge sharing increases organizational success					
TC3-M4	We provide knowledge sharing platforms					
TC3-M5	We encourage knowledge sharing					
TC3-X1	People have time to spend on knowledge sharing					
TC3-M6	We facilitate knowledge sharing					
EP1-X1	We know who are Agile supporters					
EP1-X2	We know who are willing to try something new					
EP1-X3	We know who are collaborative and understanding persons					
EP2-M1	We have someone with Agile experience in every (development) team					
CT1-M1	We have communicated the change extensively over multiple channels					
CT1-M2	We have communicated the change extensively over multiple channels					
CT1-M3	We have (almost) overcommunicated the change					
CT1-M4	We know our expectations					
CT1-M5	We have communicated our expectations					
CT1-M6	We are able to motivate the change					
CT1-M7	We have communicated the motivation to change					

CT2-X1	We show and share successes					
CT2-X2	We show and share challenges					
CT2-X3	We display the status publicly					
CT3-M1	We encourage word-of-mouth communication					
CT3-M2	We have a strategy to enable word-of-mouth communication					
CT3-M3	We free up time to celebrate victories					
CT3-M4	We provide budget for celebrations					
CT3-X1	We value informal celebrations					
CT3-M5	We have plans to compare benefits clearly					
CT4-X1	We hold cross-team meetings to exchange knowledge					
CT4-X2	We hold cross-team meetings to communicate progress					
CT4-M1	We have a Scrum of Scrums					
CT4-X3	We have Communities of Practice					
MA1-X1	We concentrate on Agile (at Scale) principles					
MA1-X2	Agile at Scale principles are more valuable than Agile practices					
MA2-X1	Social events are there for people to help shape the new way of working					
MA2-X2	Social events can create enthusiasm for Agile					
MA2-X3	Social events can create more bonding					
MA3-X1	Agile communities can raise awareness for Agile methods					
MA4-X1	The change is good for the organization					
MA4-X2	I am confident in the change					
MA4-X3	Higher ups have made a good decision to change					
MA5-X1	We encourage collaboration					
MA5-X2	We encourage collaboration between different hierarchy levels					
MA5-X3	Collaboration will get me further than going for my own successes					

MA6-M1	We encourage people to have face to face meetings					
MA6-X1	Face to face meetings are common					
MA6-X2	Face to face meetings are beneficial for cooperation					
TA1-X1	Teams need to self-organize to properly apply Agile					
TA1-M1	Self-organization will provide voluntary improvement					
TA1-M2	Self-organization will ease acceptance of Agile methods					
TA1-X2	Teams know how to prioritize work items most efficient					
TA1-M3	I trust my teams with prioritizing their work properly					
TA1-M4	I trust my teams to apply Agile methods most effective for them					
TA2-M1	Change works best when it is not forced					
RM1-X1	Being a product owner is a dedicated role that someone should fulfill					
RM1-X2	The quality of the implementation of the PO role effects team performance					
RM1-X3	We will provide dedicated Agile at Scale training					
RM2-M1	It can be hard to go from high level requirements to user stories					
RM2-M2	Adding multiple layers of requirements is beneficial					
RM2-X1	Training on requirements engineering is needed					
TS1-X1	We have automated tests					
TS1-X2	We have continuous integration					
TS1-X3	Our development environment supports distributed development					
TS1-X4	The organization shares these tools					
TS1-X5	Different parts of the organization use different tools					
TS1-M1	A good communication infrastructure is needed for successful change					
TS1-M2	Videoconferencing infrastructure is needed for distributed development					
TS1-M3	I am willing to invest into better communication					
TS2-M1	I understand that there might be a drop in velocity while going through the change					

TS2-X1	We have methods in place for technical debt management					
TS2-M2	We have plans to deal with the drop in velocity					
TS2-M3	QA is necessary to be added to teams					
TS2-X2	We have clearly defined tolerance levels for quality					
TS2-X3	We have clearly defined tolerance levels for velocity					
TS2-X4	We have visual indicators to keep an eye on tolerance levels					
TS3-X1	We do pair programming					
Cu1-M1	Our customers are stakeholders in our project					
Cu1-M2	We intent to convince our customers of the upcoming change					
Cu1-M3	We intent to convince our customers that the upcoming change is good for them					
CU2-M1	We intent to tell our customers of the upcoming change					
CU2-M2	We intent to continuously keep our customers involved in the change					
CU2-M3	We understand that the change will impact the customer					
CU2-M4	We need to figure out how to shape the change so that it works for both us as our customers					
Ot1-M1	The change is complex and brings risks					
Ot1-M2	We intent to do dedicated risk management					
Ot1-M3	Proper risk management will decide the success of the change					

Employee questionnaire

Indicator		Score				
		1	2	3	4	5
MS2-E1	Management is supporting of the transformation to Agile at Scale					
CC1-E1	I am aware that the change is non-negotiable					
CC2-X1	I think that the change is necessary					
CC2-X2	I am committed to make the change a success					
CC2-X3	The change is manageable					
CC2-E2	I trust that management is making the right decision					
Le1-X1	We have a dedicated change leader					
Le1-X2	We have a motivated change leader					
Le2-X1	We have an external/freshly hired change leader					
CCA1-X1	Adopting and customizing Agile at Scale is an evolutionary process					
CCA1-X2	Adopting Agile and Scale is an ongoing process					
TC1-X1	We understand the value of training					
TC3-X1	People have time to spend on knowledge sharing					
EP4-E1	Management knows how to encourage us					
CT1-E1	The change has been communicated intensively					
CT1-E2	I am very aware of the change					
CT1-E4	The change has been communicated intensively					
CT1-E5	I know what is expected from me					
CT1-E6	I know the motivation for the change					
CT1-E7	I agree with the motivation to change					
CT3-X1	We value informal celebrations					
CT4-E1	I can be openly critical about things					

CT4-E2	I can talk about problems without fear of repercussions					
CT4-X1	We hold cross-team meetings to exchange knowledge					
CT4-X2	We hold cross-team meetings to communicate progress					
CT4-X3	We have Communities of Practice					
MA1-X1	We concentrate on Agile (at Scale) principles					
MA1-X2	Agile at Scale principles are more valuable than Agile practices					
MA4-X1	The change is good for the organization					
MA4-X2	I am confident in the change					
MA4-X3	Higher ups have made a good decision to change					
MA5-X1	We encourage collaboration					
MA5-X2	We encourage collaboration between different hierarchy levels					
MA5-X3	Collaboration will get me further than going for my own successes					
MA6-X1	Face to face meetings are common					
MA6-X2	Face to face meetings are beneficial for cooperation					
TA1-X2	Teams know how to prioritize work items most efficient					
TS1-X1	We have automated tests					
TS1-X2	We have continuous integration					
TS1-X3	Our development environment supports distributed development					
TS1-X4	The organization shares these tools					
TS1-X5	Different parts of the organization use different tools					
TS2-X1	We have methods in place for technical debt management					
TS2-X2	We have clearly defined tolerance levels for quality					
TS2-X3	We have clearly defined tolerance levels for velocity					
TS2-X4	We have visual indicators to keep an eye on tolerance levels					
TS3-X1	We do pair programming					

