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Proposal of a performance measurement system model: overcoming effectiveness barriers

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Abstract

Although the importance of Performance Measurement Systems (PMS) is recognized by organizations in general, it is found that many of these systems are ineffective and end up being discredited. The research question inherent to this work is: how to develop a PMS capable of mitigating the main barriers to the effectiveness of this kind of system? Subsequently, the main objective of this paper is to present a new PMS, called PMS_UM, together with the respective implementation methodology, capable of reducing the impact of the most common barriers to effectiveness, something that the current PMS do not achieve. The research was conducted in the period 2021-2024, and, in terms of methodology, this paper relies on the designated Grounded Theory as it systematically brings together the knowledge needed to develop a robust and effective PMS model and implementation methodology from a set of four studies previously carried out and published by the authors. The methodology begins with identifying barriers to PMS effectiveness through scientific articles, interviews and questionnaires. It then focuses on recognizing existing PMS (and their characteristics) that can mitigate some of these barriers and developing solutions (and necessary PMS characteristics) for unaddressed barriers. All characteristics are classified into groups and their relationships are mapped to develop an effective PMS model. The process integrates theoretical research with practical organizational insights. The main results of this work are (i) the PMS_UM model, which encompasses the critical characteristics needed to be an effective PMS, along with (ii) the corresponding practical methodology for development, implementation and maintenance. Both the model and the methodology are evaluated based on their ability to mitigate or eliminate the most common barriers to PMS effectiveness, thus demonstrating the better performance of PMS_UM compared to existing PMS. As for practical implications, this work provides managers with the means to, step by step, obtain a robust and effective PMS that truly reflects the state of the company and is therefore an essential tool not only for day-to-day management but also to support any improvement intervention. The PMS_UM model and methodology have not yet been tested in real-world scenarios, which is, at the moment, the main limitation of this work.

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1. Introduction

The search for better ways to perform tasks is an intrinsic aspect of human nature (Carvalho, 2021). Continuous Improvement can be described as a continued involvement of everyone in the organization in finding, targeting and eliminating waste (Gupta & Jain, 2013). A pivotal element of the continuous improvement effort in an organization is performance measurement, which is the starting point for continuous improvement because it allows to identify where performance improvement is needed and should be done. This is facilitated

by an effective Performance Measurement System (PMS), designed to determine what, how, where, when, and why to measure performance (Zairi, 1994). The process of designing and implementing a PMS can be defined as the process of defining objectives, develop performance indicators, collect, analyse, report, interpret, review and act on performance data (Bititci, 2015). The complexity of PMS often leads them to failure. Some studies show that most attempts to implement PMS fail (Langwerden, 2015; Malagueño et al., 2018; Todorut et al., 2013), showing that as much as 70% of the attempts are unsuccessful (McCunn, 1998). It becomes essential to



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understand the reasons behind these high failure rates and finding ways to enhance the effectiveness of PMS design, implementation, and usage in an organization.

This study aims to introduce a PMS model and methodology that more effectively addresses the most common barriers to PMS effectiveness when compared to existing approaches in the literature. The research method Grounded Theory was employed in this study. This research method is a qualitative approach used to systematically gather and analyze data to develop a theory grounded in empirical evidence, specifically it refers to a theory that is grounded in or developed inductively from a set of data (Saunders et al., 2019). Using Grounded Theory, data was collected and analyzed simultaneously.

The data collection and analysis were conducted in four previously published articles authored by the researchers. In the first study (Cunha et al., 2023), the main barriers to PMS effectiveness were identified. In the second, (Cunha et al., 2024c), perceptions of these barriers within a specific organization were explored. This organization, an industrial unit specialized in the transformation of foam products for the automotive industry, is part of a large multinational company. To simplify the reading, it will be referred to as Company X throughout this article. The third study examined the ability of existing PMS to mitigate or eliminate the identified barriers (Cunha et al., 2024a). Finally, in the fourth study (Cunha et al., 2024b), the essential characteristics of an effective PMS were analysed.

The objective of this study is to develop a PMS model and methodology that more effectively eliminates or mitigates the most common barriers to PMS effectiveness compared to existing approaches in the literature. The paper is structured into the following sections: Experimental, Results and Discussion, and Summary and Conclusion.

The Methods section details the methodologies employed to develop the framework. In the Results and Discussion section, the framework is introduced and explained, engaging in an analysis of the strengths and weaknesses of the framework. Finally, the concluding section encapsulates the findings of the study and offers directions for future research in this domain.

2. Literature review

The primary role of a PMS is to align the organization and translate strategy into actionable outcomes (Fantozzi et al., 2023). Developing and utilizing a PMS involves a comprehensive process that includes defining objectives, establishing performance metrics, and systematically gathering, analyzing, reporting, interpreting, reviewing, and acting on performance data (Bititci, 2015). However, the complexity and breadth of this process present a significant challenge for organizations in both development and implementation (Fantozzi et al., 2023).

Several studies have explored PMS. Ghalayini & Noble (1996) highlight the limitations of existing PMS. Others, such as Kennerley & Neely (2002) and Gabris, (1986) and Ukko & Saunila (2020) identify and discuss what they consider the main barriers to PMS implementation. Some researchers,

rather than focusing on challenges or limitations, emphasize critical areas within a PMS, as seen in Zairi (1994), or define the key characteristics a PMS should possess, as proposed by Fitzgerald & Moon, (1996).

This study aims to address the research question: how to develop a PMS capable of mitigating the main barriers to the effectiveness of this kind of system?. It is part of a broader investigation which includes four previously published articles authored by the researchers each contributing to answering this question.

In the first study published by Cunha et al. (2023), a systematic literature review (SLR) was conducted to identify the main barriers to PMS effectiveness, following the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analysis) methodology (Moher et al., 2009), which includes identification, screening, eligibility, and inclusion phases. The search was performed on the Scopus and Web of Science databases, focusing on publications with "performance measurement" as a keyword, cited in at least five articles, and belonging to fields like Engineering, Management, Business, Social Sciences, and Computer Science. The initial search yielded 1787 and 1728 publications from Scopus and Web of Science, respectively. After removing duplicates, 2808 publications remained. Titles and keywords were screened to exclude non-PMS-related works, narrowing the list to 258 publications. Abstracts were then reviewed, leading to the removal of 176 more items. Finally, detailed analysis of the remaining 82 publications identified 31 relevant works discussing barriers, obstacles, or difficulties in implementing and maintaining a PMS. These 31 publications were used for the analysis of obstacles to PMS effectiveness. A thorough examination of these publications revealed 175 references to barriers affecting PMS effectiveness. These barriers were subsequently categorized into 19 distinct types based on their shared meaning. The types of barriers were (Cunha et al., 2023):

1. Blame culture
2. Lack of connection to strategy
3. Issues on target definition
4. Unclear system
5. Lack of top management involvement
6. Poor communication system
7. High complexity
8. Lack of use for improvement
9. Lack of balance of indicators
10. Lack of rewards
11. False expectations
12. Inappropriate IT tools
13. Excess of indicators
14. Lack of trained resources
15. Lack of employee involvement
16. Inappropriate indicators
17. Lack of indicator understanding
18. Time and resources required
19. Difficulties in collecting, analysing, and presenting data

This first study also explored the cause-and-effect relationships between these barriers. Complex interactions were identified, revealing that some barriers may cause or stem from the existence of other barriers. These interactions are represented in Appendix A, where the arrows express the probable cause-effect relationships between different barriers.

In the second study published by Cunha et al. (2024c), the perception of the 19 identified barriers across different hierarchical levels within Company X was explored. Interviews and questionnaires were conducted with 32 respondents, comprising 23 employees, 6 middle managers, and 3 top managers from Company X. The data collected revealed that the main perceived barriers were: poor communication system, lack of trained resources, issues on target definition, lack of employee involvement, indicators understanding and use for improvement (Appendix B).

Chi-square tests were also performed on the data to determine whether responses were influenced by the respondents' degree of education, gender, shift, department, or role in the company (employees, middle management, and top management). The analysis revealed that individuals' perceptions of certain barriers are significantly influenced by their category, particularly their role in the company.

The third study published by Cunha et al. (2024a), aimed to identify the main PMS documented in the literature and assess their ability to eliminate or mitigate the 19 previously identified barriers. It also sought to understand what makes each PMS capable, or not, of addressing these barriers. To identify the main PMS referenced in the literature, a systematic literature review was conducted. Following the PRISMA methodology, the search targeted scientific articles, books, and book chapters in the Scopus and Web of Science databases using the keywords "performance measurement framework" or "performance measurement model" and focusing on subject areas such as Engineering, Business, and Sociology. This search yielded 2098 publications from Scopus and 3784 from Web of Science.

