Approaches Adopted in the Implementation of Maturity Models Using Agile Initiatives in Public Bodies: A Systematic Literature Review

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Keywords: Maturity Model, Public Body, Agile Methodology, Systematic Literature Review.

Abstract: The implementation of maturity models is essential to ensure the competitiveness and quality of services provided by public bodies. By structuring their processes in a more flexible and adaptable way, organizations can answer more effectively to the demands of society, which is increasingly dynamic and demanding. However, adopting agile methodologies requires planning and care. The wide variety of agile methodologies available, such as Scrum, SAFe, Kanban, and others, can generate some confusion and make it difficult to choose the most appropriate approach for each context. A poorly planned implementation can result in process overload, team resistance, and, consequently, failure to achieve the expected results. To avoid these challenges, it is crucial that public bodies invest in a gradual and personalized implementation process, as well as in researching the models / processes adopted by other bodies. The choice of agile methodology must take into account the size of the team, the complexity of the project, the organizational culture, and the strategic objectives. In addition, it is essential to have the support of senior management and the engagement of all employees involved in the process. By adopting a gradual and personalized approach, companies increase their chances of success in implementing maturity models using agile methodologies. This paper presents a Systematic Literature Review (SLR) to identify the most effective approaches for implementing maturity models in public bodies. The SLR selected 13 primary studies that identified practices, recommendations, standards, implementation strategies, benefits, difficulties and points of attention found in the process of implementing such models. Furthermore, it was found that there were shared characteristics, regarding the implementation processes reported in the studies, among the bodies, which allows us to infer that other public bodies can use the results as a basis for adopting similar methodologies. This paper contributes by presenting, in a consolidated way, the recommendations that can facilitate the process of implementing maturity models. Ultimately, these recommendations allow managers of bodies and / or stakeholders to outline a plan for implementing maturity models in a clearer way, thus ensuring a more fluid process.

1 INTRODUCTION

Increasing technological complexity is one of the "main drivers" of the maturity models evolution. The rapid obsolescence of tools and the emergence of new technologies require constant adaptations in activities, methodologies, and processes, aiming to guarantee the competitiveness and relevance of organizations.

In this context, the adoption of maturity models in the software development process in public bodies aims to deliver solutions to the general population more quickly and effectively. However, the implementation of these models involves complex relationships, such as legal restrictions, slowness in the activities developed, strong hierarchies in the body, and others (Looks, 2022).

The evolution of software development methodologies was driven by the search for alternatives to traditional methods, often characterized by excessive bureaucracy (Nuottila et al., 2016). In this context, researchers in software engineering began to explore ways to make processes more flexible and dynamic, which led to the investigation of more agile approaches (Vacari, 2015; Almeida, 2017).

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Oliveira, A. G. S. and Oliveira, S. R. B.

Approaches Adopted in the Implementation of Maturity Models Using Agile Initiatives in Public Bodies: A Systematic Literature Review. DOI: 10.5220/001355640003964 In Proceedings of the 20th International Conference on Software Technologies (ICSOFT 2025), pages 120-131 ISBN: 978-989-758-757-3: ISSN: 2184-2833

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Taking this scenario into account, agile methodologies stand out for their flexibility and adaptability, overcoming the limitations of traditional approaches and promoting collaboration, continuous delivery and the ability to answer to changes (Gonçalves and Paiva, 2014). The growing search for greater efficiency and quality in processes has driven the adoption of maturity models in several areas, including software development (Gonçalves and Paiva, 2014).

Based on the context presented, this paper presents a Systematic Literature Review (SLR), carried out with the purpose of identifying the methodologies adopted for the implementation of maturity models using agile iniciatives in public bodies. To this end, 13 studies were identified and selected with the aim of presenting the maturity models adopted by other bodies to IT (Information Technology) managers in public bodies, as well as presenting recommendations for activities to be adopted in the context of implementing maturity models by presenting the agile practices adopted, their benefits and impacts on the organization, the difficulties and points for improvement and attention that may hinder the implementation of these models.

The results of the SLR present the scenario in which other public bodies were implementing maturity models and aim to facilitate and encourage the adoption of maturity models by other bodies.

In addition to this introductory section, this work is structured as follows: Section 2 presents some concepts on the topic of this research, Section 3 details the study design, Section 4 presents the results, Section 5 presents the discussions, Section 6 addresses some threats to the validity of this work, Section 7 brings some related works and Section 8 closes this work by presenting the conclusions.

