# Towards a Maturity Assessment Framework for MBSE Adoption: Results from a Meta-Synthesis

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Abstract. As engineering systems become increasingly complex, organizations must adopt strategic approaches to manage the interdependencies of their processes, tools, and teams. Model-Based Systems Engineering (MBSE) offers a promising solution, but transitioning from a traditional SE approach to MBSE is a complex endeavor that requires significant organizational change. This paper addresses the need for structured guidance in this process by proposing a maturity assessment framework that supports organizations in navigating this transition. The proposed framework is developed using a design science based approach and identifies key challenges, pitfalls, and best practices that are organized into several maturity levels of MBSE adoption. This structured, high-level approach provides organizations with the tools to understand their current maturity level, prioritize efforts, and avoid common missteps. The framework allows organizations to tailor the insights to their unique context, ensuring practical applicability. It emphasizes the importance of leadership, cultural readiness, technical tools, workforce development, and modeling practices for successful MBSE implementation.

Keywords: MBSE adoption  $\cdot$  maturity assessment  $\cdot$  framework  $\cdot$  design science

# 1 Introduction

MBSE is often suggested as a solution when facing challenges during the development of complex systems [6,14]. Its effectiveness during product development has been proven in numerous studies in academia as well as in industry, with advantages of improved system understanding, reduction of development time, reduction of errors, increased consistency, and traceability, improved communication, and others [36]. Although the benefits that come with the transition to MBSE are manifold, so are the challenges faced during the adoption phase [11,21]. Breaking up the traditional way of working in a company is not an easy task and the path of this transition is not clearly defined. Several surveys and studies have been conducted with varying outcomes and different best practices that have to be taken into consideration, making it difficult for practitioners and researchers alike to prioritize among them [46]. Currently the research is lacking a holistic perspective on MBSE adoption, bringing together all the mentioned

aspects, challenges faced, potential pitfalls, and best practices as well as a form of contextual prioritization. The aim of this paper is to investigate the adoption of MBSE in companies and provide an overview of the associated challenges, pitfalls, and best practices during the transition from a traditional approach of Systems Engineering to a model-based approach. While the current literature covers various aspects with regard to MBSE adoption, the challenges and difficulties encountered, the lessons learned and best practices discovered, this information remains fragmented across numerous sources. In this paper, we conduct a meta-synthesis of literature on challenges, pitfalls, and best practices for MBSE adoption. The result of this meta-synthesis is a prescriptive and comprehensive maturity assessment framework that addresses this fragmentation and is populated with the identified challenges, pitfalls, and best practices. The challenges should highlight potential issues that the organization should actively aim to resolve, while pitfalls should highlight issues that should be avoided. The best practices should fulfill the prescriptive nature of the proposed maturity framework, by providing actionable advice on overcoming challenges and pitfalls. Given that challenges, pitfalls, and best practices can be seen as different perspectives on the same underlying issue, the framework might contain some redundancies. However, we chose these categories to preserve the viewpoints expressed in the literature and ensure the prescriptive quality of the framework. The research question we address is the following:

**RQ** What challenges, pitfalls, and best practices have been identified in the literature on MBSE adoption, and how do they relate to the maturity of MBSE adoption in an organization?

In the remainder of this paper, Section 2 presents related work, followed by the methodology in Section 3. The resulting framework is presented in Section 4. Section 5 consists of an initial evaluation and critical reflection, followed by a conclusion in Section 6.

# 2 Related work

To the best of our knowledge, there is no research on maturity assessment frameworks that provide prescriptive guidance for navigating the changes required for successful MBSE adoption. To identify related work, we first searched for publications on maturity assessment frameworks in the domain of IS engineering by considering the proceedings of CAISE, EMMSAD/BPMDS, and POEM. Korsten et al. [31] developed a maturity model for organizational capabilities. Anwar et al. [5] developed a maturity model in the domain of information security audit processes. Haidar et al. [19] proposed a maturity assessment for agile development adoption in the domain of software product lines. They organize agile practices in a two-dimensional framework consisting of maturity levels and categories. van Zwienen et al. [57] propose a method for tailoring a generic maturity model for enterprise architecture to a specific domain. They apply their proposed method to develop an enterprise architecture maturity model for hospitals. These publications all apply design science research approaches and evaluate their results using illustrative examples and/or feedback from practitioners.