After removing 25 duplicates, 5857 publications remained. Titles and keywords were screened, leading to the exclusion of 5725 publications. Abstract analysis of the remaining 132 publications resulted in the removal of 60 more. Finally, 72 publications underwent detailed review, and PMS frameworks or models were identified in 39 of them.

. Within these 39 publications, 95 different PMS were identified. However, only 28 PMS were considered for the study, as only those referenced in more than one publication were included.

These 28 PMS were analysed and classified based on their ability to eliminate or mitigate each of the barriers. Each PMS was scored for each barrier as follows:

- 0: if it had weak or no capacity to eliminate or mitigate that barrier;
- 1: if it had some capacity;
- 2: if it had strong capacity.

The resulting classifications are shown in Appendix C.

The study also explored which barriers were least effectively addressed by the PMS. Appendix D illustrates the

barriers, ranked from the most addressed to the least addressed by the analysed PMS.

The fourth study published by Cunha et al. (2024b) aimed to identify the main characteristics required for PMS effectiveness, linking them to the main barriers and exploring the relationship between these characteristics. To identify these characteristics, a systematic literature review was conducted following the PRISMA methodology. In the identification phase, a search for scientific articles, books, and book chapters was conducted in Scopus and Web of Science databases using the keywords "performance measurement" and "characteristics," targeting items with at least one citation. This search yielded 2647 publications from Scopus and 3905 from Web of Science. After removing duplicates, 5762 publications remained. Titles and keywords were analysed, excluding 5611 publications. Abstract analysis of the remaining 151 publications resulted in the exclusion of 63. The final detailed analysis of 88 publications identified 27 works describing characteristics an effective PMS should have.

Within these 27 publications, 221 references to characteristics of effective PMS were identified.

These 221 references were grouped into 16 different categories based on their similar meanings. The resulting 16 types of characteristics related to PMS effectiveness were:

1. Linked to the strategy
2. Balanced (multidimensional indicators)
3. Appropriate indicators
4. Stimulate continuous improvement
5. Deployment through the organization
6. Stakeholders involvement
7. Effective communication
8. Dynamic (updatable)
9. Link performance to rewards
10. Documented procedures
11. Appropriate target definition
12. Simple system
13. Data management
14. Resources and training
15. Clear system
16. Appropriate IT tools

3. Experimental

To develop the PMS model, the methodology outlined in Fig. 1 was followed. Several steps within this methodology led to the publication of articles, which collectively contributed to achieving the final step of this methodology and culminated in this publication.

Firstly, was investigated why PMS models fail by identifying the main barriers to their effectiveness (Cunha et al., 2023). The methodology used for this was a systematic literature review that followed the PRISMA methodology.

The second step involved identifying perceptions of these barriers across different hierarchical levels at Company X (Cunha et al., 2024c). This identification was performed by collecting primary data through interviews and questionnaires, and analysing the obtained data through statistical analyses.

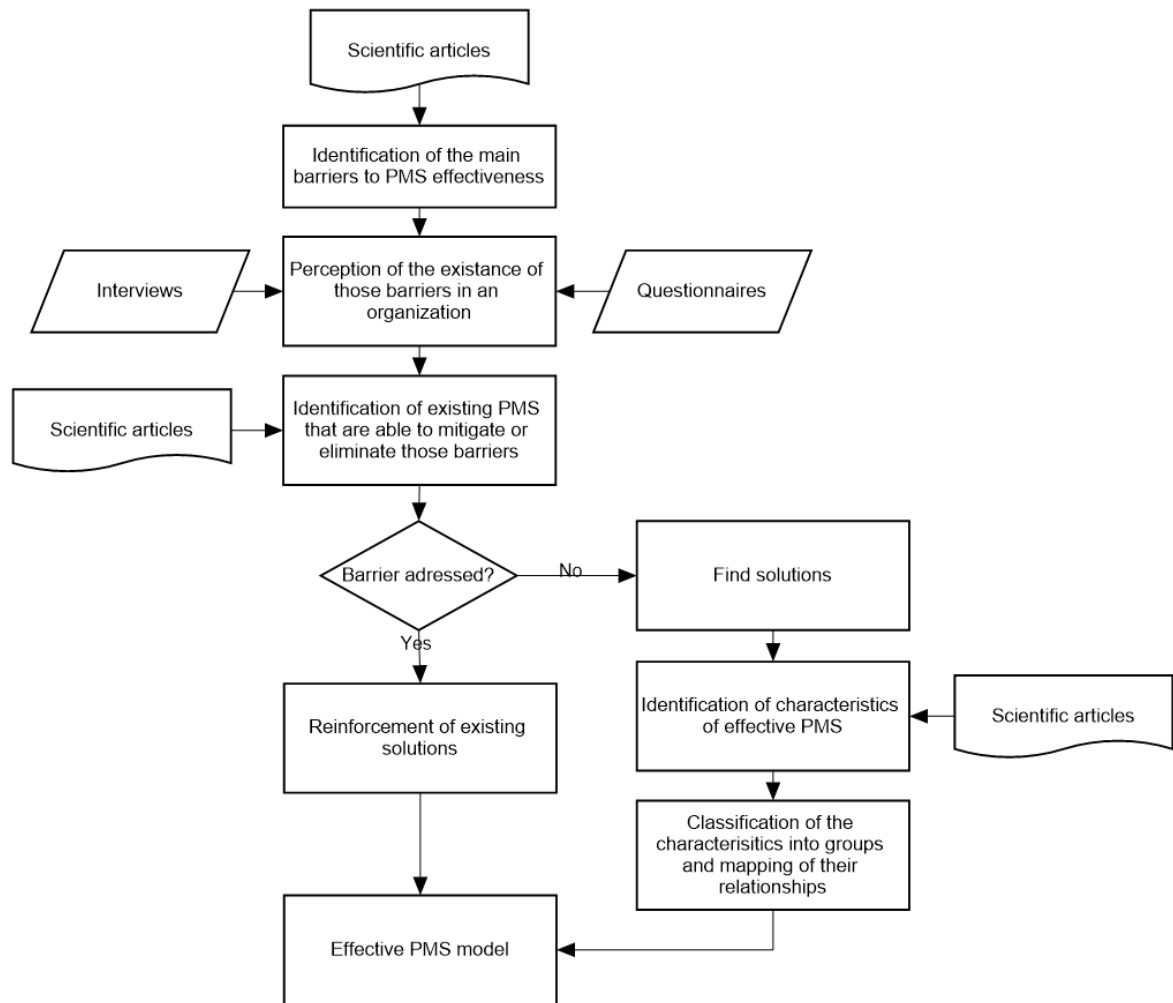


Fig. 1. Methodology adopted (Authors' own work) (Symbols legend in Appendix F)

The third step involved identifying existing PMS models in the literature and classifying them based on their ability to mitigate or eliminate each of the barriers to PMS effectiveness (Cunha et al., 2024a). The methodology used for this was a systematic literature review that followed the PRISMA methodology. Since no existing PMS model was found to effectively mitigate or eliminate all the identified barriers, the next step was to develop solutions for each barrier to PMS effectiveness. To achieve this, the key characteristics of effective PMS were identified (Cunha et al., 2024b) through a systematic literature review that followed the PRISMA methodology. Then the relationships between these key characteristics were explored and mapped, as well as their connections to the barriers.

Next, these characteristics were grouped into categories based on their similarities. These groups formed the foundation for developing a new, effective PMS model, the PMS_UM model.

The resulting PMS_UM model and methodology, developed through this methodology, are presented in detail in the Results and Discussion section. The PMS model is classified according with its ability to mitigate or eliminate the most

common barriers to PMS effectiveness, using the same methodology used by Cunha et al. (2024a).

The PMS_UM model is also evaluated by being compared to the existing PMS in Company X. For this, a questionnaire was performed. In this questionnaire, 32 individuals were randomly asked to classify, using a Likert scale, their perception of their PMS effectiveness and the presence in the organization' PMS of the key characteristics of the PMS model presented in this study (Appendix G). A five-point Likert scale was used (Joshi et al., 2015), ranging from 1 to 5 (1– Strongly disagree, 2– Disagree, 3– Indifferent, 4– Agree and 5– Strongly agree). For the data extracted from the questionnaire a descriptive statistical analysis (Boone & Boone, 2012) and a chi-square test (Pandis, 2016) were performed to ascertain whether the answers depend on the respondents degree of education, gender, shift, department or role in the company (employees, middle management and top management). The hypothesis tested with the chi-square test were:

- H0. The variables are independent; there is no relationship between the categorical variables.
- H1. The variables are dependent; there is a relationship between the categorical variables.

To test these hypotheses, the expected frequencies for each variable were first calculated. Then, the difference between observed and expected frequencies is assessed using the chi-square test, from which the p-value was obtained. If the p-value is greater than 0.05, the null hypothesis (H_0) is accepted, indicating a small difference between the observed and expected values. If the p-value is less than 0.05, the null hypothesis is rejected, indicating a significant difference between the observed and expected values (Pandis, 2016).