2 BACKGROUND

This section introduces concepts related to the topics covered in this research.

2.1 Maturity Models

Maturity models are conceptual frameworks that aim to measure the degree of evolution and capacity of an organization in relation to a specific process. Such models seek to evaluate the efficiency and effectiveness of internal processes, providing a clear view of how organizational practices are being implemented, managed, and controlled (Carr et al., 2023). The concept of process maturity is related to the implementation of practices that result in better control, greater predictability of goals, cost reduction, and increased organizational performance (Lockamy and McCormack, 2004).

The maturity of a process is typically defined by incremental stages that require the implementation of progressively more sophisticated organizational practices (Škrinjar et al., 2008), ensuring a continuous development of organizational efficiency. This evolution by stages is crucial to achieving constant improvement (Vlahovic et al., 2010). Measuring process maturity is essential to understanding how processes are being managed and whether they are achieving the desired results. According to Gudelj et al. (2021), by measuring maturity, it is possible to identify gaps and opportunities for improvement, enabling a detailed analysis of how business processes are being implemented.

In addition to assessing maturity, it is equally essential to analyze the effectiveness of processes (Dumas et al., 2018). Process effectiveness can be defined as the degree to which planned tasks are performed according to established requirements, within a given time frame, and the compliance level with these requirements, according to previously defined criteria (Seyyedamiri and Tajrobehkar, 2019).

In this context, it is important to highlight that reference models, such as CMMI (Capability Maturity Model Integration) and MPS.BR (Brazilian Software Process Improvement), present welldefined criteria for assessing a company's maturity. This reinforces the idea that mature processes are directly related to effectiveness. By adopting these models, organizations can identify gaps in their processes, gradually implement improvements, and, consequently, increase their operational effectiveness.

2.2 Agile Methodology

For a long time, software development was tied to traditional methodologies that prioritize extensive documentation, detailed planning, and final product delivery. However, the growing demand for faster, more flexible solutions aligned with customer needs has driven the emergence of agile methodologies.

The Agile Manifesto, published in 2001, represented a milestone in the transformation of project management and software development, establishing a set of values and principles that opposed traditional approaches (Vacari, 2015). Agile values prioritize: individuals and interactions over processes and tools, working software over comprehensive documentation, collaboration with the customer over contract negotiation, and answering to change over following a plan. These values, although they emerged in the context of software development, are applicable in several areas, promoting greater flexibility, adaptability, and customer focus.

Agile methodologies such as Scrum, Kanban, and XP (Extreme Programming) are based on the principles of the Agile Manifesto and offer specific structures and practices for project management (Oliveira et al., 2020). Scrum, for example, divides the project into short cycles, called sprints, which allow teams to deliver value to the customer in an incremental and iterative manner. On the other hand, Kanban emphasizes the continuous work flow and process visualization, while XP promotes code quality, constant communication, and customer participation in development. The adoption of agile methodologies has provided several benefits to organizations, including greater customer satisfaction, cost reduction, improved quality of products and services, and increased team productivity. By prioritizing collaboration, adaptation to change, and continuous delivery of value, agile methodologies allow organizations to be more competitive in an increasingly dynamic and demanding market.

3 STUDY DESIGN

This section details the research methodology, including the objectives of the work and the research questions.

3.1 Goal and Research Question

This study aims to identify strategies and approaches applied in the implementation of agile maturity models in public bodies and which are reported in specialized literature. It is hypothesized that, in projects to implement maturity models in public bodies, there are practices, stages and attention points with recurring characteristics in public bodies, which should be taken into consideration during their implementation.

The Goal-Question-Metric (GQM) approach, developed by Basili (1992), was employed to formalize the research objective of this study. Thus, this study seeks to:

• Analyze: primary studies, by a Systematic Literature Review (SLR),

- In order to: identify the methodologies and strategies used in the process of implementing maturity models that are reported in the specialized literature,
- Regarding: the reduction of delivery time of software products and the evolution of processes related to software development processes,
- From the point of view of: public service collaborators and users,
- In context: of the public bodies.

Thus, we propose the following research questions (RQ):

- RQ1: How to implement maturity models in public bodies using agile methods?
- RQ2: What were the models and standards used?
- RQ3: What were the agile methods and practices adopted?
- RQ4: What were the benefits and impacts of implementing the models and standards?
- RQ5: What were the difficulties found in implementing these models?
- RQ6: What are the points for improvement / attention in implementing the methodology?