As further discussed in Section 3, we also conduct a literature review on MBSE adoption in organizations. Two reviewed publications address research gaps comparable to our research question. The INCOSE MBSE initiative [27] presents a descriptive maturity assessment model that assesses an organization's current state of MBSE adoption and offers benchmarking against competitors or industry averages. While this paper provides clear assessment criteria for concerns such as managing requirements, modeling efforts and technical issues, it does not address other criteria such as the organization's culture and leadership buy-in. It also does not provide prescriptive guidelines for a company to advance their adoption of MBSE. Amorim et al. [3] provides no assessment, but valuable decision support for prioritizing tasks and capabilities during MBSE adoption. They introduce a framework used to calculate which capabilities to prioritize for optimizing the ROI. While this publication offers a valuable method for prioritizing specific capabilities during MBSE adoption, it focuses on task-level decisions rather than a holistic maturity assessment of the entire transition process.

## 3 Methodology

To answer the research question, we aim to develop a high-level overview for organizations to understand their MBSE adoption level and receive actionable steps tailored to each maturity level. In this way, the maturity assessment serves as an applied synthesis, transforming dispersed knowledge from the literature into a structured framework that aims to help practitioners navigate MBSE adoption with greater clarity and direction. In developing our maturity assessment, we adhere to the research methodology for maturity assessment design outlined by [13] and [30], who build on principles of design science research. In [13], the six phases of developing a maturity assessment model are (1) determining the scope; (2) designing the framework, (3) populating the framework, (4) testing the framework, (5) deploying the framework and (6) maintaining the framework. This paper follows phases 1-4. The phases 5-6 are considered future work.

**Scope.** Our maturity assessment is not focused on a specific domain but serves as a general guidance for any organization interested in adopting or transitioning to MBSE. It is meant for academia as a novel synthesized baseline of knowledge as well as for practitioners during their MBSE journey.

**Design.** In our framework, challenges, pitfalls, and best practices of MBSE adoption are categorized in cumulative maturity levels, meaning that challenges, pitfalls, and best practices from lower levels are a prerequisite for higher maturity levels. These levels were determined based on the context provided in the literature. Based on a recommendation from [13], we developed four to five targeted questions per level that practitioners can use to determine the maturity level of MBSE adoption: if all questions for a level are answered with a Yes, they continue to the next level. Once a No is encountered, that level is assigned

as their current maturity level. This approach balances comprehensive assessment with ease of use, enabling a practical evaluation without an overwhelming number of questions.

**Populate.** The next step in the development of a maturity assessment is to identify the information necessary for a deeper understanding of maturity and how this can be measured. The goal is to gather input that, when organized across defined maturity levels, remains mutually exclusive and collectively exhaustive on the topic of interest. For established domains, this is often achieved through a comprehensive literature review [13,30]. We conducted a systematic literature review aimed at identifying the challenges, pitfalls, and best practices in MBSE adoption following the guidelines by Kitchenham [29]. We searched four scientific databases (ACM Digital Library, IEEE, Scopus, and Wiley Online Library) with the following query:

 $\begin{aligned} & \text{Query} = (\bigvee MBSE_i) \land (\bigvee ADOPTION_j) \text{ where} \\ & MBSE_i \in \{ \textit{"mbse"} \lor \textit{"model-based system* engineering"} \lor \textit{"document-cent* system* engineering"} \lor \textit{"dobse"} \lor \textit{"digital engineering"} \lor \textit{"digital model-based engineering"} \} \end{aligned}$ 

and

 $ADOPTION_{j} \in \{ "adoption" \lor "implementation" \lor "transition" \lor "switch*" \lor "experience*" \lor "challenge*" \lor "strateg*" \lor "best practice*" \}$ 