4. Results and discussion

The 16 key characteristics of effective PMS, identified by Cunha et al, (2024b), were grouped into four dimensions: Culture, People, Data and Tools, and Indicators. These groupings

were based on the meaning of each characteristic. Additionally, three characteristics were identified as common to all dimensions and were not assigned to any single dimension but were considered as overarching characteristics.

4.1. The proposed PMS_UM model

The proposed effective PMS model, incorporating these dimensions and characteristics, is represented in Fig. 2. The characteristics in the model are not represented by their importance but rather by their hierarchy of precedence. According to the proposed model, an effective PMS should encompass four dimensions: Culture, People, Data and Tools, and Indicators.

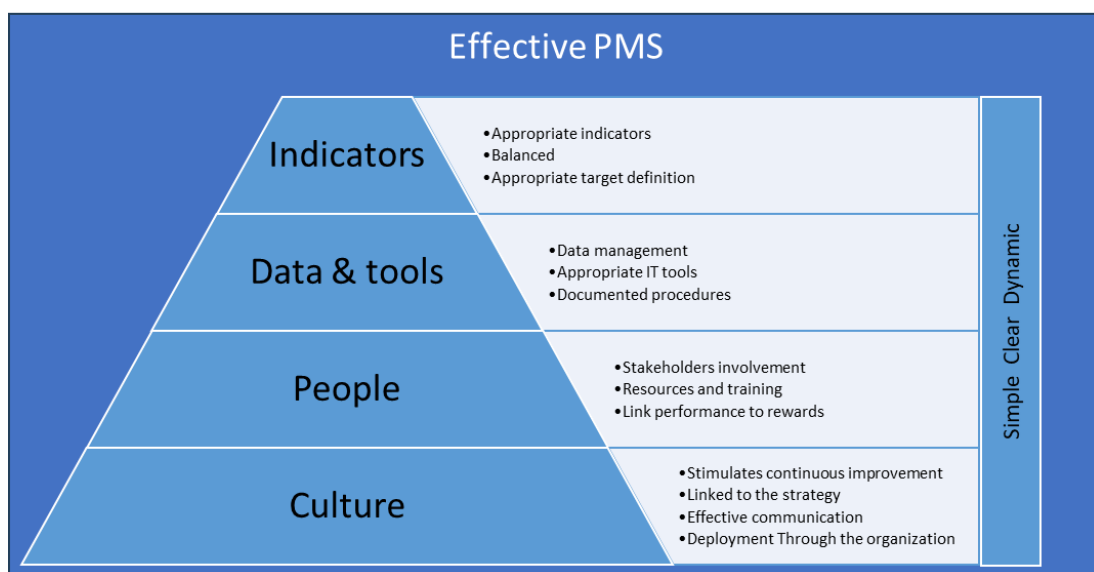


Fig. 2. PMS_UM model (Authors' own work)

The first dimension to consider is Culture. The organization's culture forms the foundation of the PMS and should instill key characteristics into the system. It should stimulate continuous improvement, assure that the PMS is linked to the organization's strategy, that there is an effective communication system linked to the PMS and that there is an effective deployment of the PMS through the organization.

Next in the hierarchy is the People dimension. This dimension should assure the stakeholders involvement in the PMS (mainly top management and employees). It should also assure that there are appropriate trained resources to implement, use and maintain the PMS. It should also ensure that appropriately trained resources are available to implement, use, and maintain the PMS, and establish a link between performance and rewards (both financial and non-financial).

The third dimension, Data and Tools, should ensure the presence of an appropriate data management process that allows an effective collection, analysis and presentation of data. It should provide appropriate IT tools to support this process and include documented procedures on how to collect, analyse, and present data, as well as other key aspects of the PMS.

The final dimension is Indicators. This dimension should ensure the existence of appropriate, balanced (multidimensional) indicators and the proper definition of targets for these indicators.

Three characteristics are inherently associated with all the dimensions of the PMS presented above. Those characteristics are simple, clear and dynamic (updatable) system. All aspects of the PMS should be as simple and clear as possible. Additionally, the PMS should be dynamic, allowing for updates as needed to keep the system up to date.

4.2. Methodology for PMS_UM model implementation

The operationalization of this model, or the methodology of implementation of a PMS according with the PMS_UM model presented above can be described according with Fig. 3. The first steps, or the pre requirements to design and implement a PMS according with the presented model is to have a culture that stimulates continuous improvement in the organization. It is also necessary for the organization to have a properly defined strategy.

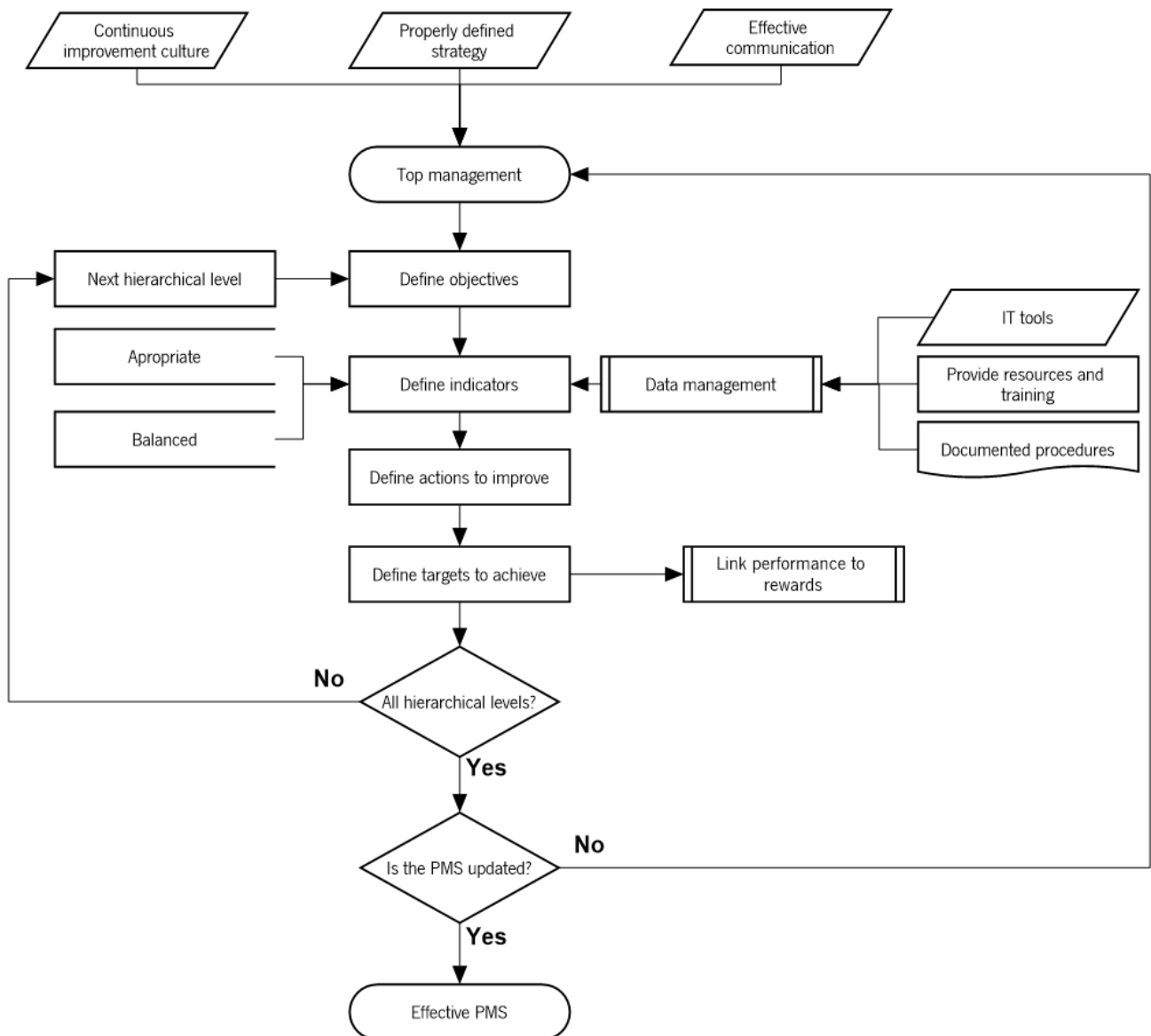


Fig. 3. Methodology to design and implement a PMS (Authors' own work) (Symbols legend in Appendix F)

Next, top management should derive objectives from the established strategy. Based on these objectives, they need to define appropriate and balanced indicators to monitor performance effectively. It's important to consider the data management required to calculate these indicators, the necessary IT tools, and the documentation of procedures related to both indicators and data management.

