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MEASURING THE ORGANIZATIONAL AGILITY LEVEL OF IT ORGANIZATIONS – A SCALE DEVELOPMENT

Completed Research Paper

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Abstract

In today's IT organizations, agile concepts are widespread, and the benefits are well recognized. However, currently, no general and widely accepted model for measuring agility in IT organizations exists. As organization design is one of the main enablers of agility, we develop a multi-item scale to measure the agility level of the organization design in today's IT organizations. After conducting an expert review and running a pilot test with subsequent statistical analyses, we create a final scale that allows measuring the organizational agility level of IT organizations. The scale consists of 45 items across 12 factors and 4 higher-order constructs. The scale can be generally applied – for example, across industries or for companies of different sizes.

Keywords: Agility measurement, Agility level, Agile IT organization design.

1 Introduction

Agility generates a variety of organizational benefits, such as increased quality, more added value, faster time to market, or improved responsiveness to change but agility measurement is still a subject of discussion (Stettina et al., 2021; Malucelli et al., 2014). Empirical studies have shown that it is still rather challenging for most organizations to perform a sustainable and holistic agile transformation (Karvonen et al., 2018). Thus, the capability to measure organizational agility to enable continuous improvement and adjustment is crucial (Telemaco et al., 2020; Packlick, 2007). Organizational agility describes the ability of an organization to sense environmental change and respond efficiently and effectively (Gerster et al., 2020; Gunsberg et al., 2018). Failing to apply agile approaches accurately can do more harm than good and jeopardize the benefits (Telemaco et al., 2020). Currently, there is no clear understanding of how to increase the ability of organizations to respond effectively to change (Nurdiani et al., 2015). The ability to measure agility is the baseline and the starting point for such discussions.

Especially in IT, agile practices today are widely accepted and applied (Houston, 2014). That means, that agile on team level is well understood, and current challenges are more about scaling agility and designing a holistic IT organization including the interaction or integration of other organizational functions (Houston, 2014). We define the IT organization as the corporate function that develops and operates information systems and services to support and enable the business (Nurdiani et al., 2015). A holistic agile transformation impacts all levels of an IT organization, such as teams, programs, and portfolios (Stettina et al., 2021). Hence, agile also includes activities related to product management, budgeting, and business-value-related decisions performed in shorter cycles (Karvonen et al., 2018). Agility in IT plays a key role in its success (Marnewick and Langerman, 2018). IT organizations today need to be flexible to cope with changing demands in the business context (Nurdiani et al., 2015; Lin et al., 2006). Otherwise, they might lose the ability to support the company's market position and competitive advantage (Nurdiani et al., 2015). Thus, it is not surprising that improving agility is still among the most

important IT management topics (Fabri et al., 2022). To further drive the agile transformation of IT organizations, the agility level needs to be measurable. The ability of a standardized and thus comparable measurement of the agility level would facilitate and deepen these discussions (Houston, 2014). Moreover, this would support firms in designing their IT organizations accordingly (Nurdiani et al., 2015). Agility measurement can help determine a course of action before or during an agile transformation of the IT organization and the need for measurement is well known (Yürüm et al., 2018; Poonacha and Bhattacharya, 2012; Escobar-Sarmiento and Linares-Vasquez, 2012). Besides, for visualizing agile benefits, such a model can help to map the agility level against the achieved benefits since it is, especially for practitioners, challenging to understand the benefits resulting from the investments required to increase agility (Stettina et al., 2021). In practice, this can help to moderate cost-benefit discussions of agility. Hence, being able to measure agility is key for further development and improvement, which is an inherent characteristic of agility. In organization science, there is a call for more research on how to measure agility at organizational level and the application and validation of such measures in different organizational functions, industrial settings, and company sizes (Gunsberg et al., 2018; Schweigert et al., 2013). We follow this call by measuring the agility level at organizational level for a specific function – the IT organization. Due to this significance, many models to measure agility can be found today.

However, there is currently no quantitative model for measuring agility that is widely accepted, applied, and that was evaluated across multiple companies and/or industries (Schweigert et al., 2014; Fontana et al., 2015; Telemaco et al., 2022). This applies in particular for measuring agility in IT organizations, where special conditions such as design options like DevOps have to be considered. Besides, there are two further points of criticism on the existing models. First, many models lack adequate scientific validation and are developed purely conceptually or based on a single-case design; therefore, the need for further evaluation arises (Rodrigues and Fontana, 2019). Secondly, and based on a limited practical evaluation, the application of the models in the industry is rather challenging due to their complexity and difficult applicability (Yürüm et al., 2018; Fontana et al., 2018).

Therefore, the purpose of this paper is to develop, validate, and test a universal measurement model for the agility level of the organization design of IT organizations, applicable to different industries or company sizes. We seek to answer the following research question:

RQ: How can the organizational agility level of an IT organization be measured?

To address this question, we develop a multidimensional scale, engage experts for a review, and run a pilot test for statistical validation. The remainder of the paper is structured as follows: First, an overview of the current literature in the context of measuring agility is given. Next, the method of developing the multi-item scale is presented. The scale is then developed, tested, and adapted based on expert interviews, a pilot test, and statistical evaluations. Finally, the revised and optimized scale is presented. We conclude the paper by outlining further research needs, limitations, and a final summary.

2 Background

This section gives an overview of the current literature on measuring agility. After briefly illustrating the necessity of measurement and an overall classification of the models, we provide a general overview of agility measurement and agile maturity models. Since there are almost no measurement models for the IT organization specifically, we must first analyze models for the entire organization and check whether these can be applied. After that, we highlight that some important agility topics and evolutions of a modern agile IT organization design are missing within the identified models. Consequently, we conclude the section by showing further gaps in the screened literature, which motivates the development of a scale for measuring the organizational agility level of IT organizations.

2.1 Agility measurement

The importance of agility and its resulting benefits have been intensely discussed in the literature. Therefore, it is not surprising that many models have been developed to measure agility. Agility is not easy to put into practice, and the path to a more agile IT organization is a development process that needs to

be accompanied by frequent measurements to continuously define a course of action (Wendler, 2014). The agile adoption process is not straightforward but the importance is particularly high due to the rising importance of the IT organization in terms of fully enduring digitalization (Adalı et al., 2016).