3.2 Method

To achieve the objective of this work, an SLR was conducted. SLR is a secondary study approach that aims to systematically identify, analyze and interpret relevant documents in primary studies, with the purpose of providing evidence related to the established research questions (Kitchenham and Charters, 2007).

We performed the SLR from May 2024 to October 2024. The study was organized in four steps, adapted from (Kitchenham and Charters, 2007; Petersen et al., 2015), as follows:

- Step 1 Definition of research questions: in this step, six research questions were defined based on the objective of the study (Subsection 3.1),
- Step 2 Search: in this step, based on the research questions, a replicable process was defined for carrying out the search for studies in selected scientific bases (Subsection 3.3),
- Step 3 Study selection: in this step a replicable process was defined and applied to select only the relevant studies according to the objective of this work (Subsection 3.4),
- Step 4 Study classification and data extraction: in this step, based on the research

questions, a strategy was defined to: (i) map the relevant data from the primary studies (Subsection 3.5) and (ii) present the results of the work (Section 4).

Two researchers participated in the planning and execution of the work: a master's studen in Computer Science and a professor / researcher with a PhD in Software Engineering.

3.3 Search Strategy

The search was carried out automatically using a string composed by a set of keywords and their respective synonyms. These keywords were defined based on the research questions, using the PICOC (Population, Intervention, Comparison, Outcomes and Context) structure suggested by Kitchenham and Charters (2007).

However, this study only aims to identify approaches related to the implementation of maturity models in public bodies, as reported in the literature, without intending to compare them. Therefore, the "Comparison" criterion was discarded. Furthermore, since the "Intervention" criterion addresses the actions that will be carried out, the inclusion of keywords for it proved unnecessary. Thus, the string was formulated with terms related to (i) population, (ii) outcome and (iii) context:

- Population: Public bodies,
- Outcome: Maturity model / practices applied by agile methods
- Context: Software development.

So the search string used was: ("cmmi" OR "spi" OR "iso" OR "model" or "standard" or "norm") AND "agile" AND ("method*" OR "practice" OR "technique" OR "principle") AND ("bod*" OR "agency" OR "administration" OR "sector") AND ("public" OR "government")

The search string was applied in the following databases: IEEE Xplore Digital Library, ACM DL, Scopus and Web of Science.

3.4 Study Selection

This phase of the research involved implementing inclusion (IC) and exclusion (EC) criteria to identify relevant works that specifically addressed our research questions. The IC and EC are detailed below:

• IC: (IC1) Studies with public bodies, and that can present a implementation case of the proposed approach (use of maturity models and

agile methods) and that can present an evaluation of the implementation,

• EC: (EC1) Studies before the agile manifesto (2001s), (EC2) studies that are not written in Portuguese and English, (EC3) duplicate studies, (EC4) studies not available for download openly or through the institutional IP of the researchers, (EC5) studies that are not full papers / articles.

We also included portuguese language because we need to analyze studies published in Brazilian conferences, which, even if written in portuguese, are indexed in repositories such as ACM and IEEEE (used to conduct the SLR), which are concerned with reporting applications of maturity models in public bodies.

Each of the studies underwent a four-step selection process: (i) two researchers conducted a preselection by reading the titles and abstracts of all studies and applying the exclusion criteria, (ii) the researchers discussed any discrepancies in the application of the exclusion criteria to reach a consensus, (iii) the researchers read the title and abstract, and the full text if necessary, of the studies selected in the first step to apply the inclusion criteria, and (iv) the researchers discussed any discrepancies in the application of the inclusion criteria to reach a consensus. This process resulted in 13 primary studies, which the list is available at https:// zenodo.org/records/14954696.

3.5 Study Classification and Data Extraction

The Parsifal database management tool was used in the review methodology to assist in the pre-selection and application of inclusion and exclusion criteria. The selected data were then organized and tabulated for quantitative analysis in Google Sheets. The results were displayed using tables and charts, enabling a quantitative analysis of the research data.

