Methodology for Assessing Digitalization Readiness and Maturity of Small and Medium-Sized Enterprises

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Abstract. Digitalization is a major trend changing both, business and society. As a result, small and medium-sized enterprises (SMEs) are also facing the challenges of a digital transformation, which is less an evolutionary process, but rather a change that must be actively shaped. However, SMEs are subject to major uncertainties and substantial challenges with regard to this transformational process. This paper proposes an assessment methodology to support SMEs in creating a holistic view of digital maturity, serving a descriptive and prescriptive purpose. The developed methodologies support SME to align strategies and to identify specific fields of action and projects. In contrast to the widespread standardised online self-assessments, the designed QuickCheck Digitalization (QCD) is based on the objective results of a detailed investigation of the enterprise and its existing processes, carried out by external assessors.

Keywords: Digitalization · Industry 4.0 · Maturity model · Change management

1 Introduction

Digital transformation is becoming a necessity [1], that jeopardizes those companies not engaging in the process [2, 3]. Consequently, recent reports revealed, that 95% of business leaders plan investments to gradually increase digital maturity [4]. However, this transformation proofs to be a big challenge. Especially, small and medium-sized enterprises (SME) are currently facing major uncertainties and substantial challenges with regard to digitalization in general [5] and measures to be implemented in particular [6].

Experience has shown that the majority of change processes in companies fail [7]. This is partly because the process often lacks clear objectives as a result of scarce information on the current state [8, 9]. The ever-increasing complexity, exponential technologies as an accelerant and constantly emerging opportunities [10, 11] make it difficult for managers to grasp digitization in total and particular twists hereof [12]. Especially SME manager face major difficulties in determining the status-quo with regard to digitalization and in most cases overestimate their level of digitalization [13]. Therefore, they often fail to identify concrete steps within the digital transformation

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[12]. Consequently, it needs methods, tools or frameworks to provide guidance and the information needed to SME managers. Recently several organizations introduced maturity models, road maps and readiness assessments to increase transparency of the digital transformation process [14]. These methods indeed have certain disadvantages and, in particular, fail to provide satisfactory assistance to SMEs [15]. In particular, SME lack a support for relating the vision of digitalization to their specific domain and individual business strategy [13, 16].

The purpose of this paper is to design an assessment methodology to support SMEs in creating a holistic view of digital maturity, serving a descriptive and prescriptive purpose. The developed methodologies support SME to align strategies and to identify specific fields of action and projects.

The remainder of this research is based on the definition on micro, small and medium-sized enterprises of the European Commission. Accordingly, SMEs are enterprises that employ less than 250 employees and either have a turnover not exceeding 50 million Euro or an annual balance sheet not exceeding 43 million Euro [17].

2 Existing Readiness and Maturity Models

Digital maturity is the goal of the transformational process [18] defining a state of ability to achieve the desired transformation [19]. In order to make this change, it is essential to determine the current state of affairs. A widely used tool to assess digital maturity are maturity models [20]. Maturity models represent a particular class of reference models, which are typically oriented towards the development of organizations or information systems [21]. These models pursue the goal of describing a desirable evolutionary path to a perfect state [22] and to evaluate the degree of progress to reach maturity [23]. In addition to their increasing distribution and purpose, maturity models are characterized by the fact those [22, 24]:

- determine the actual situation of valuation objects in a structured manner,
- derive and prioritize improvement measures based on observed data and
- monitor the successful implementation of specified measures.

As a result, maturity models are not only used to assess skill levels, but also provide incentives and measures to systematically improve or change capability levels. This implies that such models are a suitable instrument to measure the progress of the measures taken [21, 25]. Thus, maturity models constitute a suitable tool to guide enterprises in the digital transformation process.

Meanwhile, both, practitioners and researchers, designed a multitude of maturity models or assessment tools to address the digital transformation. A solid overview of the diversity is conveyed by Göklap et al. [20], Akdil et al. [26], Mittal et al. [27] and Carolis et al. [28]. In general, it can be stated that many maturity models differ with respect to their characteristics, although they share many similarities. The latter is because maturity models are based on a universal framework and many authors build on their predecessors work [29]. The majority resort to instruments and procedures that have already been tested and validated, when it comes to assess digital maturity.