In general, the approaches to measure agility can be differentiated along two dimensions – the focus ("what") and the method ("how"). The "what" describes the subject that should be measured. Current models focus on very different aspects that should be measured. This can be an organizational level, such as team level, or a specific industrial context. The "how" describes the method of measuring agility, which is again quite different. Many models are based on qualitative assessments, while others use predefined but not empirically validated scales. Alternatively, some models adopt a quantitative and empirically validated approach, and a few are based on fuzzy logic. To better understand the current state of agility measurement, we briefly review the relevant literature.

2.2 Overview of agility measurement and agile maturity models

Most of the current models to measure agility can be summarized under the term "agile maturity models". The objective of these models is to measure the stage of the agile maturity of an organization by mapping it against a defined maturity level (Stojanov et al., 2015). The maturity criteria are predefined and generally applied across organizations, and the measurement is used to determine how far they are in terms of agility (Ozcan-Top and Demirörs, 2013). The models have proven to be useful management tools to gain transparency and guide organizations in terms of further development (Fabri et al., 2022). Consequently, they are often used to assist the further agile transition (Ozcan-Top and Demirörs, 2013).

Focus ("what"): As mentioned above, the available models measure a wide range of aspects (Nurdiani et al., 2019). This can also be traced back to the fact that there is no generally accepted definition yet of what enterprise agility or agility at the organizational level means (Gunsberg et al., 2018). Especially for the team level, there is a huge demand for measuring maturity to constantly improve team maturity and guide other teams (Houston, 2014; Malucelli et al., 2014). Therefore, most of the maturity models focus on measuring the agility of teams (Packlick, 2007; Benefield, 2010). Followed by a few models that measure organizational agility in general – but not specific for the IT organization (Fontana et al., 2018; Guckenbiehl and Theobald, 2019). Furthermore, some approaches measure the degree to which agile practices support project success, or how well agile practices match the organization's strategy (Malucelli et al., 2014). Other models have more specific foci – for example, Johansson and Jaadla (2022) measure IT Service Management (ITSM) process maturity in an agile environment. The aspect of agile scaling based on rising scaling approaches such as SAFe (Scaled Agile Framework) is not significantly included in the agile maturity models. Nevertheless, a rising popularity is evident due to their importance. Finally, Fabri et al. (2022) developed and applied in a single case study setting a framework-independent and qualitative model to measure the agile maturity of IT organizations.

Method ("how"): The second major distinguishing factor of the models is the method of measuring agility. Yürüm et al. (2018) compared 22 assessment surveys and showed that they are very different in terms of measurement (e.g., yes/no questions vs. Likert Scale) or numbers of items/questions (e.g., range from 6 to 66). Many of the measurement models, especially those that were not developed in a scientific context, only measure by using yes/no questions. Moreover, those models did not follow a scientific development and validation approach. For this reason, we have excluded these models from further consideration. When it comes to scientific measurement approaches, the Likert Scale is the most widely used measurement format, either in a 5-point or 7-point version, with the 5-point being significantly more common. However, there are also models that use methods such as the analytics hierarchy process (AHP) to determine overall agility (Wendler, 2014). Some measurement models are also based on fuzzy logic to cope with the imprecise and vague phenomenon (Lin et al., 2006; Vinodh and Devadasan, 2011). Apart from this, Sidky and Arthur (2007) define agility maturity by the amount of agile practices applied – facing the criticism that just counting is not enough (Grena et al., 2019). It is rather a question of how well, detailed, and holistic they are applied.

For defining the maturity levels, the Capability Maturity Model Integration (CMMI) is the most popular framework used (Malucelli et al., 2014; Carvalho et al., 2019; Henrique and Tanner, 2017; Patel and

Ramachandran, 2009; Guckenbiehl and Theobald, 2019). For example, Nurdiani et al. (2019) analyzed 12 agile maturity models of which 9 were based on CMMI. Especially in the context of software development teams, many maturity models are based on CMMI (Santos-Neto and Costa, 2019). However, there is also criticism about applying the CMMI for agility measurement, since it is rather traditional and process oriented (Grena et al., 2019; Patel and Ramachandran, 2009).

2.3 Identified gaps and the need for developing a new scale to measure the organizational agility level of IT organizations

During the review of the current agility measurement models, four major gaps were recognized, forcing the necessity of a new model to measure agility in the organization design of today's IT organizations.

The first gap is the missing focus on IT organizations. We could not find any up-to-date model that can be used to quantitatively measure the agility in the organization design of a firm's IT organization. Most models focus on the team level, and if they are measuring agility at the organizational level, it is the whole organization, not the IT organization. Just taking over models that are developed for the entire firm does not match the specific conditions of IT organizations in the agile context – for example, the special consideration of design options comparable to DevOps. Also, the analysis of Looks et al. (2021) showed that while current models might be used as a baseline to build upon, further research is needed.

The second gap refers to the fact that many of the maturity models, due to their age, do not consider some important new characteristics and evolutions of agile IT organizations: Major agile evolutions like DevOps, BizDevOps, value stream orientation, or product orientation, are not or only partially reflected in the reviewed models. DevOps as an important evolution in IT to bridge the gap between development and operations via, for example, integrated teams, must be reflected in the scale (Stamoulis, 2022). Similarly, BizDevOps, as a further evolution of DevOps and the continuous dissolving of boundaries between functions (especially between business and IT) in the organization and direct integration of business resources in agile teams, is a major evolution that must be included in an up-to-date scale (Horlach et al., 2020). The rising concept of product orientation, where agile teams take over end-to-end responsibility and where funding processes are adjusted accordingly, needs to be considered as well (Gerster et al., 2020). Along with that, the orientation on business value streams for value creation in IT and the breakdown of personal goals via techniques like OKR (Objectives and Key Results) also need increased attention (Horlach et al., 2020). We will take these gaps into account when designing the scale.