4 RESULTS

The results of the SLR are presented in this section. An overview of the results is presented in Subsection 4.1. Subsections 4.2, 4.3, 4.4, 4.5, 4.6, and 4.7 detail the results for RQs 1, 2, 3, 4, 5, and 6, respectively. Primary studies will be referenced and identified by codes in these subsections; these codes and tables (used to sumarize the data extracted) for this study are available at the URL presented in Subsection 3.4.

4.1 Overview

The SLR search was for studies published between 2001 and 2024. In this study, we analyzed studies based on different inclusion and exclusion criteria. The results obtained provide insight into the distribution and concentration of these components in relation to each of the criteria.

The results indicated a high concentration of studies excluded based on EC3, reaching 42 studies, out of the 74 excluded in the post-selection. This indicated a high rate of duplicate studies in the study context. On the other hand, EC1 and EC5 did not present any removal of the identified studies, EC2 removed only one study. EC4 had a modest count of 25 studies removed due to the impossibility of analyzing these studies; and finally, after applying IC1, only 13 studies remained. Thus, Table 1 presents the condensed results of application the criteria in the selection phase.

Repositories	Studies	Pre Selection	Post Selection
IEEE	7	2	0
Scopus	110	22	5
Web of Science	83	-12	6
ACM	515	52	2
Total	715	88	13

Table 1: Results of the Selection Phases.

Figure 1 highlights the scarcity of studies on the topic, due to its inherent complexity and the regulations that govern these bodies, often laws. The ingrained bureaucratic culture in these bodies also hinders the implementation of agile methodologies. However, in 2020 we saw an increase in publications, possibly due to the COVID-19 pandemic, which caused significant changes in the functioning of public bodies and the need for a new organizational paradigm.

In 2021, there was a decrease in the production of studies. However, it is important to highlight that the topic remained the subject of research in the following years, which highlights its continued relevance for the academic and professional community. This temporal analysis highlights the growing need to understand the crucial role of software engineering in public bodies, that is, to find ways to improve the software development process and, consequently, improve the delivery of solutions for the benefit of the population.



Figure 1: Distribution of studies per year.

Figure 2 presents a data analysis by country. It can be seen that, in Latin America, only Brazil contributed to research in this area, publishing three studies that represent 16.7% of the total scientific production in the period analyzed. In the other countries, academic production was mostly limited to a single study, with the exception of Germany, Italy and Spain, each with two studies published. This data highlights the greater concern of public bodies, especially Brazilians, with the issue in question.



Figure 2: Distribution of studies per country.

The analysis of Figure 3 reveals a predominance of studies published in journals (69.2%) compared to conferences (30.8%). However, it is important to emphasize that the choice of publication vehicle does not seem to be related to the geographic region, since both formats are present in all continents. This distribution suggests that the decision to publish in journals and / or conferences may be more linked to factors specific to each research, such as the target audience and the stage of work development.

4.2 RQ1: How to Implement Maturity Models in Public Bodies Using Agile Methods?

The studies analyzed made it possible to identify how maturity models are implemented in public bodies, taking into account the many obstacles faced throughout this process. In summary, only PS1, PS2, PS3, PS5, PS7 and PS10 studies present a flow or activities that must be followed to adopt these models. Table 2 (as can be seen in the URL defined in Subsection 3.4) presents the recommendations, the studies they cite and the percentage of occurrence.



Figure 3: Distribution by publication vehicle.

It is important to highlight that the studies cataloged show a greater concern with the organizational structure present in public bodies before the implementation of maturity models.

PS2, PS5 and PS10 studies highlight the importance of two crucial aspects for the successful implementation of maturity models in public bodies: the clear definition of roles, responsibilities and relationships between team members, and the establishment of an efficient communication model.

When defining roles, it is essential to align the existing organizational structure with agile principles. This involves assigning specific responsibilities to each member of the existing hierarchy in the organization, considering the agile methodology adopted. In addition, it is essential to establish clear and collaborative working relationships between the different bodies and teams. To this end, developing an effective communication model is essential to ensure the success of any project. It is necessary to define the most appropriate communication channels for each interaction, respecting the organizational structure and the needs of each team. For each project, it is crucial to establish a specific communication channel with stakeholders and members of other bodies, in order to ensure transparency and alignment of expectations when disclosing results and goals.

The authors of studies PS2, PS7 and PS10 consider that defining an iterative implementation plan is essential to ensure the success of the models implementation. By allowing constant monitoring of the process, it is possible to identify any deviations early and take corrective measures. In addition, the

interactive nature of the plan facilitates the validation of results, the adjustment of strategies and the promotion of organizational changes necessary for the effective integration of the models. This approach ensures continuous improvement of the process, adapting it to the needs and challenges of the organization.

