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Maturity of Artificial Intelligence in SMEs: Privacy and Ethics Dimensions

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Abstract. Artificial intelligence (AI) remains volatile for many companies and will foster disruptive transformation processes in many industries. Companies face continuous challenges assessing AI-readiness, current state, and AI-based requirements for change. Assessment of AI applications, services and products can be built on maturity models (MM). In this case, specialized AI-based MM (AIMM) are needed. With this article, we intend to advance the AIMM development. Aspects of small and medium sized companies (SME), privacy, and ethics are in focus. We will present the current state of AIMM, its interim, and practical evaluation and an outlook on further AIMM developments.

Keywords: AI, Maturity Model, Maturity Level, AI Privacy, AI Ethics.

1. Introduction

Digital transformation is advancing and with it the gradual commercialization and rapid evolution of artificial intelligence (AI). Scientific publications and case studies attest to significant value creation using AI in private and public institutions. AI is making slow progress in company-wide adoption. It is currently used in isolated instances and is not yet a complete solution, but rather a system component.

SMEs in particular need systematic support to introduce AI technologies. So-called AI maturity models (MM) can represent an approach for determining the state of progress of AI in a company and serve as a basis for further development activities.

Our previous work [1] revealed a lack of available consistent and applicable AIMM. Main criticisms are incomplete described AIMM, lack of self-assessment by the user and not considering relevant thematic dimensions. The underlying data relevant for AI applications is subject to legal regulations of data protection. Implications of AI decisions have inherent ethical considerations that need to be considered. This research gap is addressed in this paper by systematically developing an AIMM that is suitable inter alia for SMEs. We address the following research questions (RQ):

- **RQ1:** How is the AIMM structured and how is the maturity level determined?
- **RQ2:** How can an interim evaluation of the present state of research be conducted?
- **RQ3:** How should a concept for transfer and evaluation be designed?

The paper is structured as follows: First, the scientific basis is explained by a classification of MM and AI in general as well as privacy and ethics context of AI. Then, the research design is presented using a seven-phase process model from the literature on MM development. The transfer of theory to practice on the AIMM topic is described next. This includes the iterative MM development, the attached interim evaluation and the conception of transfer and evaluation. A summary of the work presented, and an outlook of potential further research projects completes this paper.

2. Theoretical Background

2.1 Maturity Model

First theories and applications on MM were published in the early 1990s. MM follow the generally acknowledged target of capturing a specific status quo of a particular area within an organization and supporting its improvement [2]. MM are mainly applied in innovative, novel, and complex disciplines. Due to their systematic and structured approach, MMs enable a first low-threshold involvement with the topic under investigation. Challenging and complex (technologized) fields such as information systems (IS), business process management, digital transformation or AI are described by corresponding MMs [3, 4]. MM concepts and applications have made their way into cross-domain and cross-industry applications [1].

MM are usually divided into different dimensions (also called categories). For each dimension, criteria and associated metrics are defined, which allow a classification per dimension. Approaches are e.g., questionnaires with yes-no questions or the classification by means of Likert scale level. An underlying metric determines a performance level per dimension. The aggregation of these individual categorizations per dimension adds up to an overall result. The outcome is the maturity level. The MM with its maturity levels allows the status quo to be categorized. MM provides two methods for determining the maturity level. Either by working through the question catalog with an expert or by self-assessment. In both cases, the contact person should have an appropriate level of knowledge. In this way, MMs act as an initial indicator for assessing the capabilities of an organization. MMs raise awareness of a topic, provide a valid assessment of the organization's own capabilities, and can trigger innovation processes [5].

2.2 Artificial Intelligence

Historically, the AI concept has existed for about 70 years and is currently experiencing its prime. The AI domain is benefiting from five key developments in particular: The advanced performance and cost-effectiveness of hardware, as well as the combination and further development of different methods and an availability of the required dataset. AI applications are used in almost every industry. Opportunities are offered, for example, by applications in medicine (early disease detection), mobility (autonomous driving) and marketing (chatbots). The discourse of AI mentions risks such as job loss, error-prone algorithms, loss of privacy and violation of ethical code of values [6].

Data is the fuel of AI and thus a basic prerequisite for the use of AI methods. Data processing often involves the processing of personal data or data that can be used to draw conclusions about private behavior patterns. The use of personal data is regulated by strict legislation (EU-GDPR) depending on the geographic location. In the case of the EU GDPR, technical or organizational measures must be taken. According to the area of application, these include activities for pseudonymization and anonymization. When using AI methods, data protection must be taken into account in advance and privacy must be preserved [7, 8].