The third gap is about the validation of the models. Several in-depth analyses of maturity models and agile measurement models found that validation of such models is often lacking (Henrique and Tanner, 2017; Grena et al., 2019; Fontana et al., 2018; Rodrigues and Fontana, 2019; Malucelli et al., 2014). Many maturity models exist purely on a conceptual basis and their applicability is evaluated afterward, mostly by single case studies (Wendler, 2014). The models are often developed in specific environmental settings – like for SMEs or specific industries (Escobar-Sarmiento and Linares-Vasquez, 2012). This does not allow for a standardized measurement model that can be used generally (e.g., cross-industry).

The fourth gap is about the nature of the models. Due to the different nature of the models, and no final comparison criteria, it is difficult to compare them (Fontana et al., 2018; Schmitt et al., 2019). This is enforced by a missing general definition of how an agile maturity model should look like or which purpose it needs to fulfill (Schmitt et al., 2019). Furthermore, the practical application of current (scientific) maturity models is difficult (Schweigert et al., 2014). This is because the maturity models rarely take into account how long organizations apply or transform toward more agility (Nurdiani et al., 2019). The models use a very different maturity basis, which makes their application in practice difficult (Nurdiani et al., 2019). Improving agility is more than reaching formal maturity levels (Schweigert et al., 2014). Not every organization needs the same level of agility and needs to define the highest maturity as its final goal (Schweigert et al., 2013). It needs to be better understood which costs and benefits result from agile maturity (Nurdiani et al., 2019). The resulting question is what level of agility an organization really needs – agile maturity models often imply that only the highest level is the goal. For example, for agile teams, it can be seen that they reach a kind of plateau in their evolution or maturity (Packlick, 2007). This results in weighing up the cost-benefit ratio to achieve a further possible maturity level. This

is also underlined by the thinking of practitioners that agile maturity does not follow a defined path (Malucelli et al., 2014). Due to that, we will not develop a maturity model but will instead focus on a model that can be generally applied to measure the organizational agility level.

3 Developing an IT Organization Agility Scale

Based on the identified gaps in the literature, we aim to develop an up-to-date scale to measure the agility level in the organization design of IT organizations. The scale was developed following DeVellis and Thorpe's (2021) approach, using the eight steps visualized in Figure 1 – our approach is explained in detail in the following.

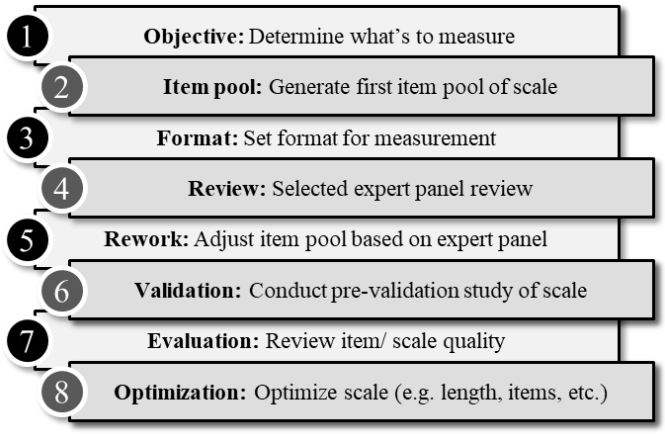


Figure 1. Scale development approach based on DeVellis and Thorpe (2021)

3.1 Determine what to measure

The first step to define a scale is to determine clearly what shall be measured. Although this seems quite obvious, it is often not sufficiently taken into account, and for example, the boundaries are not clearly defined – meaning what is in and out of scope (DeVellis and Thorpe, 2021). This might cause a drift into unintended domains (DeVellis and Thorpe, 2021). Therefore, we formulated the objective of our scale development explicitly and additionally defined what we do not want to measure. The ambition of the scale is to measure the agility level of the organization design of today's IT organizations. The scale shall be applicable across industries, company sizes, or other contextual parameters. Following Cao (2010), we define organization design as the shaping of processes, structure, people & culture, and governance (power and politics) to achieve best organizational performance. Furthermore, we consider organizational agility to be manifested in these four dimensions. Hence, these four dimensions applied to a firm's IT organization were taken as the underlying constructs of our scale. We focused on organization design and thus excluded technology as a separate characteristic with our scope setting.

3.2 Generation of a first item pool including factor definition

To define the first item pool, we used a dual approach. The first part of the pool was defined based on items already used in the literature and other scales. This improves scientific validity and reliability because these items have been the subject of other research and have therefore already been validated. Hence, our scale builds on already validated scales and further specifies them for IT organizations.

We identified three papers that are used as a baseline. These papers were selected because they meet the scientific demands of quantitative measurement models and are closely or directly related to IT organizations. The first, Wendler (2014) provides a Likert-Scale-based measurement model for assessing the current level of agility of an organization in the software and IT service industry. Wendler based his

survey on six dimensions – technology, workforce, collaboration and cooperation, agile values, management of change, and flexible structures – which have been criticized for not being sufficiently distinguishable and differentiated (Gunsberg et al., 2018).

The second paper applied Wendler's model in the single-case context of a university information service department (Gunsberg et al., 2018). The authors were able to confirm the applicability of the model (Gunsberg et al., 2018). Besides, they defined two forms (one each for leadership and staff) to avoid a bias in manager-employee interaction (Gunsberg et al., 2018). This offers us a large item pool.

The third paper is from 2020 and defined a questionnaire to assess the maturity of software development companies based on a 7-point Likert Scale including 26 items (Jungnickel et al., 2020). Due to the high empirical reliability that resulted from statistical tests, we also used this scale as a further input.

Further studies were excluded from consideration. For example, although Fabri et al. (2022) focus on the IT organization and developed a measurement model in a single case setting (German automation company KUKA) their model to measure agility is built on a purely qualitative assessment of interviews. Further, the pure counting or qualitative evaluation of how many agile practices are applied seems to be too simplifying as it does not cover the real quality and "shades of grey" (Nurdiani et al., 2019). For example, it is stated that in the dimension organization & management, the highest maturity is "strategy agility" – but without defined details (e.g., items) or any gradations of measurement (Fabri et al., 2022). The assessment is based on the defined maturity stages with the help of "Harvey balls", which does not allow for any statistical evaluation and detailed conclusions (Fabri et al., 2022). However, due to the IT-specific context, we used their paper to check against when defining constructs, factors, or single items.