In summary, the authors of the collected studies, in Table 2, demonstrate concern about the need to reformulate the structures and work processes in public bodies. The rigidity and complexity of these current structures make it difficult to effectively implement maturity models.

4.3 RQ2: What Were the Models and Standards Used?

After analyzing the selected studies, it was found that, of the 13 reviewed studies, only PS10 followed the guidelines of the MPS.BR (Brazilian Software Process Improvement model) standardizing body and proposed a process to implement this model. To this end, it integrated the development practices encouraged by agile methods, which are also suitable for the scenario of projects in micro and small enterprises (MSEs). The proposal combines these agile practices with the organized structure of process standardization offered by the MR-MPS-SW (MPS.BR Model for Software Development) model, seeking alignment between flexibility and formality in software development. This process was called Support for the Implementation of MPS - IAMPS.

PS1 chose to apply the Lean Management methodology. This methodology is an organizational philosophy first presented by Toyota, which has 5 phases: identifying value (from the customer's perspective), mapping the work flow for value delivery, defining a fluid and uninterrupted flow, developing a system that allows identifying whether a given task is necessary for value delivery and, finally, continuous process improvement.

In a similar way, PS2 proposed its own model called Hybrid Agile Model. It derived from the agile manifesto, this model aims to structure existing organizational units according to the development of human resources and the existing culture in the most flexible way possible, presenting the roles and responsibilities of each member, in order to complete the activities in the most effective and reliable way possible, being tolerant to organizational changes.

PS3 presented the ER²C SDMLC model, which is compatible with the ISO 15288:2015 standard. This life cycle model is based on the legal recommendations made to a government body in Australia. This model was developed to deal with continuous development systems, focused on managing risks present in product deliveries, in which different levels of rigor are applied according to the project stage.

PS5 presented a variation of the Scrum model called Scrum@PA, in which it is more concerned with the data destination. In this sense, new roles are created to deal with this responsibility and existing roles such as the Scrum Team assume the responsibility of considering the population needs.

PS7 adopted Lean Enterprise Architecture (LEAD), a mandatory standard organizational model for local government, which was adapted due to its complexity and associated costs. LEAD is flexible to the size of the companies that adopt it and combines an operational model based on the value chain with agile Enterprise Architecture (EA) practices, focusing on the strategic alignment between IT and business, by linking EA directly to business demands and adding value to the customer.

Finally, PS9 described the implementation of the Structured Agile Framework (SAFe), a set of organizational standards and work flows designed to apply agile practices on a large scale in companies. It offers a structured body of knowledge that provides detailed guidance on roles and responsibilities, work planning and management, and the values that must be maintained throughout the process.

These different approaches highlight the methodological diversity adopted by public bodies and companies, which adjust their choices according to the organizational context, applicable standards, and available resources. This flexibility in selecting and adapting models aims to overcome the specific challenges of each organization, ensuring greater efficiency and adherence to institutional needs.

4.4 RQ3: What Were the Agile Methods and Practices Adopted?

Research question 3 aims to identify the agile methods and practices adopted during the implementation of a maturity model in public bodies. Thus, Table 3 (as can be seen in the URL defined in Subsection 3.4) presents the methods and practices cited in the study, as well as the percentage of their occurrence during the investigation.

Based on the analysis of the collected studies, in Table 3, we identified a set of common practices in agile projects and present in the aforementioned studies. These practices include: (i) daily meetings for team synchronization, where the team is presented with what each member did the previous day, what

they plan to do, and possible impediments that may occur during its execution, (ii) iterative planning, in which the tasks that will be performed are planned and taken from the backlog for the next sprint in order to define the goals, (iii) retrospective, a meeting at the end of each cycle in which what worked and the improvement points are discussed so that there is continuous learning, (iv) the use of a backlog, a prioritized list of all tasks that need to be done in a project, to manage the work, (v) collaborative communication between team members, (vi) incremental delivery of value to the customer, allowing for better management of the product's customer expectations, progress and (vii) requirements engineering to ensure alignment with user needs, (viii) risk analysis to mitigate uncertainties, and (ix) collection of metrics to monitor project performance.