Our initial search was performed on the 5th of March 2024 and resulted in 1,295 potentially relevant publications (1,672 before removing duplicates). After applying six exclusion criteria (Publications only reporting on MBSE, DBSE or Digital Engineering in general but not on its adoption in practice; Publications not written in English; Publications where the full text is not accessible; Non-Peer-reviewed and non-scientific publications; Publications with less than 5 or more than 60 pages; Publications that are published before 2014), the selection was further reduced to 346 publications. From the remaining publications, 102 were selected to be included in the literature review based on their abstract. Another 7 publications were excluded as the full text was not accessible. As a final step, we conducted a backward and forward search in Google Scholar to identify additional relevant research. This resulted in 19 additional publications bringing the selection to 114 publications. These papers were analyzed in full. Of the 114 read papers, 44 contributed challenges, pitfalls, and best practices to the framework.

For all eventually selected papers, the reported challenges, pitfalls, and best practices for MBSE adoption were extracted to populate the maturity assessment framework. The process followed to identify and organize the challenges, pitfalls, and best practices adheres to principles from grounded theory; first, codes were assigned to relevant concepts and memos were created to document insights and support the synthesis of the identified codes. Additionally, four maturity levels for MBSE adoption were derived based on literature on maturity assessment frameworks. The synthesis of codes resulted in the final set of challenges, pitfalls, and best practices that could then be grouped in the identified maturity levels.

С	References	$\ \mathbf{C}$	References
C1	[9][20][11][26][28][10][54][53][1]	$\ C9$	[54][11][4][21][2][28][50][49]
C2	[26][40][41][46][21][2][10][47][38][54][53][1]	$\ C10$	[20][28]
C3	[9][26][46][21][37][28][1]	$\ C11$	[40][11][41]
C4	[9][21][28][47][53][48][1]	$\ C12$	[[11][21][2][54]
C5	[26][44][21][37][2][38][49][54]	$\ C13$	[44]
C6	[26][40][41][46][52][37][11][28][53]	$\ C14$	[20][2][15][1]
C7	[21][37][11][54]	$\ C15$	[40][41]
C8	[20][37][11][28][54][1]	$\ C16$	[[11][47][54]

Table 1: References for each Challenge (C) in MBSE Adoption.

We found limited guidance in the existing literature on how to prioritize challenges, pitfalls, and best practices within maturity levels. While [46] offers some direction by analyzing how contextual factors influence best practices, their conclusion remains that all best practices are generally relevant and context affects the order of priority rather than the applicability of practices themselves. This insight aligns with our structured approach, as our maturity levels naturally prioritize practices according to the general level of MBSE readiness. Furthermore, some topics identified in the literature keep repeating across challenges, pitfalls, and best practices, reflecting their relevance in different contexts. As an effort to improve visual clarity and overall structure within each level, we categorize challenges, pitfalls, and best practices into the following five categories: *Knowledge and Skills*; Work Culture; Management; Methodology, Language, and Tools; and Modeling.

**Evaluation.** To test and evaluate the maturity model, we conduct an initial validation survey aimed at domain experts investigating the respondents' MBSE background, their level of agreement with the assessment, and potential areas for improvement. In future work, a full evaluation would ideally involve extensive case studies to assess the accuracy of maturity assignments and the utility of our recommendations.

## 4 Results

In this section, we present the four levels of maturity for MBSE adoption and the challenges (C), pitfalls (P), and best practices (BP) for each level. Tables 1, 2 and 3 list the sources for each Challenge, Pitfall, and Best Practice respectively.