Change leader questionnaire

Indicator		Score				
		1	2	3	4	5
CCA3-X1	We have mapped high level management practices to the Agile approach					
Pi1-X1	We have conducted a successful pilot					
Pi1-X2	The pilot led to acceptance of Agile at Scale					
Pi1-X3	The pilot showed the potential of Agile at Scale					
Pi2-L1	We have identified relevant challenges					
Pi2-L2	We know how to mitigate identified challenges					
Pi3-L3	We have learned how to best introduce teams and managers to Agile at Scale					
TC1-X2	Managers have had training on Agile at Scale					
TC1-X3	Employees have had training on Agile at Scale					
TC2-X1	We make use of internal coaches					
TC2-X2	We make use of external coaches					
EP3-L1	We did a stakeholder analysis					
EP3-L2	We included all stakeholders in feedback meetings					
EP3-L3	We gained acceptance from all stakeholders					
CT2-X1	We show and share successes					
CT2-X2	We show and share challenges					
CT2-X3	We display the status publicly					
MA1-X1	We concentrate on Agile (at Scale) principles					
MA1-X2	Agile at Scale principles are more valuable than Agile practices					
MA2-X1	Social events are there for people to help shape the new way of working					
MA2-X2	Social events can create enthusiasm for Agile					
MA2-X3	Social events can create more bonding					

MA3-X1	Agile communities can raise awareness for Agile methods					
TA1-X1	Teams need to self-organize to properly apply Agile					

Trainer questionnaire

Indicator		Score				
		1	2	3	4	5
TC1-X2	Managers have had training on Agile at Scale					
TC1-X3	Employees have had training on Agile at Scale					
TC2-T1	We focus on the principles of Agile at Scale, not the tools					
TC2-T2	We watch from a sideline and correct if necessary					
TC2-X1	We make use of internal coaches					
TC2-X2	We make use of external coaches					
RM1-X1	Being a product owner is a dedicated role that someone should fulfill					
RM1-X2	The quality of the implementation of the PO role effects team performance					
RM1-X3	We will provide dedicated Agile at Scale training					
RM2-X1	Training on requirements engineering is needed					

Appendix E. Validation questionnaire

Constructs of CSF-variables-indicators

What is your opinion on the construct of getting from CSFs to variables to indicators? Do you think this approach works?

Reasoning behind the model's structure

What is your opinion on how the assessment comes to its conclusion?

- What do you think of the weighting of the factors
- Do you think that giving a grade/mark/doing a calculation is a correct way?
- Do you think that indicators are the correct way to do the assessment? Or should other methods to gather date be used?

Missing variables

What do you think of the identified variables?

- Are some missing?
- Are some wrong?
- Are there too many/too little?
- What do you think about the way to get from CSF to variables?

Missing CSFs

What do you think about the found critical success factors?

- Are some unexpected?
- Are some missing?
- Do some stand out?
- What do you think about the weighting and frequency of some of the critical success factors? Is this surprising to you or not at all?

Missing indicators

What do you think of the identified variables?

- Are some missing?
- Are some wrong?
- Are there too many/too little?
- What do you think about the way to get from variables to indicators?
- Do you think we missed any role to ask questions to?
- Do you think that some roles are asked too little/too much?

Readiness levels

What is your opinion on the defined readiness levels?

- Is there a clear line between ready and not?
- Should they be renamed?
- Do you think they cover the correct stages?
- Does getting an average mark to decide the level make sense?

Knockout criteria

- Would it be logical to have knockout criteria?
- Should certain success factors be at certain levels?
- What about the idea that no CSF may be 1 level lower than the average?
- Do you think that some CSFs are detrimental to being ready for Agile at Scale?

Appendix F. UTAUT questionnaire

Original UTAUT questions

Performance expectancy

- I would find the system useful in my job.
- Using the system enables me to accomplish tasks more quickly.
- Using the system increases my productivity.
- If I use the system, I will increase my chances of getting a raise.

Effort expectancy

- My interaction with the system would be clear and understandable.
- It would be easy for me to become skillful at using the system.
- I would find the system easy to use.
- Learning to operate the system is easy for me.

Social influence

- People who influence my behavior think that I should use the system.
- People who are important to me think that I should use the system.
- The senior management of this business has been helpful in the use of the system.
- In general, the organization has supported the use of the system.

Facilitating conditions

- I have the resources necessary to use the system.
- I have the knowledge necessary to use the system.
- The system is not compatible with other systems I use.
- A specific person (or group) is available for assistance with system difficulties.

Adapted UTAUT questions

Performance expectancy

- I would find the model useful in *an Agile at Scale adoption.*
- Using the model enables me to accomplish *an Agile at Scale adoption* more quickly.
- Using the model *increases the speed of Agile at Scale adoption.*
- If I use the model, I will increase my chances of getting a raise.

Effort expectancy

- My interaction with the model would be clear and understandable.
- I would find the model easy to use.
- Learning to *use* the model is easy for me.

Social influence

- People who influence my behavior think that I should use the model.
- People who are important to me think that I should use the model.
- The senior management of this business will *support* in the use of the model.
- In general, the organization *will support* the use of the model.

Facilitating conditions

- I have the resources necessary to use the model.
- I have the knowledge necessary to use the model.
- A specific person (or group) is available for assistance with model difficulties.

Control questions

The first three questions are considered with one's experience, while the fourth question is targeted at one's voluntariness of use.

1. What is your job/function?
2. How many years of experience do you have with Agile?
3. How many years of experience do you have with Agile at Scale?
4. Whenever you apply a new model, theory, way of working, method, system or anything similar in your job, is that often voluntary and by your own initiative or often pushed by management?

Appendix G. General Manager interview questions

- What is your view on the use of a assessment models such as ASRM?
- What are the first things that come to mind when being introduced to ASRM?
- Would you want that ASRM to be used at Topicus when another part of the organization will adopt Agile at Scale?
- Would ASRM make it easier to make decisions?
- What is your view on the proof of concept and the visualization possibilities?
- What is your view on the use of ASRM Lite?