Actions that can positively influence the indicators and contribute to achieving the objectives should be clearly defined. Targets associated with the indicators should be set for specific time periods. The attainment of these targets should be directly linked to the evaluation of the individuals responsible, thereby connecting performance to rewards.

Based on the objectives defined by top management, a top-down deployment should occur across every department and hierarchical level. In this process, objectives, indicators,

actions, and targets should be established in the same manner as they were for top management.

This model was also classified according to the method used by Cunha et. Al (Cunha et al., 2024a), where the PMS is evaluated based on its ability to mitigate or eliminate each barrier. The classification scale is as follows: 0 indicates a weak capacity (red colour), 1 indicates some capacity (yellow colour), and 2 indicates a strong capacity (green colour). The total score is calculated by summing the values assigned to the PMS for its effectiveness in addressing each barrier. The detailed classification can be observed in Table 1.

When comparing the classification obtained by PMS_UM model with that obtained by the PMS classified by Cunha et al. (2024a), it is evident that this model achieves a significantly higher classification. This PMS_UM model achieves a score of 92%, whereas the highest score obtained by any PMS in Cunha et al. (2024a) study was 66% (Appendix G).

Table 1. Classification of the PMS model according to his capacity to mitigate or eliminate each barrier (Authors' own work).

Barrier	Classification
1. Blame culture	●
2. Lack of connection to strategy	●
3. Issues on target definition	●
4. Unclear system	●
5. Lack of top management involvement	●
6. Poor communication system	●
7. High complexity	●
8. Lack of use for improvement	●
9. Lack of balance of indicators	●
10. Lack of rewards	●
11. False expectations	●
12. Inappropriate IT tools	●
13. Excess of indicators	●
14. Lack of trained resources	●
15. Lack of employee involvement	●
16. Inappropriate indicators	●
17. Lack of indicator understanding	●
18. Time and resources required	●
19. Difficulties in collecting, analysing, and presenting data	●
Total	35 (92%)

4.3. PMS_UM model characteristics

Each key characteristic represented in the model and methodology is explored below:

a) *Stimulate continuous improvement*

To successfully design and implement a PMS, fostering a culture of continuous improvement is essential. This culture is a key enabler of stakeholder involvement and plays a crucial role in overcoming common barriers such as lack of use for improvement, blame culture, and false expectations. By emphasizing continuous improvement, organizations can encourage proactive actions aimed at genuine progress, rather than falling into the trap of believing that mere measurement leads to improvement. Focusing on improvement rather than assigning blame helps to avoid the development of a blame culture.

A PMS that fails to drive performance improvement risks becoming irrelevant to stakeholders, ultimately leading to its failure (Kennerley & Neely, 2002; Meekings, 1995; Neely & Bourne, 2000; Schneiderman, 2013).

Cultivating a culture of continuous improvement is fundamentally an organizational challenge that extends beyond the PMS itself. However, this culture can and should be integrated into the PMS. While the PMS should serve as a tool for accountability, it must never become a vehicle for blame. To align with this culture, improvement targets should be set at every organizational level, and specific actions that can positively impact performance indicators should be identified and implemented (Ghalayini & Noble, 1996; Jonsson & Lesshammar, 1999). This process can be effectively managed through the application of PDCA (Plan, Do, Check, Act) cycles (Carvalho, 2021).

b) *Linked to the strategy*

The PMS must be closely aligned with the organization's strategy. This alignment is critical, as it directly impacts other key aspects of the PMS. For instance, indicators must be strategically linked to ensure their relevance and appropriateness, as they are intended to measure the performance of objectives derived from the organization's strategy.

Effective deployment of the PMS throughout the organization hinges on maintaining this strategic connection. Top management should derive objectives directly from the strategy, and subsequent hierarchical levels should then derive their objectives from those set by top management. If this strategic link is broken, the PMS may still be implemented, but it will likely focus on measuring and improving objectives that do not align with the organization's strategic goals.

A dynamic PMS is essential to maintaining this strategic alignment over time. It must be adaptable, allowing for updates when the organization's strategy or focus changes, ensuring that the PMS remains a relevant and effective tool for driving performance in line with the organization's evolving priorities.

c) *Effective communication*

Effective communication is crucial for ensuring stakeholder involvement and successfully deploying a PMS across an organization. A well-designed PMS, characterized by clarity and simplicity, facilitates efficient communication, which in turn depends on appropriate data management.

Inadequate communication can lead to poor employee involvement and a lack of understanding of indicators. This issue is often exacerbated by the system's complexity and difficulties in data collection, analysis, and presentation. The more complex the PMS, the harder it becomes to maintain effective communication. Conversely, communication becomes more straightforward when reliable and clear data is available, enabling effective feedback to stakeholders.

To achieve effective communication within the PMS, objectives and indicators should be clearly and consistently deployed throughout the organization, accompanied by regular updates on the status of these indicators. Employees need to be aware of their performance metrics and understand how their actions influence these indicators, either positively or negatively. Communication should be clear, simple, regular, and formal (Franco & Bourne, 2003).

Strategies and objectives should be formally communicated to all relevant parties and can also be displayed within the organization through signs and posters. Performance indicators should be communicated as frequently as possible, utilizing methods such as team performance boards or digital displays to keep everyone informed.

d) *Deployment through the organization*

Effective deployment of a PMS throughout the organization is crucial for securing stakeholder involvement and establishing appropriate targets. This deployment must be closely linked to the organization's strategy and supported by effective communication.

Successful deployment is key to mitigating or eliminating the barrier of lack of employee involvement. This is achieved by systematically cascading objectives, indicators, targets, and actions across every level and function of the organization (Behery et al., 2014; Franco-Santos et al., 2007; Stríteská et al., 2016). By following a top-down approach, you ensure that all levels remain aligned with the organization's strategic goals (Mettänen, 2005).

In the proposed model and methodology, this process is represented by a cycle in which the definition of objectives, indicators, actions, and targets is repeated across all hierarchical levels. This cyclical approach ensures that the deployment is comprehensive, reaching every part of the organization and remaining firmly grounded in the organization's strategy.

e) *Stakeholders involvement*

Stakeholders encompass a wide range of parties with an interest in the organization, but for the PMS, the primary focus is on top management and employees. Ensuring their involvement is critical to avoiding disengagement from both groups.

Stakeholder involvement requires an effective deployment throughout the organization. A simple and clear PMS is essential for fostering this involvement, as increasing complexity and ambiguity can lead to a sense of disconnection from the system. Additionally, a culture of continuous improvement is a significant enabler, encouraging stakeholders to engage with the system by focusing on performance enhancement rather than assigning blame.

Linking performance to rewards is another powerful motivator for stakeholder involvement. When stakeholders see a direct connection between their performance and tangible rewards, whether financial or otherwise, they are more likely to understand and actively influence their performance indicators to achieve the desired targets.

In the proposed model and methodology, stakeholder involvement is integrated through the deployment cycle mentioned earlier, the connection between performance and rewards, and the emphasis on maintaining a culture of continuous improvement. These elements work together to ensure that stakeholders remain engaged and committed to the PMS.

f) *Resources and training*

Allocating the necessary resources and providing adequate training are critical for the effective implementation and maintenance of a PMS. While this applies to all aspects of the PMS, it is particularly crucial for data management. To manage data effectively and develop appropriate indicators, it is essential to have personnel with the right training and expertise. This approach helps eliminate two major barriers to PMS effectiveness: the lack of trained resources and the time and resources required for proper implementation.

Implementing and sustaining a PMS demands significant financial and human resources (Bahri et al., 2017; Hudson Smith & Smith, 2007). It is essential that these resources are not only available but also well-trained in the specific skills needed to implement, use, and maintain the PMS effectively (Tung et al., 2011).

The operationalization of resource allocation and training must be tailored to the unique needs and complexities of each organization. While the proposed model and methodology highlight the importance of providing resources and training, they do not prescribe a specific approach, recognizing that the best methods will vary depending on the organization's context.

g) *Link performance to rewards*

A PMS should link performance to rewards (Cocca & Alberti, 2010; Franco-Santos et al., 2007; Lee & Lee, 2023; Lehtinen & Ahola, 2010; Stríteská et al., 2016; Tung et al., 2011) as a way of ensuring employee involvement and motivation to continuously improve and achieve the established targets. This connection between performance and rewards serves as a powerful motivator, encouraging employees to engage actively with the PMS and strive toward the organization's goals.

For this approach to be effective, however, it requires the careful and appropriate definition of targets. The success of linking rewards to performance hinges on setting clear, achievable, and strategically aligned targets for each hierarchical level and function within the organization.