Each organization is unique, with distinct characteristics, goals, and constraints that only its management fully understands. However, for a transition as complex and context-dependent as MBSE, providing precise instructions that are applicable in any organizational context is neither practical nor achievable. Therefore, the assessment intentionally focuses on a holistic, high-level approach, enabling companies to identify critical areas for attention while ensuring that no key aspect of the adoption process is overlooked.

Р	References	$  \mathbf{P}  $	References
P1	[55][56]	P7	[55][21][7][56]
P2	[55]	P8	[44][21][32][42][56]
P3	[44]	P9	[44][55]
P4	[40]	P10	[55]
P5	[[7]	P11	[[44]
P6	[55][21][32][7][56]		

Table 2: References for each Pitfall (P) in MBSE Adoption.

Table 3: References for each Best Practice (BP) in MBSE Adoption.

$\mathbf{BP}$	References	BP  References	BP  References
BP1	[20][4][46][21][39][16][1]	BP12  [10][37][34][7][49][53]	BP23  [10][44][7]
BP2	[10][4][46][21][39][16][49][45]	BP13  [9][44][37][21]	BP24  [4][40][41][37][21][54]
BP3	[4][8][12][46][37][21][47][7][54]	BP14  [4][21][38][49]	BP25  [9][8][21][35][38][51]
BP4	[20][10][4][40][41][8][46][37][21][39][7][16][45][53	3]  BP15  [4][40][46][55][21][39]	BP26  [40][4][41][7][54][9]
BP5	[9][20][12][7][46][37][21][54][53]	BP16  [20][12][46][37][21][49]	BP27  [40][41][21]
BP6	[20][4][8][25][46][37][21][49][45][53][51]	BP17  [40][41][20]	BP28  [40][41][44][37]
BP7	[20][4][12][46][21][39][7][53]	BP18  [10][4][55][21]	BP29  [40][41][21][43]
BP8	[10][8][18][46][23][37][21][38][7][49][54][45][53]	BP19 [20][10][40][41][7][16]	BP30  [10][44][21][2][35][54][43]
BP9	[12][37][47][33]	BP20  [40][41][34][53][8]	BP31  [20][21][2][49][17][51]
BP1	0   [10] [40] [41] [46] [37] [21] [35] [22] [7]	BP21  [20][23][21][7][10][40][44][37][2][35][34][38	3]
BP1	1 [[4][8][12][37][21]	BP22  [4][46]	

This approach empowers management to derive tailored, lower-level instructions and actionable steps from the holistic framework specific to their organization's needs. For example, while the assessment emphasizes the importance of selecting tools that integrate effectively with existing infrastructure, the specific tool choice depends on the organization's unique technical and operational requirements. Similarly, while it highlights the need to address knowledge gaps and align divergent understandings of MBSE, the exact methods and content of training to achieve this must be determined by the organization itself. The maturity assessment outlined in this section provides a structured and comprehensive collection of challenges, pitfalls, and best practices. In the literature, 16 challenges, 11 pitfalls, and 31 best practices were identified. A complete list with descriptions for each challenge, pitfall and best practice can be found in the online appendix [24]. Table 4 shows how they are distributed over the maturity levels and categories. The identified challenges are distributed fairly evenly over the four maturity levels, while most best practices are reported in the second maturity level and most pitfalls are reported in the third maturity level. However, the distribution over categories shows a shift in focus; challenges, pitfalls, and best practices belonging to the more people-centric categories "Knowledge and Skills" and "Work Culture" are only represented in the lower maturity levels. On the other hand, challenges, pitfalls, and best practices related to "Methodology, Language, and Tools" occur in the second and third maturity level while elements related to "Modeling" occur in the third and fourth maturity level. The

Category		Maturity level										
		Level 1		Level 2			Level 3			Level 4		
	C	Р	BP	$\mathbf{C}$	Р	BP	С	Р	BP	$\mathbf{C}$	Р	BP
Work Culture	1	-	-	-	-	-	-	-	-	-	-	-
Knowledge and Skills	3	-	-	1	-	-	-	-	-	-	-	-
Management	-	-	3	3	3	9	-	2	2	2	2	1
Methodologies, Languages and Tools	-	-	-	1	-	3	1	-	1	-	-	-
Modeling	-	-	-	-	-	-	2	4	6	2	-	6

Table 4: Overview of all in the literature identified Challenges (C), Pitfalls (P), and Best Practices (BP) in MBSE Adoption.

only category that is represented across all levels is "Management". The categories "Management" and "Modeling" are by far the most populated categories, with 27 and 20 elements, respectively.