Appendix H. Final ASRM variables and indicators

Management support

Success Factor	Variable	Indicator	Identifier	Who
Ensure management support				
	Management understands value			
		I am aware of what Agile at Scale will bring our organization	MS1-M1	M
		I am aware of the impact Agile at Scale will have on our organization	MS1-M2	M
		I am confident that Agile at Scale is the right thing to do	MS1-M3	M
		I am confident that the transformation will be a success	MS1-M4	M
	Management provides resources			
		I am aware of the time and effort that the transformation will take	MS1-M5	M
		I am willing to provide the resources for the transformation	MS1-M6	M
Make management support visible				
	Management communicates support			
		I support the transformation openly	MS2-M1	M
		I have communicated management support clearly to our employees	MS2-M2	M

	Employees experience management support		
	Management is supporting of the transformation to Agile at Scale	MS2-E1	E
Educate management on agile			
	Management has had Agile (at Scale) training		
	I have had agile training	MS3-M1	M
	I know the agile principles	MS3-M2	M
Have strategic alignment			
	The change is part of the organizational strategy		
	Changing to Agile at Scale is part of our strategy	MS4-M1	M

Commitment to change

Success Factor	Variable	Indicator	Identifier	Who
Show strong commitment				
	The change is necessary			
		I think that the change is necessary	MS2-M1	M/E
		I am committed to make the change a success	MS2-M2	M/E
	The change is achievable			
		The change is manageable	CC2-X3	M/E
		I trust that management is making the right decision	CC2-E2	E

Leadership

Success Factor	Variable	Indicator	Identifier	Who
Recognize the importance of change leaders				
	Understanding the impact of the change			
		We need someone that leads the change	Le1-M1	M
		Change requires expertise	Le1-M2	M
	Understanding the value of organized change			
		We have a dedicated change leader	Le1-X1	M/E
		We have a motivated change leader	Le1-X2	M/E
Engage change leaders without baggage of the past				
	Adopting change leaders with a fresh view			
		We have an external/freshly hired change leader	Le2-X1	M/E
Dedicated Leadership				
	Being responsible for the change			
		We have a leadership team responsible for the change	Le3-M1	M
		The dedicated leadership team is motivated	Le3-M2	M

Choosing and customizing the Agile approach

Success Factor	Variable	Indicator	Identifier	Who
Customize the agile approach carefully				
	Team customization			
		Will you allow teams to customize agile to their fit?	CCA1-M1	M
		Do you allow a pragmatic way to adopt Agile at Scale?	CCA1-M2	M
	Project/train customization			
		Customization per project might be needed	CCA1-M3	M
		Different types of project and software might need different types of customization	CCA1-M4	M
	Evolutionary process			
		Adopting and customizing Agile at Scale is an evolutionary process	CCA1-X1	M/E
		Adopting Agile and Scale is an ongoing process	CCA1-X2	M/E
Conform to a single approach				
	Having common vocabulary			
		We have defined our vocabulary	CCA2-M1	M
		We have shared and communicated our vocabulary	CCA2-M2	M
	Having common event definitions			
		We have defined the expectations and goals for different Agile at Scale meetings	CCA2-M3	M
		We have shared the expectations and goals for different Agile at Scale meetings	CCA2-M4	M

Map to old way of working to ease adaptation			
	Creating recognizable patterns		
	We have mapped high level management practices to the Agile approach	CCA3-X1	M/L
Keep it simple			
	Avoiding complex organizational structures		
	Our organizational structure is not very complex	CCA4-M1	M

Piloting

Success Factor	Variable	Indicator	Identifier	Who
Start with a pilot to gain acceptance				
	A pilot was conducted			
		We have conducted a successful pilot	Pi1-X1	M/L
	Acceptance and confidence was created			
		The pilot led to acceptance of Agile at Scale	Pi1-X2	M/L/E
		The pilot showed the potential of Agile at Scale	Pi1-X3	M/L/E
	Convince management			
		I am eager to use Agile at Scale	Pi1-M1	M
		I give approval for the use of Agile at Scale	Pi1-M2	M
Gather insights from a pilot				
	Identifying challenges that have to be tackled			
		We have identified relevant challenges	Pi2-L1	L
		We know how to mitigate identified challenges	Pi2-L2	L
		We have learned how to best introduce teams and managers to Agile at Scale	Pi3-L3	L
Careful transformation and sustainable planning				
	Understand the length of an organizational transformation			
		Adopting Agile is a long-term organizational change	Pi3-M1	M
		I understand that there might be a drop in velocity while going through the change	Pi3-M2	M
		We have a sustainable planning for gradual adoption	Pi3-M3	M
Have goals, milestones and KPIs of the change defined				
	Defined goals, milestones and KPIs			
		We have defined our goals, milestones and KPIs	Pi4-M1	M

Training and coaching

Success Factor	Variable	Indicator	Identifier	Who
Provide training on agile methods				
	Plan professional training			
		I want to provide training for my employees	TC1-M1	M
		I want to provide all managers with training	TC1-M2	M
		We understand the value of training	TC1-X1	M/E
	Conduct training			
		Managers have had training on Agile at Scale	TC1-X2	M/T/L
		Employees have had training on Agile at Scale	TC1-X3	M/T/L
Coach teams as they learn by doing				
	Acceptance the time that it takes to learn			
		We have coaches ready for ongoing training and coaching	TC2-M1	M
		We allow teams to learn and improve	TC2-M2	M
		We don't expect teams to instantly succeed	TC2-M3	M
	Learning the right things			
		We focus on the principles of Agile at Scale, not the tools	TC2-T1	T
		We watch from a sideline and correct if necessary	TC2-T2	T
	Providing coaches			
		We make use of internal coaches	TC2-X1	M/T/L
		We make use of external coaches	TC2-X2	M/T/L

Knowledge sharing management			
Understanding the importance of knowledge sharing			
	Knowledge sharing is important for organizational change	TC3-M1	M
	Knowledge sharing is important for an Agile transformation	TC3-M2	M
	Knowledge sharing increases organizational success	TC3-M3	M
Enabling knowledge sharing			
	We provide knowledge sharing platforms	TC3-M4	M
	We encourage knowledge sharing	TC3-M5	M
	People have time to spend on knowledge sharing	TC3-X1	M/E
	We facilitate knowledge sharing	TC3-M6	M

Engaging people

Success Factor	Variable	Indicator	Identifier	Who
Start with agile supporters				
	Identifying agile supporters			
		We know who are Agile supporters	EP1-X1	M/L
	Identifying people with the right personality for change			
		We know who are willing to try something new	EP1-X2	M/L
		We know who are collaborative and understanding persons	EP1-X3	M/L
Include persons with previous agile experience				
	Ensure Agile experience in every team			
		We have someone with Agile experience in every (development) team	EP2-M1	M
Engage everyone in the organization				
	Be inclusive			
		We did a stakeholder analysis	EP3-L1	L
		We included all stakeholders in feedback meetings	EP3-L2	L
		We gained acceptance from all stakeholders	EP3-L3	L
Team encouragement				
	Understand how to encourage			
		Management knows how to encourage us	EP4-E1	E