The second part of the item generation was based on the identified gaps (*cf. section 2.3*). Items can also be defined based on literature discussions or on expert interviews (explorative character) (Schmidt and Paetzold, 2017). Thus, further items were derived based on the literature presented in Table 1 and topics that are relevant for agility in IT but not reflected in the existing measures. We started by just defining items that are a paraphrasing of our constructs and refined them gradually (DeVellis and Thorpe, 2021). Finally, we validated them with the experts to ensure construct and factor conformity and fit.

In parallel, we derived related factors that are represented by the items and that cover the agile-specific characteristics of the underlying constructs (*processes, structure, people & culture, and governance*). The definition of the factors was literature-based, referring to the identified and defined items, as well as central thematic aspects in the context of agile IT organizations (*cf. section 2.3*). The factors were defined at this stage to ensure completeness of content and to validate them as early as possible during the expert interviews. This resulted in twelve factors, three being assigned to one construct each. The factors, a short definition, and the relevant literature for the definition are shown in Table 1. Often the factors are defined after a factor analysis based on the eigenvalue rule (DeVellis and Thorpe, 2021). However, for the stated reasons of better completeness verification and more focused expert interviews, we preferred to take this step upfront. It is essential to note that the literature sources used are mainly not measurement models. Instead, most of them study individual aspects (factors), and the ones that are measurement models, do not reflect the holistic picture. This is seen in the broad range of literature.

Construct	Factor		Factor rationale and definition	Literature reference
Processes	1	Flexibility	Agile processes are characterized by a high degree of flexibility. Thus, processes, products, services, or resources can be adjusted flexibly, and processes are not too rigid and allow for pragmatic solutions.	[3]; [4]; [8]; [11]; [12]; [15]; [22]; [24]; [27]; [34]
	2	Continuous improvement	Continuous improvement is an inherent attribute of agile processes. This includes regular feedback loops, relentless improvement of processes, products, services, working conditions, methods, and skills & capabilities.	[1]; [2]; [5]; [6]; [7]; [8]; [9]; [10]; [18]; [19]; [20]; [22]; [23]; [25]
	3	Speed	Agile processes accelerate strategy execution, product or service delivery, decision making, feedback loops/integration, and result in speed gains.	[3]; [4]; [5]; [8]; [12]; [14]; [17]; [19]; [22]; [23];

Structure	4	Adaptability	Agile organization structures are designed adaptively to enable flexibility, situational changes, and dynamic (re-) allocations based on agile principles.	[11]; [21]; [24]; [31]; [32]
	5	Value stream orientation	Agile structures avoid silos and streamline an efficient flow of value across the organization structure. Value delivery is done by product-oriented teams.	[5]; [12]; [16]; [17]; [28]; [32]
	6	Cross-functional integration	Agile organization design bridges the gaps between other organizational functions as development and operations or to the business to maximize value delivery.	[5]; [8]; [12]; [14]; [17]; [30]
People & culture	7	Customer centricity	A customer-centric mindset and the alignment of activities on customer needs are essential for an agile IT organization. Pursuing maximum value delivery also entails measuring customer satisfaction through metrics.	[5]; [9]; [12]; [14]; [15]; [17]; [22]; [23]; [26]; [30]; [33]
	8	Collaboration	Collaboration in an agile context is based on teamwork, some fundamental values (e.g., trust, transparency), and principles (e.g., daily communication in teams, self-organization) and enabled by an agile toolchain.	[9]; [10]; [12]; [14]; [23]; [25]; [26]; [28]; [30]; [32]; [34]
	9	Mindset and skillset	Mind-/skillset – like a growth mindset (e.g., embracing change) accompanied by an agile skillset (T-shaped skills) – are central enablers and a baseline of agility.	[3]; [9]; [10]; [15]; [17]; [20]; [22]; [25]; [30]
Governance (power & politics)	10	Decision authority	Agile decision authorities defined along guardrails support the transfer of accountability to team level to enable, for example, innovation, commitment, and speed.	[3]; [5]; [8]; [9]; [12]; [15]; [17]; [31]
	11	Leadership	Agile leadership is key to removing silos and barriers within an organization to enable agile values and principles and to drive and shape continuous change.	[5]; [8]; [11]; [12]; [13]; [16]; [20]; [24]; [26];
	12	Strategic alignment	Strategic alignment in an agile context focuses and aligns all activities (e.g., OKRs) on maximized value delivery across multiple planning horizons.	[2]; [8]; [14]; [28]; [32]

Literature reference for factor definition: [1] (Adalı et al., 2016); [2] (Benefield, 2010); [3] (Carvalho et al., 2019); [4] (Escobar-Sarmiento and Linares-Vasquez, 2012); [5] (Fabri et al., 2022); [6] (Fontana et al., 2015); [7] (Fontana et al., 2018); [8] (Gerster et al., 2020); [9] (Grena et al., 2019); [10] (Guckenbiehl and Theobald, 2019); [11] (Gunsberg et al., 2018); [12] (Horlach et al., 2020); [13] (Houston, 2014); [14] (Johansson and Jaadla, 2022); [15] (Jungnickel et al., 2020); [16] (Karvonen et al., 2018); [17] (Marnewick and Langerman, 2018); [18] (Nurdiani et al., 2019); [19] (Ozcan-Top and Demirörs, 2013); [20] (Packlick, 2007); [21] (Patel and Ramachandran, 2009); [22] (Poonacha and Bhattacharya, 2012); [23] (Rodrigues and Fontana, 2019); [24] (Schmidt and Paetzold, 2017); [25] (Schweigert et al., 2014); [26] (Sidky and Arthur, 2007); [27] (Stamoulis, 2022); [28] (Stojanov et al., 2015); [29] (Telemaco et al., 2020); [30] (Telemaco et al., 2022); [31] (Tuncel et al., 2020); [32] (Turetken et al., 2017); [33] (Henrique and Tanner, 2017); [34] (Wendler, 2014)

Table 1. Scale structure and literature baseline for item and factor definition

In the next step, the items were assigned to the twelve factors. The initial scale consisted of 60 items, of which five items each were grouped under one factor (*cf. appx. table 5*). Of the 60 items, 33 items are based on previously defined items in other scales, and 27 items were derived from the literature and based on the identified gaps. The item specification takes more items than needed into account, assuming that the scale development process will lead to some dropouts, based on internal consistency (DeVellis and Thorpe, 2021). Further, as item length is a driver for complexity, diminishes clarity, and provides more opportunities for unwanted redundancy the length was optimized by removing unneeded wording (DeVellis and Thorpe, 2021; Jebb et al., 2021). To avoid survey fatigue, we focused on items that directly address IT organization agility and removed general ones. Finally, as response behavior is different for positive and negative wording the items were adjusted and formulated positively (Munshi, 2014).