### 4.1 Maturity Level 1 – Initial Preparation

This maturity level marks the foundational phase of any organization's transition toward MBSE. It focuses primarily on preparing the workforce and management for upcoming changes, establishing a shared understanding, and addressing early challenges. This level sets essential prerequisites for a successful MBSE adoption.

There are no specific pitfalls mentioned in the literature that could be classified into Level 1 of this maturity assessment. We attribute this absence to the nature of the term itself. Pitfalls are defined as avoidable mistakes or traps that teams may fall into during the process of MBSE adoption. However, at this early level, the focus is on establishing a common ground and building the correct understanding, rendering it more about addressing fundamental challenges rather than avoiding missteps. These foundational aspects, like ensuring a mutual understanding of terms, goals, and reasons, are so critical that they tend to be classified as challenges or best practices, rather than pitfalls.

To demonstrate the use of the framework, we include an example for Level 1 (detailed descriptions of each challenge and best practice can be found in the online appendix [24]). A challenge for Level 1 is cultural resistance to change (C1). This challenge rises from the fact that engineers and stakeholders are traditionally accustomed to working with and reviewing documents, making the transition to models as primary artifacts a substantial shift in established workflows. A lack of training and time to adapt can lead to a deficiency in understanding MBSE's value and processes (see also C2). Such gaps not only foster skepticism but can create a belief among employees that their systems are too large or complex to be effectively integrated into an MBSE framework, leading to cultural resistance to change. This challenge can be mitigated by fostering an understanding of the value of MBSE (BP3). This Best Practice states that it is essential that employees not only understand the theoretical benefits of MBSE, but also recognize



Fig. 1: Simplified overview of Maturity Assessment Level 1: Initial Preparation

how it can improve their own work, such as enhancing efficiency, quality, and reducing effort. This understanding helps build a unified workforce that supports the transition. Targeted presentations and demonstrations of successful project experiences can further reinforce the value proposition and motivate engineers to collaborate toward successful adoption. This is crucial for fostering commitment and overcoming the inertia often encountered with organizational change (C1).

## 4.2 Maturity Level 2 – Planning and Structure

Once initial preparation is completed, this maturity level emphasizes strategic planning and structural decisions. Key actions include defining clear goals and scope, implementing progress metrics, managing expectations, and establishing the necessary infrastructure and teams. This sets a solid foundation for subsequent modeling efforts and enables the launch of MBSE in pilot projects.

For example, a Challenge at Level 2 is the need to define a clear scope and goals (C8). Without a well-defined scope, there is a risk of over-enthusiasm to model the whole organization (or a large part of it) from the start. This challenge leads to the Pitfall of having a fast false start (P1) with too many initiatives, causing skepticism within the organization, reinforcing the belief that modeling doesn't work. To avoid this Pitfall, organizations should think big, start small, and evolve (BP6). A strategic MBSE approach should begin by identifying clear, long-term goals, but manage the uncertainty and complexity of the transition by introducing small, manageable steps. Starting with a small, highly motivated group or a pilot project allows the organization to experiment in a controlled environment, learning from the specific challenges of the involved processes, domains, and tools. This approach helps to identify and resolve issues early, creating a foundation for broader adoption.