Communication and transparency

Success Factor	Variable	Indicator	Identifier	Who
Communicate the change intensively				
	Reaching as many people as possible			
		We have communicated the change extensively over multiple channels	CT1-M1	M
		The change has been communicated intensively	CT1-E1	E
		I am very aware of the change	CT1-E2	E
		Many of my colleagues are aware of the change	CT1-E3	E
	Making it visible			
		We have communicated the change extensively over multiple channels	CT1-M2	M
		We have (almost) overcommunicated the change	CT1-M3	M
		The change has been communicated intensively	CT1-E4	E
	Communicating the goals			
		We know our expectations	CT1-M4	M
		We have communicated our expectations	CT1-M5	M
		I know what is expected from me	CT1-E5	E
		We are able to motivate the change	CT1-M6	M
		We have communicated the motivation to change	CT1-M7	M
		I know the motivation for the change	CT1-E6	E
		I agree with the motivation to change	CT1-E7	E
Make the change transparent				
	Sharing of information			
		We show and share successes	CT2-X1	M/L
		We show and share challenges	CT2-X2	M/L

	We display the status publicly	CT2-X3	M/L
Create and communicate positive experiences in the beginning			
	Generate positive word-of-mouth		
	We encourage word-of-mouth communication	CT3-M1	M
	We have a strategy to enable word-of-mouth communication	CT3-M2	M
	Celebrate (small) victories		
	We free up time to celebrate victories	CT3-M3	M
	We provide budget for celebrations	CT3-M4	M
	We value informal celebrations	CT3-X1	M/E
	Publicly compare Agile and agile at Scale		
	We have plans to compare benefits clearly	CT3-M5	M
Strong collaboration and communication between teams and team members			
	Creating an open and transparent environment		
	I can be openly critical about things	CT4-E1	E
	I can talk about problems without fear of repercussions	CT4-E2	E
	Working together and sharing knowledge		
	We hold cross-team meetings to exchange knowledge	CT4-X1	M/E
	We hold cross-team meetings to communicate progress	CT4-X2	M/E
	We have a Scrum of Scrums	CT4-M1	M
	We have Communities of Practice	CT4-X3	M/E
Keep reminding why the adoption and change is taking place			
	Motivate the change		

	The motivation for the change has been communicated	CT1-X5	M/E

Mindset and Alignment

Success Factor	Variable	Indicator	Identifier	Who
Concentrate on agile values				
	Emphasizing Agile principles over practices and simple mechanics			
		We concentrate on Agile (at Scale) principles	MA1-X1	M/E/L
		Agile at Scale principles are more valuable than Agile practices	MA1-X2	M/E/L
Arrange social events				
	Understanding the goal and purpose of social events			
		Social events are there for people to help shape the new way of working	MA2-X1	M/L
		Social events can create enthusiasm for Agile	MA2-X2	M/L
		Social events can create more bonding	MA2-X3	M/L
Cherish Agile communities				
	Understanding value of Agile communities			
		Agile communities can raise awareness for Agile methods	MA3-X1	M/L
Align the organization				
	Acceptance of the change across all levels of the organization			
		The change is good for the organization	MA4-X1	Diff. layers
		I am confident in the change	MA4-X2	Diff. layers
		Higher ups have made a good decision to change	MA4-X3	Diff. layers

Cooperative organizational culture			
	Value cooperation		
	We encourage collaboration	MA5-X1	M/E
	We encourage collaboration between different hierarchy levels	MA5-X2	M/E
	Collaboration will get me further than going for my own successes	MA5-X3	M/E
Face to Face meetings			
	Enable face to face meetings		
	We encourage people to have face to face meetings	MA6-M1	M
	Face to face meetings are common	MA6-X1	M/E
	Face to face meetings are beneficial for cooperation	MA6-X2	M/E
Have cohesion between teams			
	Cherish cohesion		
	Teams are often working together and helping each other out	MA7-E1	E

Team autonomy

Success Factor	Variable	Indicator	Identifier	Who
Allow teams to self-organize				
	Understanding value of self-organization			
		Teams need to self-organize to properly apply Agile	TA1-X1	M/L
		Self-organization will provide voluntary improvement	TA1-M1	M
		Self-organization will ease acceptance of Agile methods	TA1-M2	M
		Teams know how to prioritize work items most efficient	TA1-X2	M/E
	Willingness to trust self-organization			
		I trust my teams with prioritizing their work properly	TA1-M3	M
		I trust my teams to apply Agile methods most effective for them	TA1-M4	M
Allow grass roots level empowerment				
	Management's understanding that top-down mandate can be ineffective			
		Change works best when it is not forced	TA2-M1	M

Requirements management

Success Factor	Variable	Indicator	Identifier	Who
Recognize the importance of the Product Owner role				
	Understanding the Product owners value and impact			
		Being a product owner is a dedicated role that someone should fulfill	RM1-X1	M/T
		The quality of the implementation of the PO role effects team performance	RM1-X2	M/T
	Providing training to ensure proper implementation			
		We will provide dedicated Agile at Scale training	RM1-X3	M/T
Invest in learning to refine the requirements				
	Understand the difficulty of requirement engineering			
		It can be hard to go from high level requirements to user stories	RM2-M1	M
		Adding multiple layers of requirements is beneficial	RM2-M2	M
		Training on requirements engineering is needed	RM2-X1	M/T

Technology support

Success Factor	Variable	Indicator	Identifier	Who
(Automated) tools and infrastructure				
	Development			
		We have automated tests	TS1-X1	M/E
		We have continuous integration	TS1-X2	M/E
		Our development environment supports distributed development	TS1-X3	M/E
		The organization shares these tools	TS1-X4	M/E
		Different parts of the organization use different tools	TS1-X5	M/E
	Communication			
		A good communication infrastructure is needed for succesful change	TS1-M1	M
		Videoconferencing infrastructure is needed for distributed development	TS1-M2	M
		I am willing to invest into better communication	TS1-M3	M
Solid engineering practices				
	Awareness			
		I understand that there might be a drop in velocity while going through the change	TS2-M1	M
	Mitigation			
		We have methods in place for technical debt management	TS2-X1	M/E
		We have plans to deal with the drop in velocity	TS2-M2	M
		QA is necessary to be added to teams	TS2-M3	M