In accordance with the AI competence area, a self-learning algorithm assesses sensitive situations. The result of an AI operation is a (possibly serious) decision. An ethical dimension arises at the human-machine interface in this case. A scientific consensus on the definition of AI ethics does not exist. The keywords fairness, accountability, and transparency, as well as data protection and privacy, are mentioned in this context [7, 9].

3. Research Design

In this section we define the scientific approach and enrich it with references from additional literature. The practical implementation takes place in section 4. The research work refers to the Design Science Research (DSR) approach [10]. The objective is the profound development of an AIMM based on a conceptual and iteratively evolving design artifact (DA). The methodological framework is provided by a procedure model for the development of MM (see Fig. 1) [11].

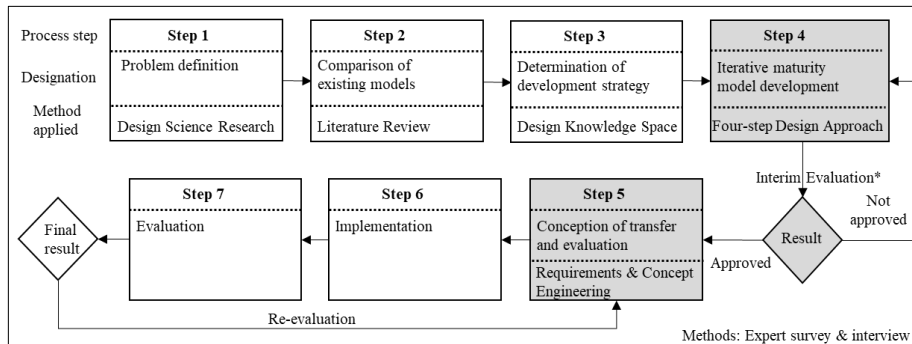


Fig. 1. Adapted procedure model for developing a maturity model based on [11]

In a previous work (see [1]) the steps (1) *Problem Definition*, (2) *Comparison of existing Models* and (3) *Determination of development strategy* were already addressed. The fourth step has been started and will be processed further in this publication. The current article therefore focuses on the steps: (4) *Iterative maturity model development* and (5) *Conception of transfer and evaluation*. highlights the process steps (gray) that are the focus of this article. The steps (6) *Implementation* and (7) *Evaluation* are currently in progress and will be articulated in future research.

3.1 Iterative Maturity Model Development

Following the procedure model for MM development [11], the main development process proceeds in four iterative sub-steps. These include the steps of (1) *select design level*, (2) *select approach*, (3) *design model selection* and (4) *test result*. The process step (4) *test result* is emphasized in the procedure model (see Fig. 1) due to its importance. The execution of this step will be considered in a separate section (see 3.2). The first step defines the design level. This includes the architecture and thus the basic structure of the MM. The maturity levels themselves and their structure are to be defined at this stage. The (sub)dimensions and their characteristics for the content of the MM should also be specified. In the second step, the theory suggests two possibilities for designing the characteristics: The bottom-up approach first defines the (sub)dimensions and then infers the maturity levels and their descriptions. The top-down approach proceeds in reverse order and first defines the maturity levels and then specifies the dimensions and their descriptions [5]. The third step is to select a suitable design model for each abstraction level. The process model recommends a literature analysis to identify success factors, comparable models and evaluation criteria for the MM when the topic has reached maturity.

3.2 Interim Evaluation

Step four (4) *test result* is intended to test the developed intermediate result in an interim evaluation. The authors propose three central evaluation requirements: problem adequacy, consistency, and completeness. A case study followed by a questionnaire is an appropriate method. The target group could be students who are familiar with the topic or first experts. The feedback should flow iteratively into process steps 1 to 3. In case of a positive outcome of the intermediate evaluation, the iterative MM-development is completed [11]. This serves as starting point for knowledge transfer, discussion and exchange that follows with the focus group of AI and IT experts to a later stage.

3.3 Conception of Transfer and Evaluation

Once the MM has been developed, both a concept for knowledge transfer and a concept for a final evaluation are to be created in accordance with the MM procedure model [11]. The target group-oriented transfer of knowledge in theory and practice can take different forms. In the referenced literature, document-based checklists or manuals are suggested for this purpose. A tool-supported, internet-based provision of the MM is recommended as technical support [11]. Publications act as an important component of knowledge transfer. The characteristics of the transfer concept determine the possibilities of the evaluation. The final user evaluation should provide a statement on the problem-solving capability of the developed MM. For this reason, the procedure model recommends that feedback possibilities for users should already be considered at the interface of transfer and evaluation concept. (Online) questionnaires in combination with reference to the MM as well as interviews with both quantitative and qualitative characteristics are adequate evaluation methods [5, 11].