3.3 Set format for measurement

As agility and its dimensions can be seen as latent variables, that therefore cannot be measured directly, they must be measured via a set of manifest items (DeVellis and Thorpe, 2021). We applied a Likert

Scale as a dominant standard to measure unobservable constructs of latent variables (Jebb et al., 2021). Since a shorter scale was seen as easier to answer by the experts and we are not expecting a concentration of answers on one scale side we chose a 5-point Likert Scale instead of a longer scale. Further, as we want to measure the status quo of the agility level, we decided to design a reflective measurement model.

3.4 Expert review and item adjustment

The first item pool was presented to and discussed with five experts in semi-structured interviews. To avoid any form of bias in the expert pool, the experts were drawn from different industries, had high levels of experience, and varied across age (*cf. Table 2*). The main objective of the expert interviews was to improve scale and item quality (Carpenter, 2018). To generate the best results, the interviews were based on open-ended questions along a defined interview guide, and the independent thoughts of each expert were captured and discussed (Wholey et al., 2015). The interviews were done remotely via video call, took 45-90 min, and were recorded for detailed analysis. The experts assessed whether the constructs, factors, and items were valid, complete in content, sufficiently clear and comprehensible, unambiguous, and not formulated in a suggestive way (DeVellis and Thorpe, 2021).

No.	Role	Age	Industry	Agile experience	Interview duration
1	Partner	>50	IT-Mgmt. Consulting	Over 15 years	90 min
2	Senior Project Manager	>30	Energy	Over 5 years	45 min
3	Vice President	>40	IT-Services	Over 10 years	75 min
4	Senior Project Manager	>30	Retail	Over 5 years	75 min
5	Director	>40	IT-Mgmt. Consulting	Over 10 years	45 min

Table 2. Overview of the experts for reviewing the scale

The interviews were analyzed and evaluated in-depth to adjust and further improve the scale quality. The content of the scale that is based on the current literature (*cf. section 3.2*) was mostly confirmed by the experts. No major blind spots concerning agile IT organizations were identified. In most of the interviews, the feedback was about the lack of technical and architectural topics. However, referring to our scope and sole focus on organization design (*cf. section 3.1),* the experts agreed on the completeness of the scale. Therefore, the overall number of constructs, factors, and items in the scale was not changed. However, in terms of clarity, distinguishability, and wording, the items were adjusted extensively based on the received feedback.

3.5 Pre-validation study

After the first evaluation based on the expert interviews, the updated version of the scale was taken as the baseline for a pre-validation study – also called pilot test. The pilot test was performed via the online survey tool Typeform and was available for 23 days, from 25 July until 17 August 2023. We used our business network to directly contact IT experts via LinkedIn to ensure that people who are already familiar with the topic were answering the form. We also ensured a mix across age, experience, industry, or company size to avoid any kind of bias. This increases the reliability of the replies and offers a better data basis for the subsequent statistical evaluations. The survey was accessed 158 times; 114 people started the online survey, and 100 of them fully completed the survey, resulting in a completion rate of 87.7 %. The average completion time of the survey was 13 min 50 s *(min = 5 min 45 s; max = 56 min 32 s)*. The data sample collected was used as the input for the statistical evaluation.

3.6 Statistical evaluation

Based on the pilot test, both exploratory (EFA) and confirmatory factor analyses (CFA) were performed. The factor analysis, as a multivariate analysis, helps to draw conclusions about the underlying latent variables (factors) based on observations of many manifest variables (items) (DeVellis and Thorpe,

2021). Based on the factor loading, which reflects the degree of correlation of an item with a factor, the items could be eliminated or reallocated, and thus the scale quality could be further improved (Bühner, 2011). Before that, we performed the Kaiser-Meyer-Olkin (KMO) and the Bartlett's test of sphericity to figure out if the data was suited for the factor analysis (Beavers et al., 2013). The initial KMO value was .748, which is defined as middling and thus suitable for the EFA (Beavers et al., 2013). The result of the Bartlett Test ($p<0.001$) also allowed to perform a factor analysis (Beavers et al., 2013). The scale and factor-specific reliabilities were verified based on Cronbach's Alpha (DeVellis and Thorpe, 2021). The initial Cronbach's Alpha value, which defines the internal consistency of the scale was .941, which is defined as excellent (DeVellis and Thorpe, 2021). For the EFA and the CFA, the maximum likelihood method was applied with a direct oblimin rotation to cope with a factor correlation.

3.7 Optimization and confirmation

We conducted two refinement iterations to further optimize the scale and finally carried out a CFA. Based on the EFA, we optimized the scale in two steps. The first step was to remove all items with a factor loading smaller than .3 due to insufficient correlation with the factor. This resulted in the removal of two items (removed items: *8.4* and *8.5*). Both removed items were originally intended for factor #8 "collaboration", which is a part of the construct "people & culture".

In the second step, the scale was adjusted to further improve the quality and to reduce its length. The length of the scale usually increases complexity and can lead to survey fatigue (DeVellis and Thorpe, 2021; Gunsberg et al., 2018). Thus, we reviewed the factor loadings of the items to identify further items with a rather low loading that can be removed without losing validity and reliability but optimizing the scale quality (i.e., scale length). Consequently, we removed 13 further items (removed items: *1.5, 2.1, 3.3, 4.5, 5.4, 6.4, 6.5, 7.3, 9.1, 9.5, 10.5, 11.4, 12.5*). As a result of the second iteration, the item number was reduced to the final set of 45 items. Table 5 in the Appendix presents the final item list and wording.