Fig. 2: Simplified overview of Maturity Assessment Level 2: Planning and Structure

#### 4.3 Maturity Level 3 – Pilot Projects

At this maturity level, organizations are applying MBSE to specific pilot projects. This is the first level to involve active modeling, requiring strategic decisions and preparatory steps to avoid early missteps. Key objectives include maximizing the return on pilot efforts, ensuring best practices in modeling, and building a foundation for sustainable MBSE use across future projects.

For example, a Challenge at Level 3 is a lack of a clear modeling purpose (C11). While high-level MBSE goals are clear, many struggle to ensure that individual models are tailored to answer well-defined questions or meet specific project needs. Without this clarity, there is a risk of overmodeling (P7) or creating models for the sake of modeling (P6), which can lead to inefficiencies and models that are not as effective or communicative as they could be. Therefore, it is essential to clearly define the model's purpose when embarking on any modeling initiative (BP19). These purposes should be articulated as specific questions that the model is intended to answer. This way the model is clearly finished when all relevant questions can be answered. By aligning each model with specific, measurable outcomes and reducing unnecessary maintenance efforts, organizations can ensure that MBSE drives meaningful results and supports business objectives effectively.



Fig. 3: Simplified overview of Maturity Assessment Level 3: Pilot Projects

### 4.4 Maturity Level 4 – Scaling MBSE Adoption

After pilot projects have been completed, the final maturity level focuses on scaling MBSE adoption across the organization. Here, the focus is on expanding the MBSE application, improving modeling efficiency, and establishing robust maintenance and long-term management of models. This level aims to secure the long-term value and success of the MBSE approach by fully integrating it within organizational processes.

For example, a Challenge at Level 4 is the need for reusability and model libraries (C16). Establishing modularity and reusability requires careful planning to ensure consistency and efficiency across the system models. The Pitfall of poor management and enforcement of reuse libraries (P11) occurs when libraries of reusable models are not properly maintained or consistently enforced. Without clear guidelines, teams may fail to use existing models effectively, leading to duplication of effort, inconsistencies, and wasted time. A key best practice when scaling MBSE adoption is to start developing and utilizing libraries of reusable model elements (BP30). As organizations gain experience through pilot projects, the creation of libraries for interfaces, components, and other reusable system elements becomes essential for accelerating future projects. Establishing modular and reusable libraries like interface-, component-, or unit-libraries, enables teams to avoid starting from scratch for each project, streamlining model development and fostering consistency across efforts. By making reusable models and modularity a cornerstone of the MBSE process, organizations can significantly accelerate project timelines and drive the successful scaling of MBSE across the enterprise.



Fig. 4: Simplified overview of Maturity Assessment Level 4: Scaling MBSE adoption

#### 4.5 Self-Assessment Questionnaire

The main goal of this questionnaire is to provide a pragmatic tool for organizations to easily identify at which maturity level of MBSE adoption they are. As stated in Section 2, we found limited guidance in the literature on developing such a questionnaire. Therefore, we formulated 3-5 questions per level covering the key aspects of that level. As long as all questions for a level can be answered with a "Yes", the organization progresses to the next level. The full set of questions can be found in the online appendix [24]. As an illustrative example, we include the self-assessment questions for Level 1:

- 1. Is there a shared understanding of MBSE across all involved teams and disciplines?
- 2. Is the workforce familiar with SE or the systems thinking approach? Do they understand thinking holistically about the system - understanding interactions and interdependencies between subsystems?
- 3. Have you already taken steps to clearly communicate the value of MBSE to relevant stakeholders?
- 4. Have you considered potential resistance from (senior) employees and provided training or developed plans to address skepticism and reluctance to change?

#### 5 Discussion

In this paper, we investigated the literature on challenges, pitfalls, and best practices for MBSE adoption. Challenges, pitfalls, and best practices were identified through a meta-synthesis of the literature and organized in a maturity assessment framework with four maturity levels, thus answering the research question.

The framework also provides a self-assessment questionnaire that allows practitioners to identify at what level their organization is situated.