4. Results on Development, Interim Evaluation and Conceptions of AIMM

We identified 15 AIMM approaches in our previous literature review. Only three of them [3, 12, 13] were partially convincing according to scientific and practical criteria. The main deficit turned out to be that all three of them cover only a small solution space [14]. Also, they show weaknesses in practical application and evaluation. Also, other criteria remain unconsidered, e.g., AIMM is an important tool for SME, but these were not examined further. The dimensions of privacy and ethics received likewise found little or no consideration. Therefore, we developed our own AIMM approach and are in the process of continuously improving it and testing its suitability for practice.

We first present our approach, and we show how we intend to make AIMM particularly applicable for self-assessment in SMEs. Then, we address open RQs and present the status of our evaluation.

4.1 Iterative Maturity Model Development

The topic of MM development has already been described initially in our previous paper [1]. Our research status shall be described in terms of an iterative procedure. The present status already contains the results of the interim evaluation (see section 4.2). Ideas and suggestions for improvement of the focus group were reviewed for consistency and adopted if positive. Decision made when choosing the (1) *design level* remains in place. In line with the works of Yams et al. [3] and Alsheibani et al. [12] we argue for a concept with multiple AI dimensions. This includes a one-dimensional sequence of discrete stages (Table 1) and multidimensional maturity stages (see Fig. 2).

The bottom-down approach has proven itself analogously in the selection of an implementation approach in step (2) *select approach*. One is that AI dimensions have been identified, analyzed, and evaluated during our preliminary work. This approach is recommended when the research domain has reached a certain level of maturity. This conclusion is supported by both, related work and other AIMM approaches. The definition of the dimensions is based on other AIMM approaches and on identified research gaps being described in detail in our preliminary work. A description of the defined AI dimensions can be found in Table 1. These dimensions comprise the following dimensions: (1) strategy, (2) organization, (3) Culture/ Mindset, (4) technology, (5) data, (6) privacy and (7) ethics. The table also includes objectives, scope for action and potential measures for each dimension. An interim evaluation result revealed a shift from an alphabetical order to a hierarchical logical sequence.

Table 1. AIMM dimensions and scope of action

#	Dimension	Objective n	Scope of action and potential measures
1	Strategy	Establishes the strategic enablers for the commercial AI application.	<ul style="list-style-type: none"> • AI vision for AI usage • AI data strategy • AI strategy successfully communicated • AI field and use cases • AI process model
2	Organization	Provides framework conditions (resources and structures) to enable AI application.	<ul style="list-style-type: none"> • AI Experts • AI further education and training • AI incentive system • AI governance structure • AI standard process for projects
3	Culture/ Mindset	A workplace culture of innovation and change is created and positive attributed towards AI.	<ul style="list-style-type: none"> • AI information workshop • Leaders promote AI • AI as opportunity • Innovation-friendly atmosphere • AI contact person defined
4	Technology	Delivers technologies and tools that create value using AI.	<ul style="list-style-type: none"> • Access to AI hardware • Access to AI software • Developed and applied AI applications • Usage of AI technologies • Added value through AI
5	Data	Creates foundations to enable AI technologies.	<ul style="list-style-type: none"> • Usage of data management systems • Collecting data for AI usage • AI process pipeline • Available Data for AI • Data quality generate added value
6	Privacy	Added value through AI under the premise of compliant handling of sensitive data.	<ul style="list-style-type: none"> • Awareness AI privacy regulations • Data protection officer in place • Technical and organizational measures regarding AI privacy • Anonymization mechanism for processing personal data • Privacy assurance system
7	Ethics	Addressing ethical concerns when using AI.	<ul style="list-style-type: none"> • Code of (ethic) values • Awareness human-machine relationship • Ethical guidelines/principles for AI • Compliance process with guidelines • Review of AI sensitive and security-related decisions

The AIMM is completed by the definition of AI maturity levels. The model was presented in outline in an earlier work and has been improved punctually. The maturity level designations have been adapted and their descriptions have been revised:

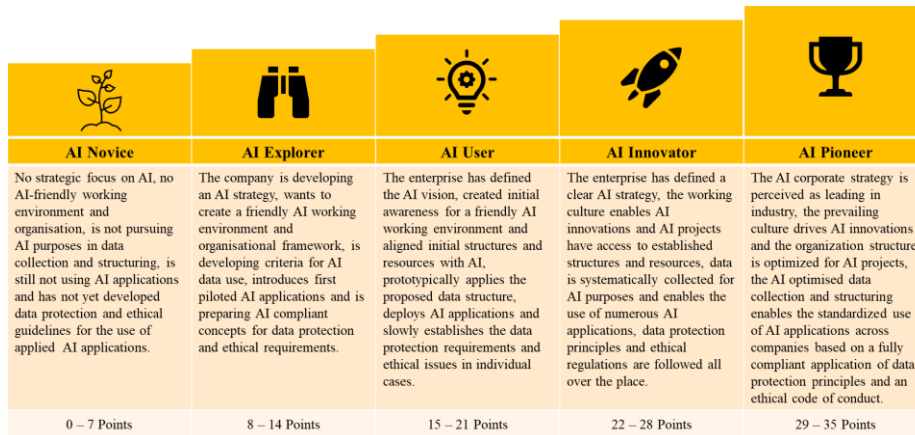


Fig. 2. Score-based determination of the AI maturity level

The AI dimensions, their characteristics, the AIMM and the included maturity levels are presented. Step (3) *design model selection* requires detail for each abstraction level. None of the AIMMs identified in advance offer both the possibility of a general classification within their model nor that of a self-classification on a questionnaire basis or information technology DA. In terms of consistent maturity level identification, we are particularly concerned with the explainability of our approach. Organizations should be able to perform the maturity assessment independently, transparently, and comprehensibly. For this purpose, the level of fulfillment of each AI dimension must be determined. The maturity assessment process can be supported by an expert. But a self-evaluation should also be feasible.

Adapted from Gassmann et al. MM [15] from the smart city domain, our AIMM enables a targeted and supported self-assessment based on yes/no questions. For each of the seven AI dimensions, five easy-to-answer yes/no questions were defined in logical order to match the defined maturity levels. One point is scored for each yes-answered question. All points scored are added up. As a result, a total of 35 points can be achieved. Furthermore, specific point ranges were assigned to each of the five maturity levels (see Fig. 2). For example, 18 yes answered questions equals to 18 points, meaning that the *AI User* maturity level has been reached. The questions for the respective AI dimensions are listed in excerpts in Table 2 and are tested by the interim evaluation. The complete AIMM Dimensions and related questions are available online.¹

Table 2. Exemplary excerpt of the AIMM dimensions and question sets for self-assessment

1. Strategy	
1.1	Is there a company-wide vision for the use of AI?
1.2	Do you have a data strategy that fosters AI?
1.3	Are the AI goals defined and communicated in a way that is understandable to the workforce?

¹ The latest development status can be found at <https://github.com/hochschule-pforzheim/aimm>

1.4	Are AI fields of business defined and use cases described?
1.5	Is there a process model for the use of AI?
2. Organization	
2.1	Do you have experts / experienced staff in using AI?
2.2	Is further education and training in the AI field supported?
2.3	Are there incentive systems to engage with AI?
2.4	Has a governance structure been created to manage AI development?
2.5	Are standard processes established for AI projects?
...	

4.2 Interim Evaluation

The interim evaluation is part of the iterative AIMM development approach. We prepared a four-step evaluation process to support further development of AIMM. First, the AIMM was designed as digital questionnaire. In addition to the 35 questions, further explanations were given, and the MM was illustrated. In the second step, a set of three different case studies was developed. These case studies describe three different AI maturity levels. Each case study refers to a fictitious company and explains its AI activities. The information contained in the case studies enables the user to assess the AI maturity level independently. In a third step, a feedback questionnaire was created. The overarching evaluation criteria are problem adequacy, consistency, and completeness. These were supplemented by detailed questions (quantitative and qualitative) on the superordinate criteria. In a fourth step, a focus group was defined, and the implementation of the evaluation was organized. Twenty-five students from advanced bachelor's and master's degree programs in information systems and industrial engineering (with AI as specialization) were selected as participants. Students have completed at least one practical phase in companies (practical semester) and are currently working part-time in a company (working students). The survey was carried out anonymously and in compliance with data protection regulations. The findings (see Fig. 3 bis Fig. 5) from the feedback survey are listed as follows:

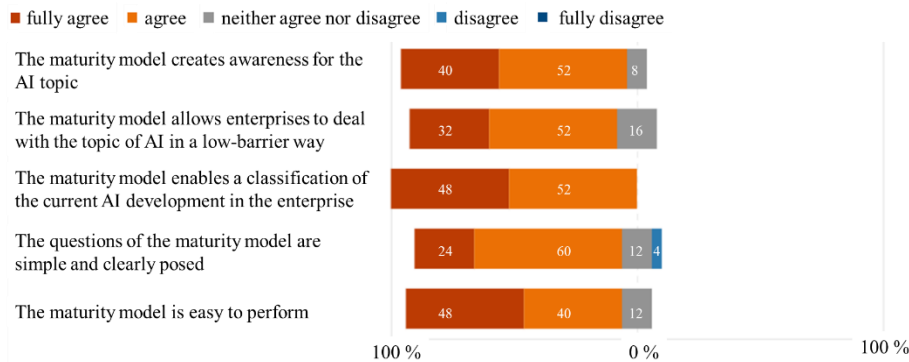


Fig. 3 Evaluation results of the criterion Problem Adequacy

The participants confirmed the problem adequacy. The MM provides added value in terms of raising awareness. It offers a low-threshold access to the topic of AI. Marginal negative feedback on the clarity of the questions was taken as an opportunity to simplify them once again. For most of the participants conducting the MM was easy.

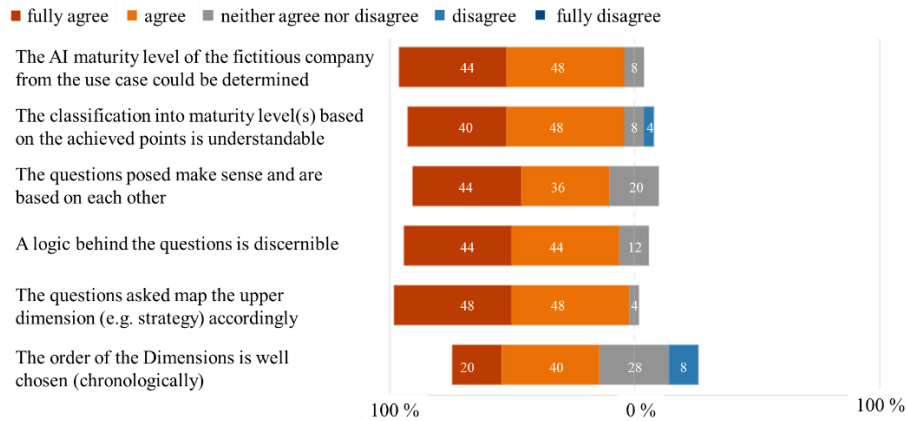


Fig. 4 Evaluation results of the criterion Consistency

The consistency criterion was covered by six questions. The participants evaluated this category positively too. Accordingly, the degree of maturity can be determined. A logic in the design is confirmed as well. Criticism was expressed about the chronologically presented order of the dimensions. We see this point of view equally and have made a change to a hierarchical order.

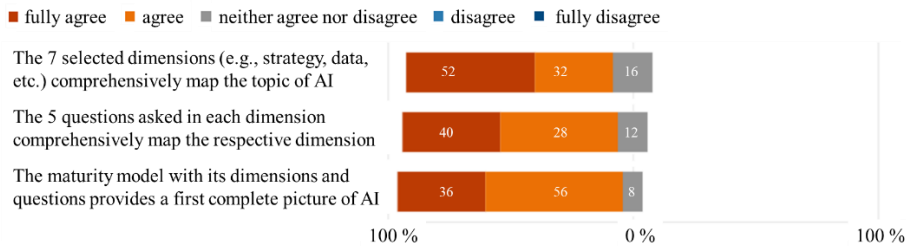


Fig. 5 Evaluation results of the criterion Completeness

The findings of the completeness test turn out to be positive. The participants agree with the AI dimensions as well as with the five accompanying questions. The involvement of employees was suggested as a contextual note to the questions. This proposal was considered in dimension 3 Culture/Mindset.

In response to the question of what the first overall impression of the MM is, the subjects answered an average of 8.2 on a scale of 0 very poor to 10 very good. The feedback and suggestions for improvement were implemented. The revised status is already presented in section 4.1. We consider the interim evaluation to be predominantly positive and will proceed to the next phase.

4.3 Conception of Transfer and Evaluation

According to the applied methodology [11], a transfer and evaluation concept must be developed in the fifth step. This step is discussed in this section. It addresses the positively evaluated AIMM state of development. The subsequent implementation of the AIMM as DA forms the basis for a final evaluation. The indicated interface between implementation and evaluation should be considered. Table 3 provides an overview of the two conceptions.