Although SMEs are the backbone of western economies [30], existing maturity models rarely consider their specific perspective and unique requirements, in particular [27]. SME face different challenges and barriers when it comes to digitalization [31]. Consequently, most instruments to assess digital maturity are restricted in their use for SMEs by the lack of considering SME specific requirements [27]. This results in variety of difficulties for SME using these instruments. The following disadvantages with existing maturity models were identified:

- Maturity models promise a certainty of success, although this is not always attainable in practice. On the one hand, most of the existing models specify a gap between an actual and a target situation, but either how to close this gap is left open or the methodology fails to hint on how the transformation process can be completed. SME are less experienced in managing new technologies and often lack a strategy department to work with assessment results [32]. They also struggle to derive measures and to identify concrete steps to be taken [33, 34]. Therefore, it is essential to identify further measures to reach a desired level of digital maturity.
- On the other hand, most maturity models assume that all companies develop in the same way. Situational factors (such as corporate culture, structure, size) are often neglected to reduce complexity [35]. It is also criticized that many maturity models are aiming for a level of development that is not achievable, especially in high levels of maturity [36]. This is especially true for SMEs, which usually lack financial resources to reach levels that are based on pricy high-end technologies [32]. Thus, assessment methodologies should also consider individual situational factors in addition to domains, when defining a suitable digital maturity level.
- Maturity Models capture an area of application with several relevant dimensions and their variable expressions. These are normalized on an ordinal scale, the so-called maturity levels [24]. Mittal et al. [27] argue that most instruments to assess digital maturity "start from a somewhat advanced level that includes connected machines, sensors, and some form of OT/IT integration." However, large enterprises, which are in the focus of these instruments, are often way ahead of SMEs, which have not reached the starting level yet [37]. The transition to this first stage is often associated with much more effort as SMEs, in particular, struggle with the implementation and adaption of these technologies [33].
- A general disadvantage of self-assessment tools and maturity models that are based on questionnaires is that respondents require at least basic knowledge on the concepts of digitalization in order to give proper answers. Especially when it comes to assessing the readiness of high-end technologies, the lack of experts and experiences makes it harder for SME to properly evaluate the level of digitalization [27, 38]. A single person usually lacks the necessary information to answer the questions for all division in detail. Thus, assessment suffer from a poor quality of the provided information. In addition, objectivity is a further cause of objection. In general, respondents have to accurately reflect on both strengths and weaknesses answering the questions. Bley et al. [13] revealed that many enterprises overestimate their level of digitalization.

3 Research Approach

Since Nolan [39] and Crosby [40] introduced the concept of maturity models, a large number have been developed in science and practice [35]. However, most lack a theoretical and methodological foundation in construction [41]. Maturity models are often not well documented and the methodological foundations are not explicated [42]. Nevertheless, various design processes have been established lately, which can be understood as a specializing in the general research process of design-science. Currently, there are five different process models with comparable design steps [43, 44]. In order to design an assessment methodology for digital maturity Becker et al.'s [22] step-by-step procedure, which builds on Henver et al.'s [45] design science approach, was adapted and extended. Accordingly, a multi-methodological development approach was carried out. This includes a systematic comparison of existing maturity models, a systematic literature review, expert interviews and an iterative development of the assessment methodology.

The procedure model by Becker et al. [22] postulates an eight-phase development approach that is illustrated in Fig. 1.

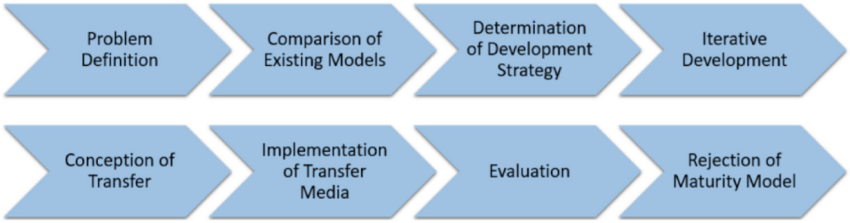

Fig. 1. Eight-phase development approach according to Becker et al. [22].

In a first step, expert interviews with representatives of 38 SME were conducted to identify key problems when it comes to the implementation of digitalization in practice. It proofed that SME face uncertainties on determining their current level of digitalization and lack a clear idea on where to start the digital transformation. This knowledge forms the basis for further development and analysis. Due to the rapidly increasing number of publications on maturity models and digitization in general, a systematic approach to analyze existing literature is indispensable [46, 47]. Therefore, Cooper's literature review process serves as a framework, in order to guarantee high-quality analysis for this paper [48]. The review on digitalization and existing digital maturity models is input to for:

- the gap analysis on digital maturity models,
- the derivation of suitable structures, like assessment mode, dimensions, maturity levels etc.,
- the definition of concrete maturity levels.