	We have clearly defined tolerance levels for quality	TS2-X2	M/E
	We have clearly defined tolerance levels for velocity	TS2-X3	M/E
	We have visual indicators to keep an eye on tolerance levels	TS2-X4	M/E
Have the proper software and team architecture that allows you to scale			
	Do not have a big 'monolith'		
	Our software is build up out of components	TS3-E1	E
	Teams can work individually on different components	TS3-E2	E

Customer

Success Factor	Variable	Indicator	Identifier	Who
Customer satisfaction				
	Making sure the customer is feeling heard			
		Our customers are stakeholders in our project	Cu1-M1	M
	Making the customer understand that the change is good			
		We intent to convince our customers of the upcoming change	Cu1-M2	M
		We intent to convince our customers that the upcoming change is good for them	Cu1-M3	M
Strong collaboration with customer				
	Communicating change with customers			
		We intent to tell our customers of the upcoming change	CU2-M1	M
	Incorporating customers in the change			
		We intent to continuously keep our customers involved in the change	CU2-M2	M
		We understand that the change will impact the customer	CU2-M3	M
		We need to figure out how to shape the change so that it works for both us as our customers	CU2-M4	M

Other

Success Factor	Variable	Indicator	Identifier	Who
Risk management				
	Executing risk management			
		The change is complex and brings risks	Ot1-M1	M
		We intent to do dedicated risk management	Ot1-M2	M
		Proper risk management will decide the success of the change	Ot1-M3	M

Appendix I. Final ASRM questionnaires

Management questionnaire

Code	Indicator	Score				
		1	2	3	4	5
MS1-M1	I am aware of what Agile at Scale will bring our organization					
MS1-M2	I am aware of the impact Agile at Scale will have on our organization					
MS1-M3	I am confident that Agile at Scale is the right thing to do					
MS1-M4	I am confident that the transformation will be a success					
MS1-M5	I am aware of the time and effort that the transformation will take					
MS1-M6	I am willing to provide the resources for the transformation					
MS2-M1	I support the transformation openly					
MS2-M2	I have communicated management support clearly to our employees					
MS3-M1	I have had agile training					
MS3-M2	I know the agile principles					
MS3-X1	Management has had Agile at Scale training					
MS4-M1	Changing to Agile at Scale is part of our strategy					
CC1-X1	I think that the change is necessary					
CC1-X2	I am committed to make the change a success					
CC1-X3	The change is manageable					
Le1-M1	We need someone that leads the change					
Le1-M2	Change requires expertise					
Le1-X1	We have a dedicated change leader					
Le1-X2	We have a motivated change leader					
Le2-X1	We have an external/freshly hired change leader					

Le3-M1	We have a leadership team responsible for the change					
Le3-M2	The dedicated leadership team is motivated					
CCA1-X1	Teams will be allowed to customize agile to their fit					
CCA1-X2	Teams are allowed a pragmatic way to adopt Agile at Scale					
CCA1-M1	Customization per project might be needed					
CCA1-M2	Different types of project and software might need different types of customization					
CCA1-X3	Adopting and customizing Agile at Scale is an evolutionary process					
CCA1-X4	Adopting Agile and Scale is an ongoing process					
CCA2-X1	We have defined our vocabulary					
CCA2-X2	We have shared and communicated our vocabulary					
CCA2-M1	We have defined the expectations and goals for different Agile at Scale meetings					
CCA2-X3	We have shared the expectations and goals for different Agile at Scale meetings					
CCA3-X1	We have mapped high level management practices to the Agile approach					
CCA4-X1	Our organizational structure is not very complex					
Pi1-X1	We have conducted a successful pilot					
Pi1-X2	The pilot led to acceptance of Agile at Scale					
Pi1-X3	The pilot showed the potential of Agile at Scale					
Pi1-M1	I am eager to use Agile at Scale					
Pi1-M2	I give approval for the use of Agile at Scale					
Pi3-M1	Adopting Agile is a long-term organizational change					
Pi3-M2	I understand that there might be a drop in velocity while going through the change					
Pi3-M3	We have a sustainable planning for gradual adoption					
Pi4-M1	We have defined our goals, milestones and KPIs					
TC1-M1	I want to provide training for my employees					
TC1-M2	I want to provide all managers with training					

TC1-X1	We understand the value of training					
TC1-X3	Employees have had training on Agile at Scale					
TC2-M1	We have coaches ready for ongoing training and coaching					
TC2-X1	Teams are allowed to learn and improve over time					
TC2-X2	Teams are not expected to succeed instantly					
TC2-X3	We make use of internal coaches					
TC2-X4	We make use of external coaches					
TC3-M1	Knowledge sharing is important for organizational change					
TC3-M2	Knowledge sharing is important for an Agile transformation					
TC3-M3	Knowledge sharing increases organizational success					
TC3-X1	Knowledge sharing platforms are provided					
TC3-X2	Knowledge sharing is encouraged					
TC3-X3	People have time to spend on knowledge sharing					
EP1-X1	We know who are Agile supporters					
EP1-X2	We know who are willing to try something new					
EP1-X3	We know who are collaborative and understanding persons					
EP2-M1	We have someone with Agile experience in every (development) team					
CT1-X1	The change has been communicated intensively over multiple channels					
CT1-X2	The change has almost been overcommunicated					
CT1-M3	We have (almost) overcommunicated the change					
CT1-X3	Expectations are clear					
CT1-X4	Expectations are communicated					
CT1-X5	The motivation for the change has been communicated					
CT2-X1	Successes are shown and shared					
CT2-X2	Challenges are shown and shared					

CT2-X3	The status of the change is communicated openly					
CT3-X1	Word-of-mouth communication is encouraged					
CT3-M1	We have a strategy to enable word-of-mouth communication					
CT3-X2	Time is freed up to celebrate victories					
CT3-M2	We provide budget for celebrations					
CT3-X3	We value informal celebrations					
CT3-M3	We have plans to compare benefits clearly					
CT4-X1	We hold cross-team meetings to communicate progress					
CT4-M1	We have a Scrum of Scrums					
CT4-X2	We have Communities of Practice					
MA1-X1	We concentrate on Agile (at Scale) principles					
MA1-X2	Agile at Scale principles are more valuable than Agile practices					
MA2-X1	Social events are there for people to help shape the new way of working					
MA2-X2	Social events can create enthusiasm for Agile					
MA2-X3	Social events can create more bonding					
MA3-X1	Agile communities can raise awareness for Agile methods					
MA4-X1	The change is good for the organization					
MA4-X2	I am confident in the change					
MA4-X3	Higher ups have made a good decision to change					
MA5-X1	We encourage collaboration					
MA5-X2	We encourage collaboration between different hierarchy levels					
MA5-X3	Collaboration will get me further than going for my own successes					
MA6-M1	We encourage people to have face to face meetings					
MA6-X1	Face to face meetings are common					
MA6-X2	Face to face meetings are beneficial for cooperation					