The proposed model and methodology incorporate these principles, recommending that the linkage between performance and rewards be established only after performance targets have been defined for each level and function. This ensures that rewards are directly tied to meaningful and relevant performance outcomes, reinforcing the overall effectiveness of the PMS.

h) *Data management*

Effective data management is essential for establishing accurate and relevant indicators within a PMS. As a critical support infrastructure for the PMS (Franco-Santos et al., 2012), data management encompasses the entire process of data acquisition, collection, sorting, analysis, interpretation, and dissemination (Franco-Santos et al., 2007). These steps are crucial for calculating performance indicators both accurately and in a timely manner.

To ensure the success of this process, it is necessary to have documented procedures, appropriate IT tools, and well-trained resources. These elements work together to create a robust data management system that underpins the reliability of the performance indicators.

In the proposed model and methodology, data management is identified as the foundational support process for performance indicators. This process relies on the appropriate IT tools, documented procedures, and trained resources, which will be discussed in greater detail within the broader context of the model.

i) *Appropriate Information Technology (IT) tools*

Appropriate IT tools are a fundamental requirement for effective data management within a PMS (Cocca & Alberti, 2010; Ukko & Saunila, 2020). These tools are crucial for establishing an efficient information system that ensures the timeliness, integration, aggregation, and accurate scope

definition of the information used to calculate performance indicators (Munir et al., 2012).

In the proposed model and methodology, IT tools are depicted as integral to data management and are a prerequisite for generating reliable performance indicators. Simply put, indicators can only be developed if the underlying data and tools facilitate their accurate calculation.

The suitability of IT tools will vary based on the specific needs and complexities of each organization. Depending on these factors, the IT solutions may range from basic spreadsheet applications to sophisticated, customized software tailored to the organization's unique requirements.

j) Documented procedures

Documented procedures are a crucial component of effective data management and are essential for developing appropriate performance indicators within a PMS. Clear and well-documented processes contribute to maintaining the simplicity and clearness of the system, ensuring that all stakeholders can easily understand and engage with it.

To keep the PMS straightforward and accessible, all aspects related to process indicators, data collection methods, and relevant information should be thoroughly documented (Cocca & Alberti, 2010; Franco-Santos et al., 2012; Lehtinen & Ahola, 2010; Mettänen, 2005; Wouters & Wilderom, 2008). This practice not only enhances the clarity of the system but also supports the accurate calculation and interpretation of indicators.

In the proposed model and methodology, this requirement is represented within the "data and tools" dimension and is considered a prerequisite for developing reliable indicators. A comprehensive understanding of both data and indicators is critical, and therefore, each indicator should be meticulously documented with the following information:

- Identification Details: Including the indicator's name, decision center, time horizon, and reporting period.
- Objectives and Drivers: Clearly outline the objectives associated with the indicator and the underlying factors influencing it.
- Potential Adverse Effects: Identify any possible negative consequences or unintended effects related to the indicator.
- Required Data: Specify the data necessary for the indicator's implementation.
- Data Processing Methods: Detail the methods used to process the data for accurate indicator calculation.
- Visual Reporting: Utilize graphical representations to ensure that the indicator is communicated clearly and effectively.

This comprehensive approach to documenting indicators aligns with the standards outlined in ISO 22400:2014 (ISO/TC 184/SC5, 2014), ensuring that the PMS adheres to best practices and maintains a high level of quality and transparency.

k) Appropriate indicators

Indicators play a crucial role in a PMS and must meet several key criteria to be effective. They should be closely aligned with the organization's strategy, balanced, and fulfil other

essential characteristics to ensure their appropriateness and utility.

In the proposed model and methodology, indicators are addressed in the "indicators" dimension. This dimension is achieved through the integration of various characteristics outlined in the model, such as alignment with strategic objectives and balance. Indicators should derive from the strategic objectives defined by the organization and be supported by robust data management practices to ensure their accurate and timely calculation.

To ensure indicators are appropriate, they should possess several key characteristics. Recommendations for effective indicators include frameworks such as SMART (Specific, Measurable, Attainable, Relevant, Time-bound) (Kerzner, 2017) and ISO 22400:2014 (ISO/TC 184/SC5, 2014), which outlines a comprehensive set of attributes: alignment, balance, supported, validity, quantifiability, precision, real-time capability, predictiveness, actionability, traceability, relevance, correctness, completeness, clarity, automation, consensus, documentation, comparability, understandability, and cost-effectiveness.

Indicators are fundamental to measuring performance within a PMS. They provide the basis for setting targets and driving actions aimed at performance improvement. By meeting these criteria, indicators ensure that performance measurement is both meaningful and actionable, ultimately guiding the organization toward its strategic goals.

l) Balanced (multidimensional indicators)

Indicators must be balanced, meaning they should be multidimensional to provide a comprehensive view of performance (Baird, 2017; Behery et al., 2014; Cocca & Alberti, 2010; Munir et al., 2012; Naslund & Norrman, 2019; Střiteská et al., 2016; Tung et al., 2011; Ukko & Saunila, 2020). Achieving this balance involves considering various dimensions, including financial vs. non-financial, leading vs. lagging, efficiency vs. effectiveness, internal vs. external factors, and integrating indicators both vertically and horizontally across different levels (Bahri et al., 2017; Franco-Santos et al., 2007; Pedersen & Sudzina, 2012).

Maintaining this balance also requires mapping and documenting the influence of each indicator on overall performance and understanding how indicators interact with each other—whether their effects are positive or negative.

The proposed model and methodology address this balance by incorporating it into the "indicators" dimension. This integration ensures that the process of defining indicators considers these multidimensional aspects, providing a more holistic approach to performance measurement.

m) Appropriate target definition

Appropriate targets definition requires appropriate indicators and effective deployment of the PMS across the organization. This alignment is crucial for linking performance to rewards and enhancing stakeholder involvement.

Appropriate target definitions are essential for setting objective performance criteria (Neely et al., 2000). They involve establishing performance targets that both the organization

and individuals strive to achieve (Baird, 2017; Choong, 2014; Cocca & Alberti, 2010; Franco-Santos et al., 2007; Lee & Lee, 2023; Ukko & Saunila, 2020).

In the proposed model and methodology, this concept is integrated within the "indicators" dimension. Targets should be defined only for indicators that have already been established and for specified time periods.

Targets must be clear and attainable to provide direction and purpose. This clarity empowers stakeholders to direct their efforts effectively toward achieving shared goals and reinforces their engagement with the PMS.

n) Simple system

Simplicity in a PMS is crucial for ensuring stakeholder involvement and effective communication. The complexity of the system can hinder the effectiveness of the communication to employees, thereby jeopardizing their involvement.

A PMS should be simple to understand, use (Cocca & Alberti, 2010; Ghalayini & Noble, 1996; Jonsson & Lesshammar, 1999), and maintain (Cocca & Alberti, 2010; Yang et al., 2015). Simplicity in all aspects of the PMS is important because increased complexity will require more resources for management and maintenance, which can hinder the PMS effectiveness (McCunn, 1998).

The proposed model and methodology emphasize this principle across all dimensions of the PMS. It advocates for maintaining simplicity to enhance the overall effectiveness of the system. This is particularly critical when defining indicators, where focusing on a limited number of key performance metrics aligned with strategic objectives ensures clarity and manages complexity.

o) Clear system

A clear system is essential for effective communication and stakeholder involvement. When a PMS is clear, it becomes easier to communicate and understand, which enhances user engagement and ensures that stakeholders remain involved. The appropriateness of indicators plays a key role in achieving clarity. When indicators are relevant and well-defined, stakeholders can easily understand what is being measured, how it is measured, where it is measured, and why it is measured (Zairi, 1994).

The PMS should be explicitly defined with a clear purpose (Cocca & Alberti, 2010; Strítěská et al., 2016), and roles and responsibilities should be clearly assigned (Cocca & Alberti, 2010). Ambiguity in the PMS can lead to misalignment with its intended use and may result in failure. It can also cause confusion among employees, reducing their involvement due to a lack of understanding.

The proposed model and methodology incorporate this need for clarity as a fundamental characteristic across all dimensions of the PMS. The approach emphasizes striving for maximum clarity to ensure the system is effectively implemented and understood.

p) Dynamic (updatable)

A PMS must be dynamic and updatable to ensure ongoing alignment with the organization's strategy. It should be

capable of adapting to changes in both internal and external circumstances (Ghalayini & Noble, 1996; Jonsson & Lesshammar, 1999; Lehtinen & Ahola, 2010; Neely et al., 2000; Strítěská et al., 2016; Striteska & Svoboda, 2012), maintaining its relevance over time (Hudson Smith & Smith, 2007). Regular evaluation is necessary to confirm that the PMS remains current and effective (Cocca & Alberti, 2010).

To be dynamic, a PMS should exhibit the following traits (Suwignjo et al., 2000):

- Sensitivity to Change: It should be responsive to shifts in both the internal and external environments of the organization.
- Objective Review and Reprioritization: The system must allow for the review and adjustment of internal objectives in response to significant changes.
- Implementation of Changes: It should facilitate the modification of objectives and priorities to ensure continuous alignment with the organization's evolving strategy.
- Sustained Improvement: The system must ensure that performance improvements are maintained over time.