When analyzing the methods and practices used, there is a convergence around the principles of the Agile Manifesto. However, it is important to emphasize that each public body makes specific adaptations to meet its particularities and the context in which it operates.

4.5 RQ4: What Were the Benefits and Impacts of Implementing the Models and Standards?

Research question 4 aimed to identify the benefits and impacts of implementing maturity models in the context of public bodies. In this sense, Table 4 (as can be seen in the URL defined in Subsection 3.4) presents the benefits identified, the studies that cited the benefit, as well as the percentage of occurrence of the same.

According to the reports in PS2, PS3, PS5 and PS10, the approach with stakeholders is a fundamental element for the success of any initiative, be it a project, a product or an organizational strategy. By involving stakeholders from the beginning of the process, organizations can reap several benefits such as the active participation of stakeholders, the dissemination of the work stages as well as their expected objectives, which promotes a greater sense of cohesion throughout the stages.

Strategic alignment as presented in PS2, PS3, PS5 and PS10 aims to present the business values and objectives to be achieved more quickly and effectively with the implementation of maturity models. This practice ensures that agile projects are aligned with the organization's long-term vision, optimizing resources and maximizing the impact of initiatives. The definition of risk profiles (PS2, PS3, PS5 and PS10) is essential to identify, classify and evaluate potential deviations and their impacts on a company's activities. By mapping these risks, it is possible to establish an effective management plan, allowing greater control over processes, optimization of resources and more assertive decision-making. This approach contributes to risk mitigation, crisis prevention and continuous improvement of organizational processes by allowing the application of different rigor levels to the process (SP3) in line with the levels of risks involved.

Increasing the capacity and maturity of a body is an evolutionary and continuous process. As evidenced in the PS1, PS2, PS3 and PS10 studies, the implementation of maturity models provides a structured framework to consolidate the experiences and skills acquired over time. This systematic approach allows for the identification of gaps (PS4 and PS5), optimization of processes (PS1 an PS10) and promotion of sustainable growth of the organization by reducing rework rates (PS10).

In summary, there are several benefits and impacts that can occur during the implementation of maturity models in public bodies. Such occurrences are linked to the evolutionary process of the work process that acts as catalysts in the transformation of public bodies, which contributes to the modernization of public management and the delivery of more efficient and effective services to society.

4.6 RQ5: What Were the Difficulties Found in Implementing These Models?

Research question 5 sought to identify which difficulties are most common in implementing maturity models in public bodies. To better visualize this information, Table 5 (as can be seen in the URL defined in Subsection 3.4) shows that the main problems are related to the bureaucracy that exists in public bodies, whether at the communication level or due to greater forces that are often external to the bodies.

PS2 and PS7 studies show that the rigidity of the organizational structure is one of the main challenges for the successful implementation of maturity models in public bodies. In order to overcome this barrier, it is essential to promote a restructuring that allows for greater flexibility and integration between the different bodies, aligning them with a common objective.

PS2 and PS13 studies highlight the difficulty of interfunctional communication as a significant

obstacle to the implementation of maturity models. The lack of integration between the different bodies prevents effective collaboration and the exchange of information, compromising the achievement of organizational objectives.

PS7 and PS13 studies point out that legal restrictions represent a significant challenge for the implementation of maturity models in public bodies. The requirement to adopt rigid and inefficient processes, such as TOGAF and others, for example, limits the flexibility and capacity for innovation of organizations.

As highlighted in the PS2 study, the lack of funding is a crucial challenge for public bodies. The lack of financial resources for the execution of projects compromises the capacity of these bodies to meet the demands of society, limiting their social role and making it difficult to achieve their objectives.

The PS13 study highlights the following problem: the rigid hierarchical structure. This structure is an obstacle to the participation of employees in decisionmaking. This centralization of power hinders fluid communication and the exchange of ideas, limiting innovation and the organization's adaptation to changes.

The difficulty in defining roles and responsibilities, addressed in PS2 study, is intrinsically linked to the organizational culture. The resistance of employees to taking on new responsibilities may be a reflection of a culture that values the comfort zone and discourages proactivity. The implementation of maturity models requires a cultural change that encourages collaboration, autonomy and a sense of responsibility.

Finally, the PS2 study also highlights the difficulty that public bodies have in assessing the progress and success of their projects. The lack of clear metrics and indicators, as well as an effective monitoring system, makes it difficult to measure results and identify areas for improvement.