The results of the EFA and the application of the *Kaiser Criterion* indicated a total number of 14 factors, due to an eigenvalue ≥1.0 (Beavers et al., 2013). However, the specific eigenvalues of factor #14 had a value of 1.0 and factor #13 one of 1.1, and thus directly at or very close to the threshold for consideration. Therefore, due to the low eigenvalues of both factors #14, and #13 and for consistency reasons, we set the factor count of 12 for the EFA to determine the factor loadings. Based on those refinement steps, an improved KMO value of .781 was reached. After that, we performed the CFA for scale confirmation. The results of the CFA confirmed our newly defined scale with a total of 12 factors and 45 items (loadings <0.3 are suppressed). Table 3 shows the EFA and CFA factor loads for the final 45 items.

	EFA												**CFA**
	F1	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**	**F8**	**F9**	**F10**	**F11**	**F12**	
1.1	.882	-	-	-	-	-	-	-	-	-	-	-	.892
1.2	.810	-	-	-	-	-	-	-	-	-	-	-	.838
1.3	.442	-	-	-	-	-	-	-	-	-	-	-	.632
1.4	.553	-	-	-	-	-	-	-	-	-	-	-	.801
2.2	-	.674	-	-	-	-	-	-	-	-	-	-	.770
2.3	-	.840	-	-	-	-	-	-	-	-	-	-	.770
2.4	-	.627	-	-	-	-	-	-	-	-	-	-	.830
2.5	-	.439	-	-	-	-	-	-	-	-	-	-	.687
3.1	-	-	.730	-	-	-	-	-	-	-	-	-	.763
3.2	-	-	.720	-	-	-	-	-	-	-	-	-	.797
3.4	-	-	.776	-	-	-	-	-	-	-	-	-	.798
3.5	-	-	.620	-	-	-	-	-	-	-	-	-	.707
4.1	-	-	-	.877	-	-	-	-	-	-	-	-	.897

4.2	-	-	-	.945	-	-	-	-	-	-	-	-	.925
4.3	-	-	-	.794	-	-	-	-	-	-	-	-	.830
4.4	-	-	-	.752	-	-	-	-	-	-	-	-	.897
5.1	-	-	-	-	.659	-	-	-	-	-	-	-	.754
5.2	-	-	-	-	.548	-	-	-	-	-	-	-	.614
5.3	-	-	-	-	.733	-	-	-	-	-	-	-	.815
5.5	-	-	-	-	.695	-	-	-	-	-	-	-	.815
6.1	-	-	-	-	-	.343	-	.496	-	-	-	-	.603
6.2	-	-	-	-	-	.595	-	-	-	-	-	-	.546
6.3	-	-	-	-	-	.753	-	-	-	-	-	-	.958
7.1	-	-	-	-	-	-	.379	-	-	-	-	-	.770
7.2	-	.318	-	-	-	-	.329	-	-	-	-	-	.707
7.4	-	-	-	-	-	-	.521	-	-	-	-	-	.754
7.5	-	-	-	-	-	-	.746	-	-	-	-	-	.733
8.1	-	-	-	-	-	-	-	.389	-	-	-	-	.811
8.2	.305	-	-	-	-	-	-	.595	-	-	-	-	.747
8.3	-	-	-	-	-	-	-	.489	-	-	-	-	.665
9.2	-	-	-	-	-	-	-	-	.583	-	-	-	.828
9.3	-	-	-	-	-	-	-	-	.842	-	-	-	.828
9.4	-	-	-	-	-	-	-	-	.555	-	-	-	.694
10.1	-	-	-	-	-	-	-	-	-	.747	-	-	.842
10.2	-	-	-	-	-	-	-	-	-	.769	-	-	.828
10.3	-	-	-	-	-	-	-	-	-	.709	-	-	.741
10.4	-	-	-	-	-	-	-	-	-	.815	-	-	.789
11.1	-	-	-	-	-	-	-	-	-	-	.722	-	.869
11.2	-	-	-	-	-	-	-	-	-	-	.760	-	.834
11.3	-	-	-	-	-	-	-	-	-	-	.652	-	.717
11.5	-	-	-	-	-	-	-	-	-	-	.728	-	.757
12.1	-	-	-	-	-	-	-	-	-	-	-	.700	.718
12.2	-	-	-	-	-	-	-	-	-	-	-	.575	.571
12.3	-	-	-	-	-	-	-	-	-	-	-	.898	.904
12.4	-	-	-	-	-	-	-	-	-	-	-	.801	.797

Table 3. Final oblimin rotated EFA and CFA results (maximum likelihood)

To also ensure the internal consistency of the scale and the factors, we checked against Cronbach's Alpha and the resulting change in value because of the refinement iterations. Table 4 shows the initial Cronbach's Alpha values at the beginning and the final values after the two refinement iterations.

Factor		Initial Cronbach's Alpha	Scale optimization action	Resulting Cronbach's Alpha
1	Flexibility	.832	Item 1.5 removed	.871
2	Continuous improvement	.840	Item 2.1 removed	.846
3	Speed	.856	Item 3.3 removed	.850
4	Adaptability	.927	Item 4.5 removed	.936
5	Value stream orientation	.852	Item 5.4 removed	.835

6	Cross-functional integration	.784	Items 6.4 and 6.5 removed	.732
7	Customer centricity	.866	Item 7.3 removed	.826
8	Collaboration	.673	Items 8.4 and 8.5 removed	.765
9	Mindset and skillset	.829	Items 9.1 and 9.5 removed	.824
10	Decision-making	.892	Item 10.5 removed	.876
11	Leadership	.892	Item 11.4 removed	.869
12	Strategic alignment	.848	Item 12.5 removed	.826

Table 4. Factor reliability evolution based on scale refinement and optimization

4 Discussion of results

Based on the results of the pilot test and the EFA and CFA performed, we were able to generally confirm the overall structure and content of the developed agile scale. With a view to further optimizing the scale (e.g., scale length) and its practical applicability, we reduced the number of items from 60 to 45, with the confirmation of the derived 12 factors. Based on the optimization, all factors experienced an item reduction from at least 5 to 4. The factors cross-functional integration (#6), collaboration (#8), and mindset and skillset (#9) were reduced to 3 items in the final version.