Initial Evaluation: Expert Survey. To validate the structure and utility of the maturity assessment, we conducted an initial survey with eight domain experts. Overall, most participants agreed with the proposed framework. Most of their feedback can be summarized in the sense that they would prefer more detailed information. Another suggestion is to include a fifth level such that Level 4 would represent adoption by some teams, while Level 5 would signify widespread adoption across most of the company. This might better reflect the gradual scaling of MBSE efforts, according to one participant. The respondents also suggested enhancing the framework with a focus on tools and toy examples in the first two levels to increase employee involvement. Another recommendation was to include "applying MBSE to existing projects" as an alternative for pilot projects in Level 3, to increase the framework's applicability. Finally, respondents noted that currently, MBSE adoption efforts often begin bottom-up rather than top-down. This indicates that the adoption is typically initiated by employees with technical skills. With this framework, we hope to provide a useful tool for managers who want to adopt MBSE to improve their organization's SE processes.

The final overall feedback on the maturity assessment was largely positive, with six respondents agreeing that the maturity framework is meaningful. Additionally, they indicated they would consider using the maturity assessment professionally. The feedback emphasized the relevance and value of the maturity assessment. Comments included praise for its applicability, with one respondent specifically mentioning its alignment with their current MBSE program and another calling the work "very important".

Limitations and Future Work. While this paper provides a comprehensive framework for guiding organizations through the MBSE adoption process, it is not without limitations. The methodology relies on existing literature, which inherently reflects the biases, scope, and limitations of previous studies. As such, while the findings are rooted in established research, they may not capture emerging practices or innovations in rapidly evolving industries. We mitigated this limitation by conducting a survey with domain experts to collect feedback and suggestions rooted in current practice. Additionally, the high-level nature of the maturity assessment prioritizes generalizability over specificity. This leaves the task of deriving detailed, actionable steps to individual organizations; however, it ensures the broad applicability of the framework as a starting point across diverse organizations. The survey format was chosen to maximize accessibility and reach within the professional community, allowing participants to efficiently provide feedback. While it was recognized that this method might not yield the depth of insight possible through dedicated expert interviews, it enabled a broader and more time-efficient collection of initial feedback.

The feedback gathered from the survey offers specific possibilities for refinement. Future research could focus on validating and refining the maturity assessment framework through empirical studies and real-world case applications. Testing the tool's effectiveness in diverse organizational settings would not only provide valuable feedback for improvement but also enhance its credibility and practical relevance. Another suggestion from the survey participants is incorporating a fifth level into the framework and adjusting the focus of certain levels to align with earlier phases. As suggested by the respondents, this could better reflect the nuanced progression of MBSE adoption. Finally, as MBSE and the fields around it continue to evolve, ongoing research should aim to keep the framework up-to-date. Incorporating advancements will ensure the maturity assessment remains a relevant and effective resource for organizations navigating MBSE transitions. However, the proposed framework and self-assessment already provide significant added value by synthesizing an extensive set of findings from literature. The usefulness and applicability of the framework were confirmed by domain experts.

# 6 Conclusion

This paper presents a maturity assessment model for the adoption of MBSE in organizations. The framework synthesizes reported challenges, pitfalls, and best practices of MBSE adoption from 44 publications by means of a systematic literature review and organizes them into four cumulative maturity levels and five topic categories. The framework demonstrates that the focus of the challenges, pitfalls, and best practices shifts from more people-oriented categories ("Work Culture" and "Knowledge and Skills") to more technical categories "Methodologies, Language and Tools" and "Modeling") as the maturity level of MBSE adoption increases. This approach balances the complexity of MBSE transitions with actionable steps specific to the maturity level, naturally prioritizing and focusing on key areas that past projects highlighted as critical. The framework was evaluated by means of a survey with experts from the MBSE community. The overall reception was positive with six out of eight respondents agreeing that the assessment is meaningful for supporting MBSE adoption, while specific feedback was given on possible refinements and further research opportunities.

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