A dynamic PMS supports regular review and updates to stay aligned with strategic changes, ensuring that performance measurement evolves with the organization's needs.

The proposed model and methodology incorporate this dynamic characteristic as a core element across all dimensions of the PMS. This means that any changes in the organization that necessitate updates will prompt a review and potential revision of the PMS. This dynamic trait is also present in the question if the PMS is updated, if not, it should be reviewed completely from the top down.

4.4. Evaluation of the PMS of Company X

When comparing the proposed model and methodology with the PMS implemented in Company X through a questionnaire, the results presented in Appendix J were obtained. Additionally, the responses were analysed to determine whether they were influenced by factors such as respondents' education level, gender, work shift, department, or role within the company (employees, middle management, and top management). The results of this analysis are shown in Appendix K.

The analysis revealed that the responses were dependent on the following factors:

- Education level: 55% of the questions.
- Gender: 0% of the questions.
- Work shift: 28% of the questions.
- Department: 11% of the questions.
- Role within the company: 6% of the questions.

Notably, respondents with a basic level of education and those working shifts (A or B) were more likely to classify several questions as "disagree" or "completely disagree." This trend was particularly evident in questions 1, 5, 6, 7, 10, 12, 14, 16, 17, and 18. These questions highlight key features of the proposed PMS model and methodology, such as effective deployment through the organization, effective communication, and the system's simplicity, clarity, and dynamism.

These findings suggest a lack of involvement from employees with a basic education and working in shifts, many of whom are production operators. The failure to effectively deploy the PMS through the organization has led to their disengagement, as indicated by their perception that communication within the system is ineffective, and the PMS itself is not functioning in an effective manner. Furthermore, there is a widespread perception that the PMS lacks simplicity and clarity, which may be a critical factor contributing to the disengagement of employees with lower levels of education, as these characteristics are essential for their understanding and use of the system.

Overall, the organizational PMS is perceived as ineffective, primarily because it lacks several essential characteristics outlined in the proposed model and methodology for an effective PMS. This lack of key features, including clarity and simplicity, is likely a major contributor to the low level of employee involvement.

4.5. Discussion

The proposed PMS_UM model as well as the methodology to design and implement it responds to the research question and are the key contributions of this study to the knowledge in the field of Performance Measurement Systems. The capacity of a PMS to mitigate or eliminate a set of 19 known barriers was used to evaluate existing PMS models. The PMS_UM model obtained the highest score (92%) of all known PMS, and the highest score obtained by the second best was 66%, the ECOGRAI model.

The compilation of a list of 16 characteristics that should exist in an effective PMS was used to build the PMS_UM model and also represents an important contribution of this study.

An interesting work to be done in the future is the application of the methodology and model proposed in a company in order to adjust the details of the methodology. This is not easy to achieve because the company will have to have some dimension, and the leaders would have to be fully committed to a project of this magnitude.

5. Summary and conclusion

This study aimed to address the research question: how to develop a PMS capable of mitigating the main barriers to the effectiveness of this kind of system? The objective was to propose a new PMS, termed PMS_UM, along with its implementation methodology, designed to reduce the impact of the most common barriers to effectiveness, a gap that existing PMS frameworks fail to address. The result is the PMS_UM model, introduced along with an associated methodology, with its effectiveness assessed in terms of its ability to eliminate or mitigate the main barriers to PMS effectiveness. This assessment includes a comparison with existing models, as well as an evaluation against the current PMS of Company X through a questionnaire distributed across various hierarchical levels and departments.

The proposed PMS_UM model is based on key characteristics of PMS effectiveness, which are organized into four dimensions:

- Culture: Stimulates continuous improvement, linked to the strategy, effective communication, and deployment throughout the organization.
- People: Stakeholders involvement, resources and training, link performance to rewards.
- Data and Tools: Data management, appropriate IT tools, documented procedures.
- Indicators: Appropriate indicators, balanced, appropriate target definition.

Certain characteristics, such as simplicity, clarity, and dynamism, were recognized as essential across all dimensions of the PMS. The model's design and implementation process begins with fostering a culture of continuous improvement, establishing a well-defined strategy, and ensuring effective communication—prerequisites for top management setting clear objectives. Following this, appropriate and balanced performance indicators should be defined, supported by an efficient data management process that includes appropriate IT tools, resources and training, all documented in formal procedures.

Once indicators are established, actions that positively influence these indicators should be identified, and performance targets should be set for specific time periods. These targets should be linked to rewards, acting as an enabler of stakeholders involvement. This process should be repeated across all hierarchical levels, starting with the definition of objectives. Additionally, the entire process should be revisited whenever there are significant changes in the internal or external environment, ensuring that the PMS remains updated and aligned with the organization's strategy.

When evaluated using the methodology of Cunha et al. (2024a), the proposed model achieved a classification of 92%, significantly outperforming other PMS models previously assessed in the study by Cunha et al. (2024a).

Furthermore, by applying the proposed model and methodology for an effective PMS to assess an existing system within Company X, using a questionnaire distributed to multiple employees, it was possible to identify critical gaps in the organization's PMS. Several essential features of the proposed PMS model were missing in Company X's current system, rendering it ineffective in the eyes of its own employees.

In conclusion, the presented PMS_UM model includes all the characteristics identified as key to an effective PMS and that none of the existing ones can fulfil. The model and methodology offer valuable insights for managers and employees involved in designing, implementing, and maintaining an effective PMS.

The PMS_UM model is unique since it includes all the characteristics that have been identified as key to an effective PMS which none of the existing models do. The systematic nature of the methodology presented means that for each objective and indicator defined at each of the hierarchical levels, all characteristics are taken into account in order to guarantee their effectiveness. This is not the case with the models found in the literature.

The main limitation of the study is essentially the lack of implementation of the model in a company. Another limitation of this study lies not in the PMS_UM model itself, but in the many challenges of implementing the model in an organisation. Many of the challenges are the same as those identified in the literature as barriers to the effectiveness of a PMS.

An important piece of future work will be to use the model and the proposed methodology in a company and identify its real effectiveness. It is also necessary to develop mechanisms and good practices to overcome each barrier and fulfil each key characteristic of the proposed PMS_UM.

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Appendix

Appendix A

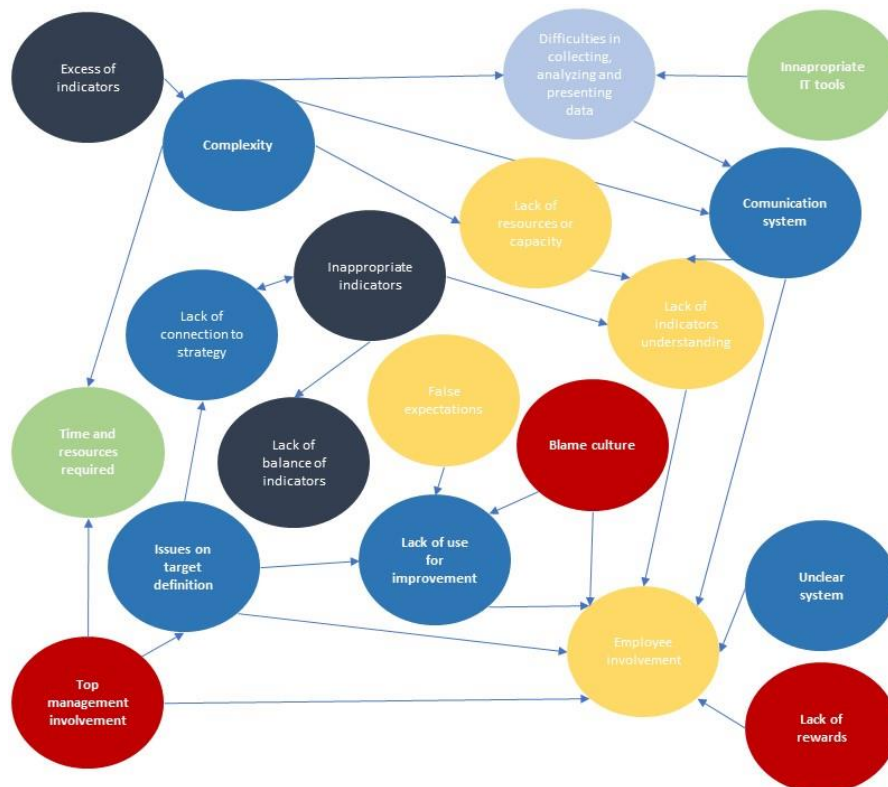


Fig. 4. Interaction between the types of barriers (Cunha et al., 2023)