We also checked the item removal from a content perspective, that no important facets were forgotten. For our first factor, flexibility (#1) item 1.5 was removed and with that the aspect of continuously scanning the (internal/ external) environment. It is acceptable to drop this aspect, especially since the factor is then even more focused on the flexibility aspect. The four resulting loadings of factor #1 are also good and the factor's reliability is thereby improved. For the second factor, continuous improvement (#2), item 2.1 was removed. The item deals with the learning of employees to better assess the size of their activities. However, the continuous improvement aspect is still reflected sufficiently in terms of content across the four remaining items. By removing the item, Cronbach's Alpha value was also slightly increased. The resulting factor loads are good and therefore define our second factor. Item 3.3 was removed for the third factor, speed (#3). Speed topics are appropriately included in the other items, and the aspect of customer feedback integration is also covered by the remaining items and by factors #1 (flexibility) and #7 (customer centricity). Cronbach's Alpha decreased slightly from .856 to .850, which is fully acceptable. In the fourth factor, adaptability (#4), item 4.5 was removed. It covers the aspect of adapting agile frameworks and methods. Through this removal, Cronbach's Alpha value increased to .936, which is defined as excellent. Also, the factor loadings of the four remaining items are all very high and confirm the factor match. The fifth factor, value stream orientation (#5), also remains with four items by removing item 5.4 due to the initial factor loading. The factor reliability decreased marginally from .852 to .835 but remains very good. From a content perspective, the orientation on value streams in the IT organization is still adequately reflected. Cross-functional integration (#6) was reduced by two items due to low and missing factor loading. Items 6.4 and 6.5 were removed to improve factor loading. From a content perspective, the important aspects of cross-functional integration, such as cross-functional teams, DevOps, and BizDevOps, in an agile IT organization are retained. This is also the reason why we left item 6.1 with factor #6 although it loads slightly higher on factor #8 (collaboration). We can accept the reduction in Cronbach's Alpha of the factor because it is still >0.7 and thus still acceptable. For our seventh factor, customer centricity (#7), we removed item 7.3 due to the initial factor load. The orientation on the customer as the central aspect of the factor is still reflected highly enough. Item 7.2 also loads on the factor continuous improvement (#2) but with reduced factor loading and does not fit from a content perspective. The factor collaboration (#8) provides the lowest initial Cronbach's Alpha with a value of 0.673, which is defined as questionable. We optimized the factor via the removal of items 8.4 and 8.5 due to corresponding low factor loads. As a result, the value of Cronbach's Alpha could be improved significantly to .765 and is now acceptable. Item 8.2 also loads on factor flexibility (#1) but with a lower factor load. Based on that and the better fit concerning the context, a reallocation of the item is not reasonable. For the ninth factor, mindset and skillset (#9), we also decided to remove

two items (9.1 and 9.5). The initial factor loads were not that high, and mindset and skillset are still sufficiently covered by the other three items. Factor 10, decision-making, includes four items in the final stage. Item 10.5 was removed which is about the definition and transparency of the decision authorities in the IT organization. With the removal of the item, the value of Cronbach's Alpha is minimally reduced and still acceptable. Concerning the last two factors, factor #11 (leadership) is reduced by item 11.4. The item describes the aspect of leadership supporting the transfer of accountability to team level. The aspect is also included in item 11.1, which defines the interplay of leadership and individuals/ teams. From the last factor, strategic alignment (#12), item 12.5 was removed. Mapping the requirements to the strategy is also reflected in the factor customer centricity (#7) and value stream orientation (#5).

Based on the statistical evaluation and the refinements and optimizations derived from it, the scale quality could be significantly increased. At the same time, the optimization of the scale reduced the length by 25%, which increases the practical applicability and quality of the results by, among other things, reducing survey fatigue. The final Cronbach's Alpha value of the scale in total is .921, which is excellent. The scale provides a robust model that is easy to use and that is universally applicable across all IT organizations to evaluate the agility level of the organization design.

5 Summary and conclusion

We developed and validated a scale to measure the agility level of the organization design of today's IT organizations. The scale is defined by four constructs: *processes*, *structure*, *people & culture,* and *governance (power & politics)*. Based on twelve factors (three factors per construct) and 45 items, the scale was discussed and successfully validated with agile experts. We further optimized the scale in terms of validity, reliability, and scale length based on our pilot test and the EFA performed. Finally, we were able to confirm the scale through the CFA. The scale can be used across industries and different company sizes. Our scale contains the most recent organization design evolutions of agility for modern IT organizations. From a practical point of view, with our scale and the given measurement option, IT organizations can derive a course of action and validate their efforts improving the agility level. Our scale delivers a major contribution to gain transparency and to reflect on the evolution of the agility level of a firm's IT organization. More specifically, the scale can be used in practice to measure progress in agile transformations and map it over time. In addition, benchmarks can be established across companies and IT organizations to provide evidence of adequate agility.

In general, we see three limitations to be mentioned. First, due to our scope setting, our scale does not measure technical or architectural topics like automated pipelines, which are also important for enabling agility. If needed, the technical aspects have to be further considered via a new construct and underlying factors. Additionally, we also must highlight the inherent limitations of scales as a measurement method like item limitation, brevity of the scale, or difficulties in controlling all variables. We met those challenges by following a structured and scientifically established procedure to define the scale. Finally, concerning the pilot test, the sample size for the factor analyses is sufficient but not immense. Besides, our scale for the pilot test was quite long (60 items), and too many questions might have led to a lack of concentration. As a possible result, the answers might be indifferent, and the quality of the participants' answers has decreased with increasing progress. We tackled both risks with a dedicated selection of IT experts as participants in the pilot test to gain the best possible results. However, the model should be further applied to generate more data to gain more insights and further improve and adjust the scale.