Table 3. Characteristics of transfer and evaluation

	Transfer concept for implementation	Evaluation concept for the final evaluation
Focus groups	<ul style="list-style-type: none"> • Users • AI/IT experts • Scientists 	
Input	<ul style="list-style-type: none"> • AIMM State of development • Online AIMM catalog of questionnaires 	<ul style="list-style-type: none"> • Software-based AIMM tool • Case Study from interim evaluation
Activities	<ul style="list-style-type: none"> • Technical implementation software based tool • Preparation of AIMM description • Composing documents AIMM knowledge transfer 	<ul style="list-style-type: none"> • Definition of evaluation criteria and questionnaire • Identification of further experts and users • Self-assessment of AIMM maturity level • Conduct questionnaire / interview with focus group
Output	<ul style="list-style-type: none"> • Software-based AIMM tool • AIMM documentation • AIMM Publication 	<ul style="list-style-type: none"> • Evaluation results • If necessary Re-Evaluation

The focus groups are identical for both the implementation and the final evaluation. This was already considered in the design phase (see [1]). The technical implementation of the current AIMM online questionnaire into a stand-alone software based AIMM tool will be carried out in the next step. In parallel, a describing AIMM documentation and further focus group-oriented publication will take place. The implemented AIMM tool will be used for the final evaluation with the focus groups. The focus will primarily be on users (mainly organizations in SMEs). After the self-determination of the maturity level, either interviews or (online) feedback questions are envisaged. Evaluation results will provide information on improvement potentials. During a re-evaluation, remarks can be included and the AIMM can reach a higher level of maturity.

5. Conclusion and Future Work

As key technology, AI applications will create added value in organizations. To achieve competitive advantages, companies must address this and develop competencies and capacities. We observe that especially SMEs still have difficulties in doing so. Besides a lack of resources and know-how, there are often no initial touchpoints with AI. A lack

of adequate getting started offers can be observed (see [1]). Our AIMM development seeks to overcome this issue. Our AIMM encompasses measures of the current situation through self-assessment and furthermore reveals potentials.

We outlined the current design and structure of AIMM, its dimensions and their implications. The iterative development approach we selected favors a progressive maturity of AIMM itself. We set value on the self-assessment of maturity by organizations. For this purpose, we have developed a set of 35 easy-to-answer yes/no questions. This approach offers a good opportunity for the initial classification of AI status quo, a finding we were able to confirm with the interim evaluation. The 35 questions represent a good balance between the time spent on the maturity assessment and the meaningfulness of the results. This way, we respond adequately to RQ1.

The interim evaluation serves as a classification of the state of research. To this end, the current state was depicted as a digital questionnaire. Three designed case studies were processed by 25 participants and the degree of maturity was determined as a result. The state of research was then assessed by means of an anonymous feedback form. Emphasis was placed on the areas of problem adequacy, consistency, and completeness, which were detailed through questions (see section 4.2). Valuable feedback has already been used to improve the AIMM. We consider the results of the interim evaluation positive and respond herewith to RQ2.

The applied methodology [11] describes friction points between later implementation and final evaluation. The intersections should be defined in an early phase. For this purpose, we created a concept describing further procedure for the implementation and its evaluation. In addition to focus groups, we specifically define required inputs, activities, and outputs. The developed concept offers us the possibility to start the implementation work and addresses RQ3.

Our work created a solid foundation for a user-friendly AIMM targeted at SMEs. The conducted interim evaluation achieved positive feedback of the current research state. We are building on this and planning further steps, which can be summarized in two main areas: First, we address incremental improvements to the current state. Our AIMM determines the AI maturity level. Improvement measures based on AI maturity level state cannot be suggest. We want to add this feature. In parallel, the AIMM is to undergo further iteration stages and be continuously enriched with further information. The latest updates will be available online (see GitHub Repository²). Second, we plan to apply the developed transfer and evaluation concept in practice as soon as possible. This procedure includes the steps (6) *Implementation* and (7) *Evaluation*. The implementation as a software-based tool is the subsequent objective of our research. Implementation as a standalone tool is a challenge that should be done in a timely manner. As result of this evaluation approach, we expect extensive feedback from our intended target group. A final evaluation with the focus groups of users and IT and AI experts is scheduled as well. In doing so, we also collaborate closely with regional stakeholders to reach the most diverse evaluation group possible.

² Available under <https://github.com/hochschule-pforzheim/aimm>

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