Appendix B

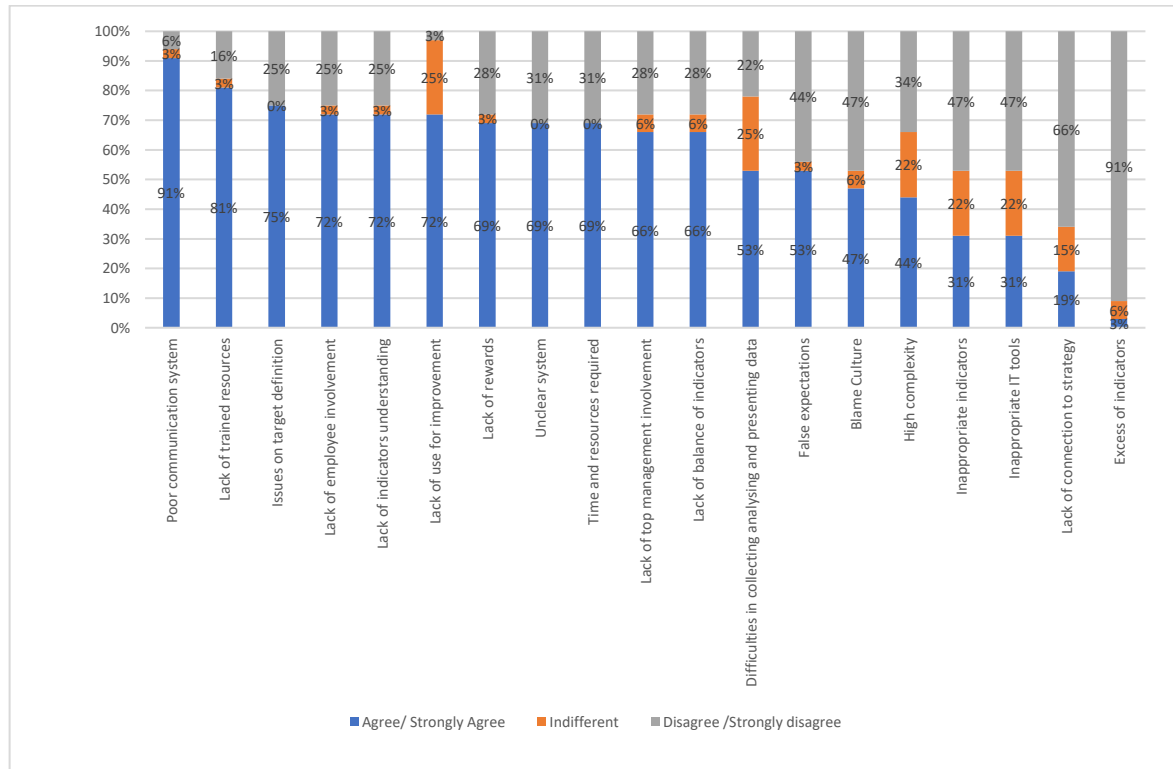


Fig. 5. Likert scale classification of the existence of the barriers in Company X (Cunha et al., 2024c)

Appendix C

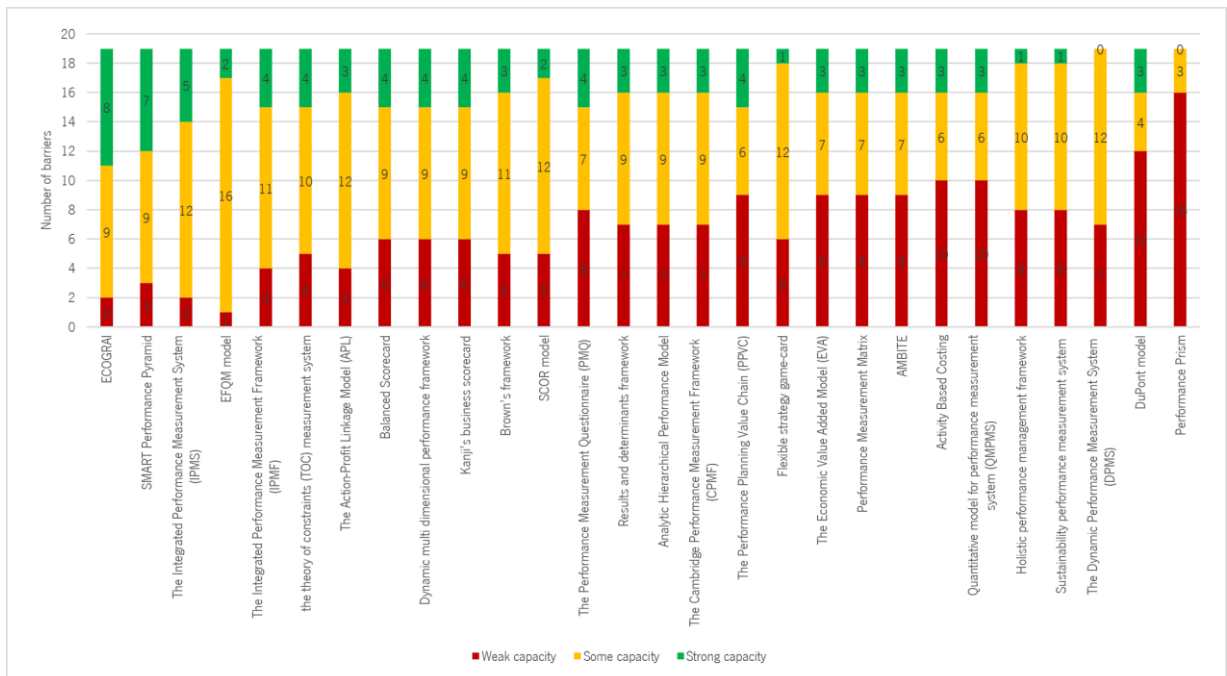


Fig. 6. Number of classifications of each type per PMS (Cunha et al., 2024a)

Appendix D

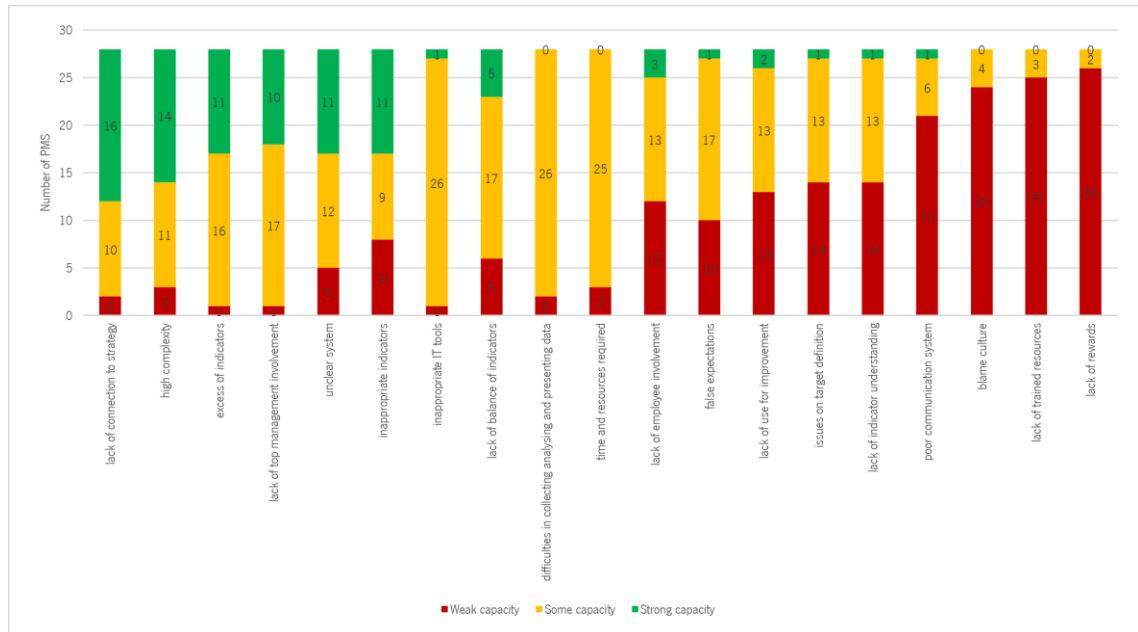


Fig. 7. Number of PMS of each category of mitigation/elimination capacity per barrier (Cunha et al., 2024a)