The objective of our scale is to measure the agility level in the organization design of today's IT organizations. Based on our pre-validation study, the statistical evaluation revealed good results that confirmed the objective. In the next step, the scale shall be applied in a wider context to confirm and validate the application across company sizes and different industries. Besides, we see two other research avenues. Firstly, one should analyze which factors drive the agility level of an IT organization. Secondly, it is of interest whether different agility levels can be grouped as a cluster and if the clusters are described by specific design elements. Finally, in the long term, the scale, combined with a scale to measure the success of agility, can contribute to the cost-benefit discussion regarding the transformation of an IT organization toward a higher agility level.

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Appendix

Overview of items for IT Organization Agility Scale (removed items marked as excl.)
1.1 In our IT organization, we flexibly react to upcoming changes by updating our processes and/or products/services. **1.2** We flexibly adjust or re-prioritize our IT product requirements to be always up to date. **1.3** Our IT managers can deploy their resources flexibly (material, budget, workforce, . . .) to make use of opportunities and minimize risks. **1.4** Feedback from employees, customers, and strategic partners is flexibly incorporated into further development (e.g., IT product development). **1.5** (excl.) In our IT organization, we anticipate change (e.g., by the help of meetings) by systematically scanning and analyzing our (internal/ external) environment. **2.1** (excl.) Over time, our IT employees learn to assess the size and scope of tasks more and more accurately. **2.2** Our feedback culture enables each IT employee to improve continuously and drive innovation. **2.3** Our IT employees drive proactive continuous improvement rather than reacting to crisis or

"fire-fighting". **2.4** Our IT employees continuously improve our products, services, processes, working methods. **2.5** Our IT employees drive regular feedback loops for continuous improvement. **3.1** In our IT organization, we rapidly gain the needed decisions. **3.2** In our IT organization, we are quick in pushing down changes resulting from a strategy update to the operational level. **3.3** (excl.) In our IT organization, we are fast in implementing feedback from our (internal/ external) customers. **3.4** In our IT organization, we are able to accelerate our (new) product and/or service development through early involvement of the relevant departments and/or functions. **3.5** In our IT organization, we quickly implement changes in IT products and/or services and release them for the customers. **4.1** If needed, our IT employees can be re-organized in different team configurations to adapt to changing requirements. **4.2** If needed, our IT employees can rotate among different activities, tasks, positions, or products/ services. **4.3** In our IT organization, we continuously inspect and adapt our org. structure to enable an efficient flow of value. **4.4** In our IT organization, the functional work focus and organizational allocation of the agile teams can be easily adjusted if needed. **4.5** (excl.) In our IT organization, we (regularly) adjust/ tailor agile frameworks/methods based on our needs. **5.1** Our IT organization structure avoids functional silos and instead reflects a horizontal end-to-end view. **5.2** Our IT organization structure includes an overarching portfolio level to optimize the IT value delivery. **5.3** The IT organization is built around product teams and teams with a supporting/enabling function. **5.4** (excl.) In our IT organization, we are organized around development value streams derived from business value streams. **5.5** Our IT organization structure is designed with a focus on efficient value flow across the organization. **6.1** In our IT organization, we work in small cross-functional (agile) teams. **6.2** In our IT organization, business employees are directly integrated via defined roles (e.g., Product Owner) in the agile teams (BizDevOps). **6.3** In our IT organization, cross-functional integration between development and operations is applied and valued (DevOps). **6.4** (excl.) Our IT-providers are closely integrated in our IT organization and are a direct part of our agile teams. **6.5** (excl.) In our IT organization, borders within and across functions are more and more blurring and we are more organized in (virtual) networks. **7.1** In our IT organization, we align all our activities to customer requirements and needs. **7.2** In our IT organization, all employees understand how IT contributes to business value for our customers. **7.3** (excl.) Our agile teams derive products/services for customer value delivery from the end-to-end business flow. **7.4** Our IT employees continuously apply customer centric practices like customer journeys to fully understand the customer needs. **7.5** In our IT organization, we measure the customer satisfaction rate to constantly increase customer value. **8.1** Our employees in the agile teams collaborate on a daily basis. **8.2** Our IT organization values a team-work oriented culture. **8.3** In our IT organization, we use agile collaboration tools (e.g., Jira, Confluence, Asana…). **8.4** (excl.) Our employees regularly communicate with each other based on trust, goodwill, and esteem. **8.5** (excl.) In our IT organization, we have established communities of practice for cross-team collaboration. **9.1** (excl.) Our employees obtain and develop an agile mindset purposeful. **9.2** Our managers have the mindset and skills necessary to manage change. **9.3** Our employees have a broad range of skills that allow them to switch tasks if needed. **9.4** Leadership supports an agile mindset and the agile principles. **9.5** (excl.) In our IT organization, we see failure as an opportunity to grow. **10.1** Along pre-defined guardrails, decisions can be made with a high autonomy. **10.2** IT employees and teams on the operational level are encouraged to make decentral decisions. **10.3** IT employees are prepared to take responsibility for their own decisions. **10.4** Decisions are based on local knowledge besides strategic and/or heavy impact decisions that justify a central decision. **10.5** (excl.) Decision authorities in the IT organization are clearly defined and transparent for all IT employees. **11.1** In our IT organization, an open leadership authority eliminates barriers between individuals and/ or teams. **11.2** Our managers ensure a lean IT governance that couples and synchronizes our agile teams. **11.3** In our IT organization, we change leadership authorities when tasks change, and leadership authority is related to defined roles. **11.4** (excl.) Our IT leadership supports the transfer of accountability to team level. **11.5** In our IT organization, the leadership authority is to define and transform the working environment for all people to deliver maximum value. **12.1** Our business-side managers understand the value of IT activities/initiatives from a company-wide perspective. **12.2** Based on our strategy, personal goals are set for each team and/or employee. **12.3** The IT organization has defined guiding principles with clear direction so that all IT employees understand their contribution. **12.4** The IT organization provides a clearly communicated (strategic) direction across multiple planning horizons. **12.5** (excl.) Our requirements are constantly mapped to our strategy and prioritized based on business value.

Table 5. Overview of items for IT Organization Agility Scale