TA1-X1	Teams need to self-organize to properly apply Agile					
TA1-M1	Self-organization will provide voluntary improvement					
TA1-M2	Self-organization will ease acceptance of Agile methods					
TA1-X2	Teams know how to prioritize work items most efficient					
TA1-X3	Teams are trusted with prioritizing their work properly					
TA1-X4	Teams are trusted to apply Agile methods most effective for them					
TA2-M1	Change works best when it is not forced					
RM1-X1	Being a product owner is a dedicated role that someone should fulfill					
RM1-X2	The quality of the implementation of the PO role effects team performance					
RM1-X3	We will provide dedicated Agile at Scale training					
RM2-M1	It can be hard to go from high level requirements to user stories					
RM2-M2	Adding multiple layers of requirements is beneficial					
RM2-X1	Training on requirements engineering is needed					
TS1-X1	We have automated tests					
TS1-X2	We have continuous integration					
TS1-X3	Our development environment supports distributed development					
TS1-X4	The different parts of the organization share these tools					
TS1-M1	A good communication infrastructure is needed for successful change					
TS1-M2	Videoconferencing infrastructure is needed for distributed development					
TS1-M3	I am willing to invest into better communication					
TS2-X1	We have methods in place for technical debt management					
TS2-M3	QA is necessary to be added to teams					
TS2-X2	We have clearly defined tolerance levels for quality					
TS2-X3	We have clearly defined tolerance levels for velocity					
TS2-X4	We have visual indicators to keep an eye on tolerance levels					

Cu1-M1	Our customers are stakeholders in our project					
Cu1-M2	We intent to convince our customers of the upcoming change					
Cu1-M3	We intent to convince our customers that the upcoming change is good for them					
CU2-M1	We intent to tell our customers of the upcoming change					
CU2-M2	We intent to continuously keep our customers involved in the change					
CU2-M3	We understand that the change will impact the customer					
CU2-M4	We need to figure out how to shape the change so that it works for both us as our customers					
Ot1-M1	The change is complex and brings risks					
Ot1-M2	We intent to do dedicated risk management					
Ot1-M3	Proper risk management will decide the success of the change					

Employee questionnaire

Code	Indicator	Score				
		1	2	3	4	5
MS2-E1	Management is supporting of the transformation to Agile at Scale					
CC1-X1	I think that the change is necessary					
CC1-X2	I am committed to make the change a success					
CC1-X3	The change is manageable					
CC1-E1	I trust that management is making the right decision					
Le1-X1	We have a dedicated change leader					
Le1-X2	We have a motivated change leader					
Le2-X1	We have an external/freshly hired change leader					
CCA1-X1	Teams will be allowed to customize agile to their fit					
CCA1-X2	Teams are allowed a pragmatic way to adopt Agile at Scale					
CCA1-X3	Adopting and customizing Agile at Scale is an evolutionary process					
CCA1-X4	Adopting Agile and Scale is an ongoing process					
CCA2-X1	We have defined our vocabulary					
CCA2-X2	We have shared and communicated our vocabulary					
CCA2-X3	We have shared the expectations and goals for different Agile at Scale meetings					
CCA4-X1	Our organizational structure is not very complex					
Pi1-X2	The pilot led to acceptance of Agile at Scale					
Pi1-X3	The pilot showed the potential of Agile at Scale					
TC1-X1	I understand the value of training					
TC2-X1	Teams are allowed to learn and improve over time					
TC2-X2	Teams are not expected to succeed instantly					
TC3-X1	Knowledge sharing platforms are provided					

TC3-X2	Knowledge sharing is encouraged					
TC3-X3	People have time to spend on knowledge sharing					
EP4-E1	Management knows how to encourage us					
CT1-X1	The change has been communicated intensively over multiple channels					
CT1-E1	I am very aware of the change					
CT1-E2	Many of my colleagues are aware of the change					
CT1-X2	The change has almost been overcommunicated					
CT1-E3	The change has been communicated intensively					
CT1-X3	Expectations are clear					
CT1-X4	Expectations are communicated					
CT1-X5	The motivation for the change has been communicated					
CT1-E4	I agree with the motivation to change					
CT2-X1	Successes are shown and shared					
CT2-X2	Challenges are shown and shared					
CT2-X3	The status of the change is communicated openly					
CT3-X1	Word-of-mouth communication is encouraged					
CT3-X2	Time is freed up to celebrate victories					
CT3-X3	We value informal celebrations					
CT4-E1	I can be openly critical about things					
CT4-E2	I can talk about problems without fear of repercussions					
CT4-X1	We hold cross-team meetings to communicate progress					
CT4-X2	We have Communities of Practice					
CT1-X5	The motivation for the change has been communicated					
MA1-X1	We concentrate on Agile (at Scale) principles					
MA1-X2	Agile at Scale principles are more valuable than Agile practices					

MA4-X1	The change is good for the organization					
MA4-X2	I am confident in the change					
MA4-X3	Higher ups have made a good decision to change					
MA5-X1	We encourage collaboration					
MA5-X2	We encourage collaboration between different hierarchy levels					
MA5-X3	Collaboration will get me further than going for my own successes					
MA6-X1	Face to face meetings are common					
MA6-X2	Face to face meetings are beneficial for cooperation					
MA7-E1	Teams are often working together and helping each other out					
TA1-X2	Teams know how to prioritize work items most efficient					
TA1-X3	Teams are trusted with prioritizing their work properly					
TA1-X4	Teams are trusted to apply Agile methods most effective for them					
TS1-X1	We have automated tests					
TS1-X2	We have continuous integration					
TS1-X3	Our development environment supports distributed development					
TS1-X4	The different parts of the organization share these tools					
TS2-X1	We have methods in place for technical debt management					
TS2-X2	We have clearly defined tolerance levels for quality					
TS2-X3	We have clearly defined tolerance levels for velocity					
TS2-X4	We have visual indicators to keep an eye on tolerance levels					
TS3-E1	Our software is build up out of components					
TS3-E2	Teams can work individually on different components					

Change leader questionnaire

Code	Indicator	Score				
		1	2	3	4	5
MS3-X1	Management has had Agile (at Scale) training					
CCA3-X1	We have mapped high level management practices to the Agile approach					
Pi1-X1	We have conducted a successful pilot					
Pi1-X2	The pilot led to acceptance of Agile at Scale					
Pi1-X3	The pilot showed the potential of Agile at Scale					
Pi2-L1	We have identified relevant challenges					
Pi2-L2	We know how to mitigate identified challenges					
Pi3-L3	We have learned how to best introduce teams and managers to Agile at Scale					
TC1-X2	Managers have had training on Agile at Scale					
TC1-X3	Employees have had training on Agile at Scale					
TC2-X3	We make use of internal coaches					
TC2-X4	We make use of external coaches					
EP1-X1	We know who are Agile supporters					
EP1-X2	We know who are willing to try something new					
EP1-X3	We know who are collaborative and understanding persons					
EP3-L1	We did a stakeholder analysis					
EP3-L2	We included all stakeholders in feedback meetings					
EP3-L3	We gained acceptance from all stakeholders					
CT2-X1	Successes are shown and shared					
CT2-X2	Challenges are shown and shared					
CT2-X3	The status of the change is communicated openly					
MA1-X1	We concentrate on Agile (at Scale) principles					