4.7 RQ6: What Are the Points for Improvement/ Attention in Implementing the Methodology?

During the implementation of maturity models, identifying points that require improvement and collecting data from previous experiences are crucial to ensuring the success of the initiative. By analyzing reports from other studies, it is possible to outline a more effective action plan, overcoming common challenges and optimizing results. Table 6 (as can be seen in the URL defined in Subsection 3.4) summarizes the main points for attention identified in

PS2, PS5 and PS9 studies, presenting the points for improvement / attention, the studies that cite them, as well as the percentage of occurrence in order to provide support for other bodies seeking to implement maturity models.

Continuous training of employees is a fundamental pillar for the implementation of maturity models in public bodies, being cited in 23% of the studies identified (PS2, PS5 and PS9). By promoting learning about the steps that concern a maturity model, bodies ensure that changes are understood and applied effectively, contributing to the integration of these methodologies into the organizational culture. In this way, maturity models are perceived as useful tools for improving processes and not as obstacles imposed by management.

The development of an effective Communication Plan is a fundamental strategic tool for the successful implementation of maturity models in public bodies (PS2 and PS5). It ensures that all stages of the process are communicated in a clear, objective and transparent way to all those involved, from senior management to base employees, so that everyone involved understands the purpose of the practices and tools adopted and that they aim to improve the body's productivity.

The creation of multifunctional teams (PS5) is one of the pillars for the successful implementation of maturity models. By bringing together professionals from different areas, these teams provide a holistic view of the processes, stimulate innovation and ensure the construction of more complete and effective solutions. Additionally, the active involvement of all stakeholders (PS9), from the beginning of the process, is crucial to foster a sense of belonging and commitment to change, contributing to the sustainability of results.

5 DISCUSSION

The studies presented in Section 4 demonstrate the clear concern regarding the implementation of maturity models in public bodies at many stages. It is observed that one of the main factors that impede implementation is the bureaucracy that exists in the organizational structure of these companies. However, the cataloged studies present several recommendations with the aim of minimizing and overcoming these problems commonly found in public bodies, such as: the definition of roles, authorities, interrelationships, communication models and others, valuing agile principles.

It is observed that the studies do not define in detail, examples of documents or ceremonies, the way to implement each of these recommendations, given that each body has its own peculiarities. However, there are reports of the context and objectives of each recommendation in which these implementations were made in order to serve as a guide for other bodies. In addition, the fact that these recommendations can be followed gradually and iteratively allows for greater flexibility when implementing these maturity models, since following them creates a solid basis for the adoption of agile methodologies in software engineering.

Furthermore, it is important to highlight that several models and standards used during the implementation of maturity models by the bodies where the studies were conducted are presented. This is due to the context in which these bodies are inserted, as is the case of PS10 study, which presents a process to support the implementation of the MR-MPS-SW, a model supported by the Ministry of Science, Technology and Innovation (MCTI) in Brazil, at the Federal University of Mato Grosso do Sul (UFMG), while PS7 study presents a case of implementation of LEAD, a model derived from Enterprise Architecture (EA) that is mandatory in Finland. These examples highlight the diversity in the adoption of maturity models, which reinforces the idea that there are recommendations for activities, rather than rigid obligations.

Regarding the recommended practices in the process to be implemented, the presence of the practices described in the agile manifestos is common. Practices such as: daily, planning, retrospective, maintenance of a backlog and iterative delivery are present in at least half of the identified studies, which indicates their relevance and the added value in the agile processes adopted.

Regarding the benefits acquired by the implementation of maturity models, some aspects are important to highlight. The proximity with stakeholders not only ensures a more fluid process, but also avoids constant rework, since such proximity allows for a better understanding of the customer / population needs. Similarly, the strategic alignment encouraged by the implementation of maturity models contributes to greater delivery of value, which enables greater use of the work products delivered by the body.

Regarding the difficulties faced during the implementation of maturity models, the greatest incidence was observed in relation to the adjustment of the organizational structure, legal restrictions and communication between the different bodies of the body. These issues are characteristic of public bodies, due to the regime, culture and bureaucracy associated with public service. Although they may or may not be solved quickly, they require careful attention.

In this sense, in addition to the difficulties mentioned above, it is essential to pay attention to the continuity of the implementation of the agile maturity model, which involves conducting training, creating an effective communication plan and recognizing the real importance of the process for the organization.