4 QuickCheck Digitalization

The QuickCheck Digitalization (QCD) provides a snapshot of the current digital maturity based on a detailed investigation of the enterprise and its existing processes. Therefore, six core dimensions were identified and divided into a total of 16 sub-dimensions with several criteria. Table 1 gives a brief overview of the six dimensions, including a brief review of their key items. Each item undergoes six maturity levels, whereby the first level represents a state of missing all the attributes to constitute to the concepts of digitalization. Level 6 on the other hand represents a reasonable state-of the art with regard to SME specific requirements.

Table 1. The six dimensions of the QCD.

Dimension	Description
Business model and strategy	Adaption of business model, available resources, comprehensive digitalization strategy, cooperation, pioneering spirit
Human capital and people	Competence management, autonomy, openness to new technologies, variation of specifications, digital leadership
Digital production	Digitalization of products, individualization, wearables and mobile devices, existence of ICT, information processing
Digital processes	Decentralization of processes, collaboration, data gathering and analysis, digital support of processes, modelling and simulation
Connectivity	Machine-to-machine communication, modern ICT, real-time fieldbus systems, sensor nodes, cloud computing
Knowledge management	Transparency, documentation, knowledge sharing, open innovation

The QCD consists of five phases: Initiation, Execution, Evaluation of Results, Review of Results and Retrospective (see Fig. 2).

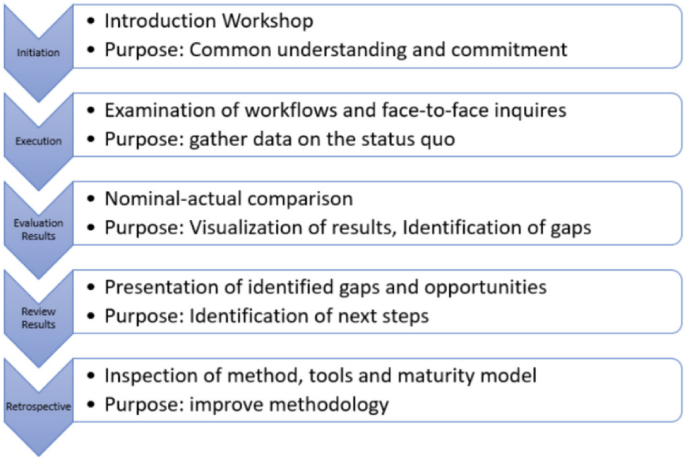

Fig. 2. Methodology to assess digital maturity and readiness.

During initiation, external moderators carry out an introductory workshop with direct clients to reach a common understanding of the assessments' purposes, goals and execution. To be successful, assessments and assessors must be borne by the principal. This includes commitment to the detailed approach and the provision of required resources. In addition, the company's basic concepts and current initiatives regarding digitalization are discussed. This information provides assessors with a first insight and serves their preparation.

Initiation is followed by execution. The designed QCD provides a snapshot of the current digital maturity based on a detailed investigation of the enterprise and its existing processes. Therefore, external assessors observe the companies workflows to get an idea of basic processes of the enterprise under investigation. Particularly critical processes and workflows are examined carefully. Results are complemented by face-to-face inquiry to eliminate ambiguities and a misunderstanding of terminology and technologies. A previously developed interview guideline forms the basis for the semi-standardized interviews. This guarantees a standardized process and comparable results [49]. The guideline builds on the current version of the maturity model. In order to identify the actual situation, these interviews are carried out not only in all areas of the company but also across all hierarchical levels. This allows for a reliable rating of the digitalization level. It has already been shown that the perception of management does not always correspond to reality. For example with regard to the acceptance and actual use of digital tools and methods. This also ensures reliable input to assess the dimensions with regard to the human element in the digital change. Among others, people's recognition of the need to enforce change and their willingness to submit to it are a crucial basis for digital transformation.