MA1-X2	Agile at Scale principles are more valuable than Agile practices					
MA2-X1	Social events are there for people to help shape the new way of working					
MA2-X2	Social events can create enthusiasm for Agile					
MA2-X3	Social events can create more bonding					
MA3-X1	Agile communities can raise awareness for Agile methods					
TA1-X1	Teams need to self-organize to properly apply Agile					

Trainer questionnaire

Code	Indicator	Score				
		1	2	3	4	5
MS3-X1	Management has had Agile at Scale training					
TC1-X2	Managers have had training on Agile at Scale					
TC1-X3	Employees have had training on Agile at Scale					
TC2-T1	We focus on the principles of Agile at Scale, not the tools					
TC2-T2	We watch from a sideline and correct if necessary					
TC2-X3	We make use of internal coaches					
TC2-X4	We make use of external coaches					
RM1-X1	Being a product owner is a dedicated role that someone should fulfill					
RM1-X2	The quality of the implementation of the PO role effects team performance					
RM1-X3	We will provide dedicated Agile at Scale training					
RM2-X1	Training on requirements engineering is needed					

Appendix J. Final ASRM Lite variables and indicators

Management support

Success Factor	Variable	Indicator	Identifier	Who
Ensure management support				
	Management understands value			
		I am aware of what Agile at Scale will bring our organization	MS1-M1	M
		I am aware of the impact Agile at Scale will have on our organization	MS1-M2	M
		I am confident that Agile at Scale is the right thing to do	MS1-M3	M
		I am confident that the transformation will be a success	MS1-M4	M
	Management provides resources			
		I am aware of the time and effort that the transformation will take	MS1-M5	M
		I am willing to provide the resources for the transformation	MS1-M6	M
Educate management on agile				
	Management has had Agile (at Scale) training			
		I have had agile training	MS3-M1	M
		I know the agile principles	MS3-M2	M

Commitment to change

Success Factor	Variable	Indicator	Identifier	Who
Show strong commitment				
	The change is necessary			
		I think that the change is necessary	MS2-M1	M/E
		I am committed to make the change a success	MS2-M2	M/E

Leadership

Success Factor	Variable	Indicator	Identifier	Who
Recognize the importance of change leaders				
	Understanding the impact of the change			
		We need someone that leads the change	Le1-M1	M
		Change requires expertise	Le1-M2	M
	Understanding the value of organized change			
		We have a dedicated change leader	Le1-X1	M/E
		We have a motivated change leader	Le1-X2	M/E

Piloting

Success Factor	Variable	Indicator	Identifier	Who
Careful transformation and sustainable planning				
	Understand the length of an organizational transformation			
		Adopting Agile is a long-term organizational change	Pi3-M1	M
		I understand that there might be a drop in velocity while going through the change	Pi3-M2	M
		We have a sustainable planning for gradual adoption	Pi3-M3	M

Training and coaching

Success Factor	Variable	Indicator	Identifier	Who
Provide training on agile methods				
	Plan professional training			
		I want to provide training for my employees	TC1-M1	M
		I want to provide all managers with training	TC1-M2	M
		We understand the value of training	TC1-X1	M/E
	Conduct training			
		Managers have had training on Agile at Scale	TC1-X2	M/T/L
		Employees have had training on Agile at Scale	TC1-X3	M/T/L
Coach teams as they learn by doing				
	Acceptance the time that it takes to learn			
		We have coaches ready for ongoing training and coaching	TC2-M1	M
		We allow teams to learn and improve	TC2-M2	M
		We don't expect teams to instantly succeed	TC2-M3	M
	Learning the right things			
		We focus on the principles of Agile at Scale, not the tools	TC2-T1	T
		We watch from a sideline and correct if necessary	TC2-T2	T
	Providing coaches			
		We make use of internal coaches	TC2-X1	M/T/L
		We make use of external coaches	TC2-X2	M/T/L

Communication and transparency

Success Factor	Variable	Indicator	Identifier	Who
Strong collaboration and communication between teams and team members				
	Creating an open and transparent environment			
		I can be openly critical about things	CT4-E1	E
		I can talk about problems without fear of repercussions	CT4-E2	E
	Working together and sharing knowledge			
		We hold cross-team meetings to exchange knowledge	CT4-X1	M/E
		We hold cross-team meetings to communicate progress	CT4-X2	M/E
		We have a Scrum of Scrums	CT4-M1	M
		We have Communities of Practice	CT4-X3	M/E

Mindset and Alignment

Success Factor	Variable	Indicator	Identifier	Who
Cooperative organizational culture				
	Value cooperation			
		We encourage collaboration	MA5-X1	M/E
		We encourage collaboration between different hierarchy levels	MA5-X2	M/E
		Collaboration will get me further than going for my own successes	MA5-X3	M/E

Team autonomy

Success Factor	Variable	Indicator	Identifier	Who
Allow teams to self-organize				
	Understanding value of self-organization			
		Teams need to self-organize to properly apply Agile	TA1-X1	M/L
		Self-organization will provide voluntary improvement	TA1-M1	M
		Self-organization will ease acceptance of Agile methods	TA1-M2	M
		Teams know how to prioritize work items most efficient	TA1-X2	M/E
	Willingness to trust self-organization			
		I trust my teams with prioritizing their work properly	TA1-M3	M
		I trust my teams to apply Agile methods most effective for them	TA1-M4	M
Allow grass roots level empowerment				
	Management's understanding that top-down mandate can be ineffective			
		Change works best when it is not forced	TA2-M1	M

Requirements management

Success Factor	Variable	Indicator	Identifier	Who
Invest in learning to refine the requirements				
	Understand the difficulty of requirement engineering			
		It can be hard to go from high level requirements to user stories	RM2-M1	M
		Adding multiple layers of requirements is beneficial	RM2-M2	M
		Training on requirements engineering is needed	RM2-X1	M/T