In short, agile maturity models present recommendations and good practices that can be followed by bodies that wish to adopt this model regardless of legal restrictions, standards and other problems that may arise as long as some effort is made. This occurs due to the possibility of customizing the process to be implemented in order to adapt it to the reality of each organization.

As for the innovative aspect of this paper, we can characterize it is presenting findings on the implementation of Maturity Models and Agile Methods used in Public Bodies, which is quite scarce when researching on the subject.

6 THREATS TO VALIDITY

This section addresses potential threats to the validity of this study and the steps taken to address validity issues using the framework proposed by Wohlin et al. (2000).

6.1 Construct Validity

To test the effectiveness of the search string and ensure that SLR provided relevant studies, four studies that met the search criteria were manually selected. The search string was then run against the databases, and the same four studies were returned, confirming the effectiveness of the string.

6.2 Internal Validity

To ensure impartiality and accuracy, during the extraction process, studies were assessed and ranked through discussions and consensus in weekly meetings. We recognize that the subjective judgment inherent in some studies can introduce bias, and we sought to mitigate this through this collaborative and judicious approach to study selection.

6.3 External Validity

It is possible that SLR does not provide all relevant studies on strategies and approaches applied in the implementation of agile maturity models in public bodies. To mitigate this risk, we identified and relied on analogous studies, thus avoiding starting the search from scratch.

6.4 Conclusion Validity

In order to ensure the conclusion validity, Section 4 presents tables that illustrate the results obtained directly from the data. The observations, approaches, and concerns that emerge from these results are discussed to ensure a high degree of traceability between data and conclusions. The corpus of the study is available to other researchers, and the SLR process was supervised by a professor with a PhD and extensive experience in studies of this nature, with a track record of several publications in software engineering.

7 RELATED WORK

Okan and Akca (2024) conducted a Systematic Literature Mapping (SLM) aiming to identify and compare the maturity models proposed between 2010 and 2022. To this end, the authors selected and evaluated 17 works. The main reports refer to the evaluation of the maturity models implemented by Public Bodies, which, according to the authors, are more consolidated because they consider the context of application.

From the related work, it is noted that there is some distinction in relation to this work, as it focused on identifying the approaches adopted in the implementation of maturity models in public bodies.

8 CONCLUSION

This work presented the execution of a Systematic Literature Review, carried out between May and October 2024, aiming to identify the approaches adopted for the implementation of agile maturity models in Public Bodies. In this sense, 13 works were selected from 715 found in the repositories: ACM, IEEE, Scopus and Web of Science; which covered a period of 23 years (2001 to 2024).

As a result of this investigation, several recommendations were identified to be followed

during the implementation of agile methods, such as the definition of roles, responsibilities, interrelationships, communication models, among others. These recommendations allow other managers, implementers and/or stakeholders to develop plans based on the experiences of other bodies, setting clear goals and objectives.

The authors of this paper reiterate these last statements because the findings obtained in the SLR, and which were described in the paper, served as a support instrument for the managers of 2 Public Bodies located in Brazil for the implementation of maturity models using agile methods during the mapping of their software development processes. In fact, these statements defined in the paper were extracted from feedback provided by these managers after applying the paper's findings.

Ultimately, this work can be used to highlight some contributions to society and academia, such as:

- Dissemination of implementation cases on the agile maturity models by other public bodies,
- Presentation of common practices and recommendations,
- Presentation of the benefits and impacts of implementing maturity models,
- Alerting to possible difficulties that may arise during the process,
- Points of attention that should contribute to effective implementation,
- Reduction in waste of resources;

Therefore, the results of this research offer an overview that can guide bodies interested in adopting agile methodologies in their work process, allowing for greater delivery of value to the population that depends on the services provided by them.

As for the limitations of the work, there is a low number of implementation reports on agile maturity models in the literature by public bodies. Another important point to highlight is the existence of studies that could not be included in the research due to the unavailability of access to them.

With regard to future work, the results of this review can be considered as a basis for further investigation of the problems related to the implementation of maturity models by public bodies. In this way, it is expected to identify the factors that lead to many attempts to adopt maturity models to failure. Furthermore, investigating other bodies that have adopted agile maturity models and analyzing and adapting recommended practices, according to the results of this SLR, can facilitate the adoption of these models by Public Bodies.

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