During the evaluation phase, results from all interviews are aggregated to identify the status quo of the entire enterprise. A breakdown by functional divisions is also conceivable. The evaluation of individual interviews is based on Mayring's [50] qualitative content analysis. This provides the following sequence: Classification of the conversation, creation of a keyword index, identification of the most important topics, structured summary of the written interviews and an intercoder reliability check. In a second step, experts define a reasonable digital maturity level for the individual SME to deduce target levels for all core dimensions. This is input for a nominal-actual comparison to identify existing gaps and to propose further measures and potentials. It is important to stress that the defined target levels are rather subjective and dependant on the expert's professional experience. For this reason, the experts' assessment is complemented by findings from current literature and experiences from previous Quick Checks. Identified gaps, potentials and the currents status-quo on digital maturity are visualized and discussed with SME managers in a review meeting. A radar chart is used to visualize the overall results and the results within the single dimensions (see Fig. 3). Experts also provide methodological support in prioritizing potentials to help SME managers to getting started.

A final workshop is an opportunity for the assessors to inspect themselves, as well as the method and the instruments used to generate a snapshot of the status-quo of digital maturity. It is crucial to involve the representatives of SMEs into the review process and to evaluate their satisfaction with the presented results and the assessment in general. The representatives are not only regarded as customers but also take on the

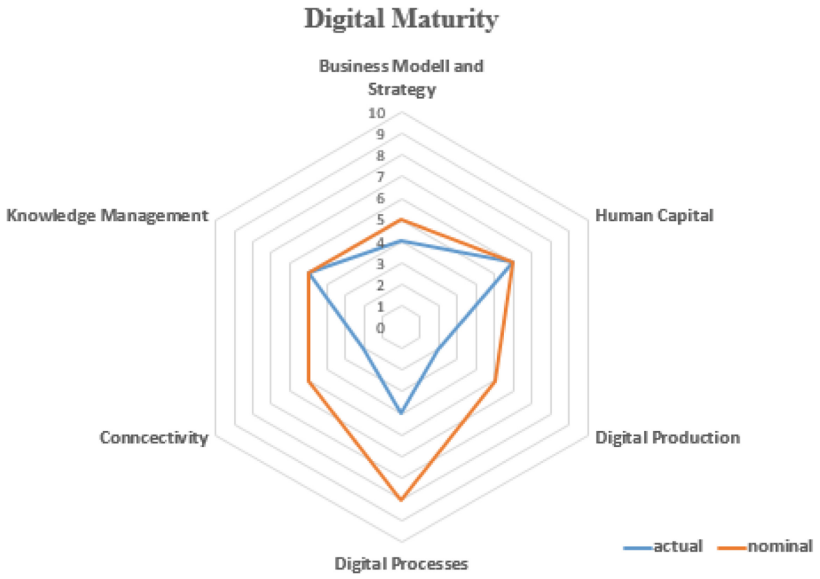

Fig. 3. Radar chart visualizing digital maturity in the dimension "digital processes".

role of experts for SMEs that give valuable hints on the companies' specific requirements and the applicability of the QCD. By the end of the retrospective, improvements on the general procedure, structure of the maturity model and the maturity items are identified and will be implemented before the next assessment.

5 Conclusion

Companies that exploit the opportunities of digitalization will gain competitive advantage. Therefore, digital transformation has become a high priority on management agendas. However, proponents argue that most enterprises are ill-prepared to benefit from digital innovations and its capabilities [51, 52].

The QCD assists SMEs throughout the digital transformation process by providing a holistic view of digital maturity during each transformational phase. With its general applicability and its practical relevance, the proposed methodology supports decision makers based on a much more extensively and intensively investigation than any self-assessment methodology. An individual definition of the digital maturity level is the basis for the identification of gaps and for the proposition of reasonable improvement measures. Thus, the QCD also serves a prescriptive purpose.

The presented method is designed for a determination of the digital maturity in SMEs. Therefore, it already reaches its limits on the edge of the SME definition. The more employees are included in the assessment the more information must be included in the assessment of digital maturity. However, time becomes a crucial factor from a certain number. In order to get a basic understanding of essential processes and work steps and to conduct decent interviews, an average time of 30 min is planned for each

attendant. Since the total duration of the data collection phase is limited to two days, limitations of a certain complexity and size are required.

Through agile adaptation, the QCD can be adapted to the observed values and expressions. As a result, the QCD benefits from an increasing number of assessments and new insights from research. In particular, the proposed assessment will benefit from findings with regard to the implementation of digital technologies in SME and the SME specific requirements on digitalization.

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