Technology support

Success Factor	Variable	Indicator	Identifier	Who
(Automated) tools and infrastructure				
	Development			
		We have automated tests	TS1-X1	M/E
		We have continuous integration	TS1-X2	M/E
		Our development environment supports distributed development	TS1-X3	M/E
		The organization shares these tools	TS1-X4	M/E
		Different parts of the organization use different tools	TS1-X5	M/E
	Communication			
		A good communication infrastructure is needed for succesful change	TS1-M1	M
		Videoconferencing infrastructure is needed for distributed development	TS1-M2	M
		I am willing to invest into better communication	TS1-M3	M

Customer

Success Factor	Variable	Indicator	Identifier	Who
Customer satisfaction				
	Making sure the customer is feeling heard			
		Our customers are stakeholders in our project	Cu1-M1	M
	Making the customer understand that the change is good			
		We intent to convince our customers of the upcoming change	Cu1-M2	M
		We intent to convince our customers that the upcoming change is good for them	Cu1-M3	M
Strong collaboration with customer				
	Communicating change with customers			
		We intent to tell our customers of the upcoming change	CU2-M1	M
	Incorporating customers in the change			
		We intent to continuously keep our customers involved in the change	CU2-M2	M
		We understand that the change will impact the customer	CU2-M3	M
		We need to figure out how to shape the change so that it works for both us as our customers	CU2-M4	M

Appendix K. Final ASRM Lite questionnaires

Management questionnaire

Code	Indicator	Score				
		1	2	3	4	5
MS1-M1	I am aware of what Agile at Scale will bring our organization					
MS1-M2	I am aware of the impact Agile at Scale will have on our organization					
MS1-M3	I am confident that Agile at Scale is the right thing to do					
MS1-M4	I am confident that the transformation will be a success					
MS1-M5	I am aware of the time and effort that the transformation will take					
MS1-M6	I am willing to provide the resources for the transformation					
MS3-M1	I have had agile training					
MS3-M2	I know the agile principles					
CC1-X1	I think that the change is necessary					
CC1-X2	I am committed to make the change a success					
CC1-X3	The change is manageable					
Le1-M1	We need someone that leads the change					
Le1-M2	Change requires expertise					
Le1-X1	We have a dedicated change leader					
Le1-X2	We have a motivated change leader					
Pi3-M1	Adopting Agile is a long-term organizational change					
Pi3-M2	I understand that there might be a drop in velocity while going through the change					
Pi3-M3	We have a sustainable planning for gradual adoption					
TC1-M1	I want to provide training for my employees					
TC1-M2	I want to provide all managers with training					

TC1-X1	I understand the value of training					
TC1-X2	Managers have had training on Agile at Scale					
TC1-X3	Employees have had training on Agile at Scale					
TC2-M1	We have coaches ready for ongoing training and coaching					
TC2-X1	Teams are allowed to learn and improve over time					
TC2-X2	Teams are not expected to succeed instantly					
TC2-X3	We make use of internal coaches					
TC2-X4	We make use of external coaches					
CT4-X1	We hold cross-team meetings to communicate progress					
CT4-M1	We have a Scrum of Scrums					
CT4-X2	We have Communities of Practice					
MA5-X1	We encourage collaboration					
MA5-X2	We encourage collaboration between different hierarchy levels					
MA5-X3	Collaboration will get me further than going for my own successes					
TA1-X1	Teams need to self-organize to properly apply Agile					
TA1-M1	Self-organization will provide voluntary improvement					
TA1-M2	Self-organization will ease acceptance of Agile methods					
TA1-X2	Teams know how to prioritize work items most efficient					
TA1-X3	Teams are trusted with prioritizing their work properly					
TA1-X4	Teams are trusted to apply Agile methods most effective for them					
TA2-M1	Change works best when it is not forced					
RM2-M1	It can be hard to go from high level requirements to user stories					
RM2-M2	Adding multiple layers of requirements is beneficial					
RM2-X1	Training on requirements engineering is needed					
TS1-X1	We have automated tests					

TS1-X2	We have continuous integration					
TS1-X3	Our development environment supports distributed development					
TS1-X4	The different parts of the organization share these tools					
TS1-M1	A good communication infrastructure is needed for succesful change					
TS1-M2	Videoconferencing infrastructure is needed for distributed development					
TS1-M3	I am willing to invest into better communication					
Cu1-M1	Our customers are stakeholders in our project					
Cu1-M2	We intent to convince our customers of the upcoming change					
Cu1-M3	We intent to convince our customers that the upcoming change is good for them					
CU2-M1	We intent to tell our customers of the upcoming change					
CU2-M2	We intent to continuously keep our customers involved in the change					
CU2-M3	We understand that the change will impact the customer					
CU2-M4	We need to figure out how to shape the change so that it works for both us as our customers					

Employee questionnaire

Code	Indicator	Score				
		1	2	3	4	5
CC1-X1	I think that the change is necessary					
CC1-X2	I am committed to make the change a success					
CC1-X3	The change is manageable					
CC1-E1	I trust that management is making the right decision					
Le1-X1	We have a dedicated change leader					
Le1-X2	We have a motivated change leader					
TC1-X1	I understand the value of training					
TC2-X1	Teams are allowed to learn and improve over time					
TC2-X2	Teams are not expected to succeed instantly					
CT4-E1	I can be openly critical about things					
CT4-E2	I can talk about problems without fear of repercussions					
CT4-X2	We hold cross-team meetings to communicate progress					
CT4-X1	We hold cross-team meetings to communicate progress					
CT4-X2	We have Communities of Practice					
MA5-X1	We encourage collaboration					
MA5-X2	We encourage collaboration between different hierarchy levels					
MA5-X3	Collaboration will get me further than going for my own successes					
TA1-X2	Teams know how to prioritize work items most efficient					
TA1-X3	Teams are trusted with prioritizing their work properly					
TA1-X4	Teams are trusted to apply Agile methods most effective for them					
TS1-X1	We have automated tests					
TS1-X2	We have continuous integration					

TS1-X3	Our development environment supports distributed development					
TS1-X4	The different parts of the organization share these tools					

Change leader questionnaire

Code	Indicator	Score				
		1	2	3	4	5
TC1-X2	Managers have had training on Agile at Scale					
TC1-X3	Employees have had training on Agile at Scale					
TC2-X3	We make use of internal coaches					
TC2-X4	We make use of external coaches					
TA1-X1	Teams need to self-organize to properly apply Agile					

Trainer questionnaire

Code	Indicator	Score				
		1	2	3	4	5
TC1-X2	Managers have had training on Agile at Scale					
TC1-X3	Employees have had training on Agile at Scale					
TC2-T1	We focus on the principles of Agile at Scale, not the tools					
TC2-T2	We watch from a sideline and correct if necessary					
TC2-X3	We make use of internal coaches					
TC2-X4	We make use of external coaches					
RM2-X1	Training on requirements engineering is needed					