Appendix E

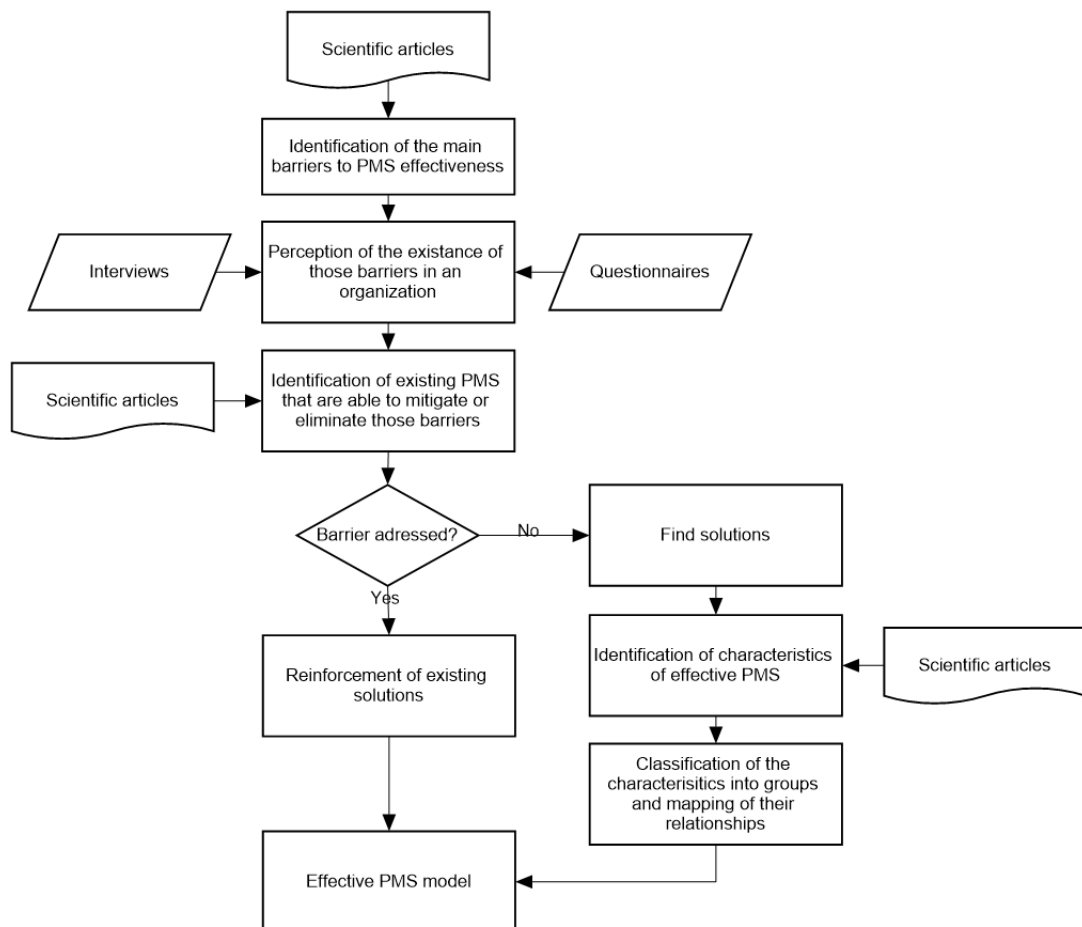
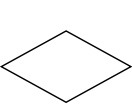


Fig. 1. Methodology adopted (Authors' own work)

Appendix F

Table 2. Legend of the flowchart symbols

Symbol	Meaning
	Input/Output
	Start/End
	Process
	Sub Process
	Document
	Annotation
	Decision

Appendix G

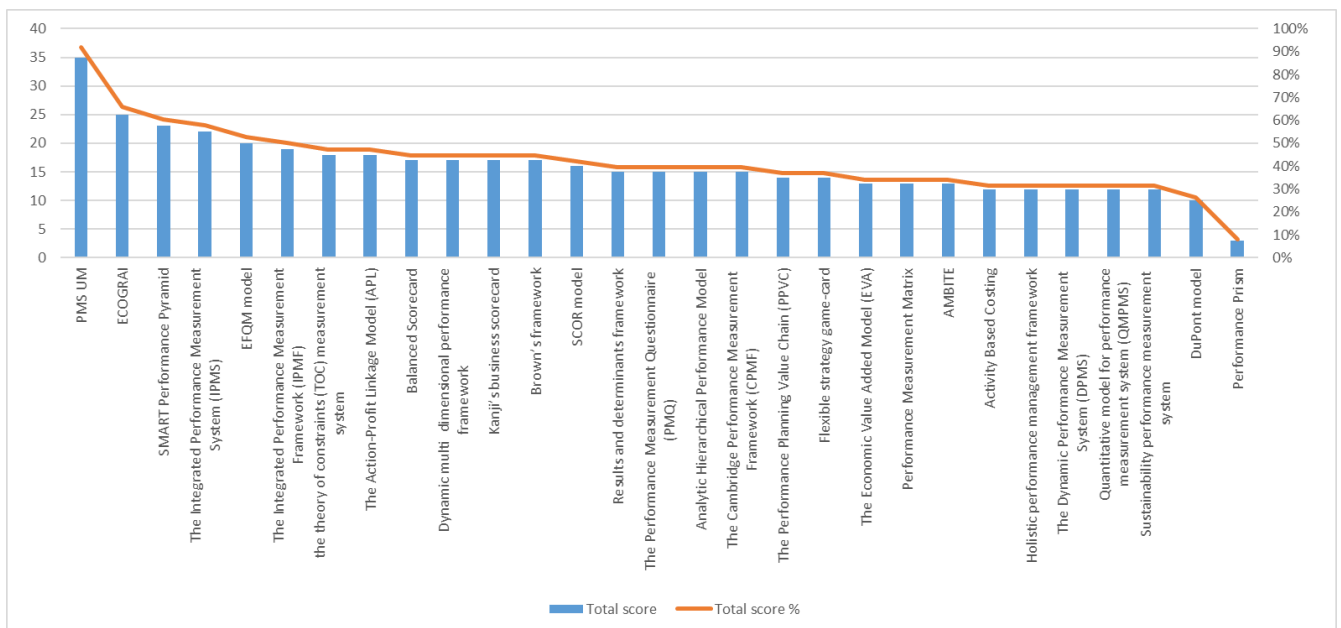


Fig. 8. Total score of each PMS (Authors' own work)

Appendix H

Table 3. Questions in the questionnaire (Authors' own work)

Question
The PMS of the organization is effective?
The PMS improved since the last questionnaire?
The company culture stimulates continuous improvement?
The PMS is linked to the organization strategy (objectives, indicators, targets)?
The communication system is effective?
The deployment of the PMS through the organization is effective?
The stakeholders are involved (top management and employees)?
The resources and training necessary exist?
The performance is linked to rewards?
The performance is linked to rewards?
The appropriate IT tools exist?
The procedures associated with the PMS are documented?
The indicators are appropriate?
The indicators are balanced?
The indicators are balanced?
The system is simple?
The system is clear?
The system is dynamic?

Appendix H

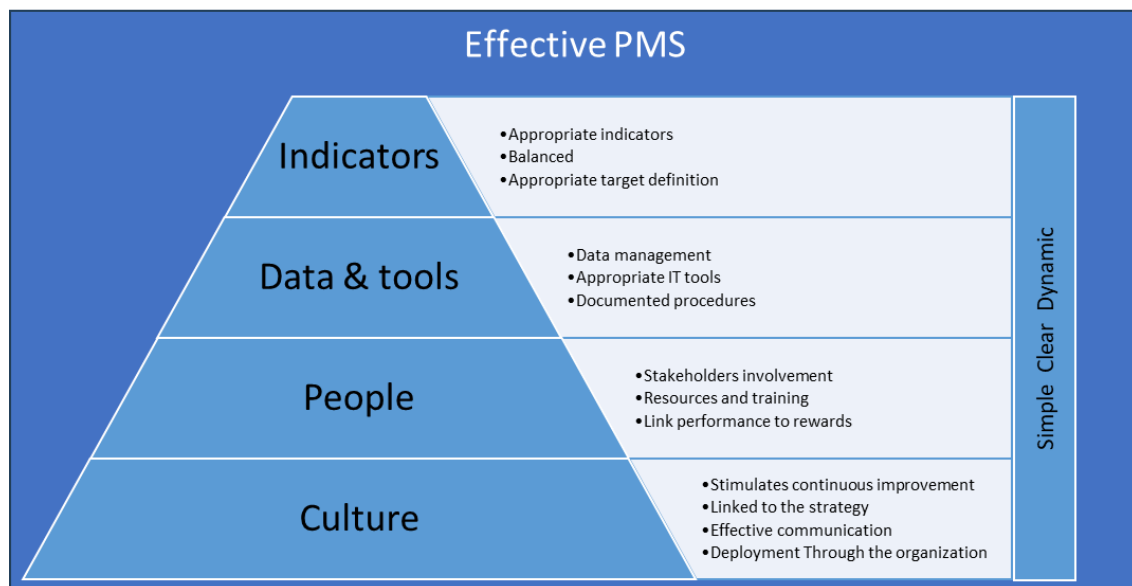


Fig. 2. PMS_UM model (Authors' own work)

Appendix I

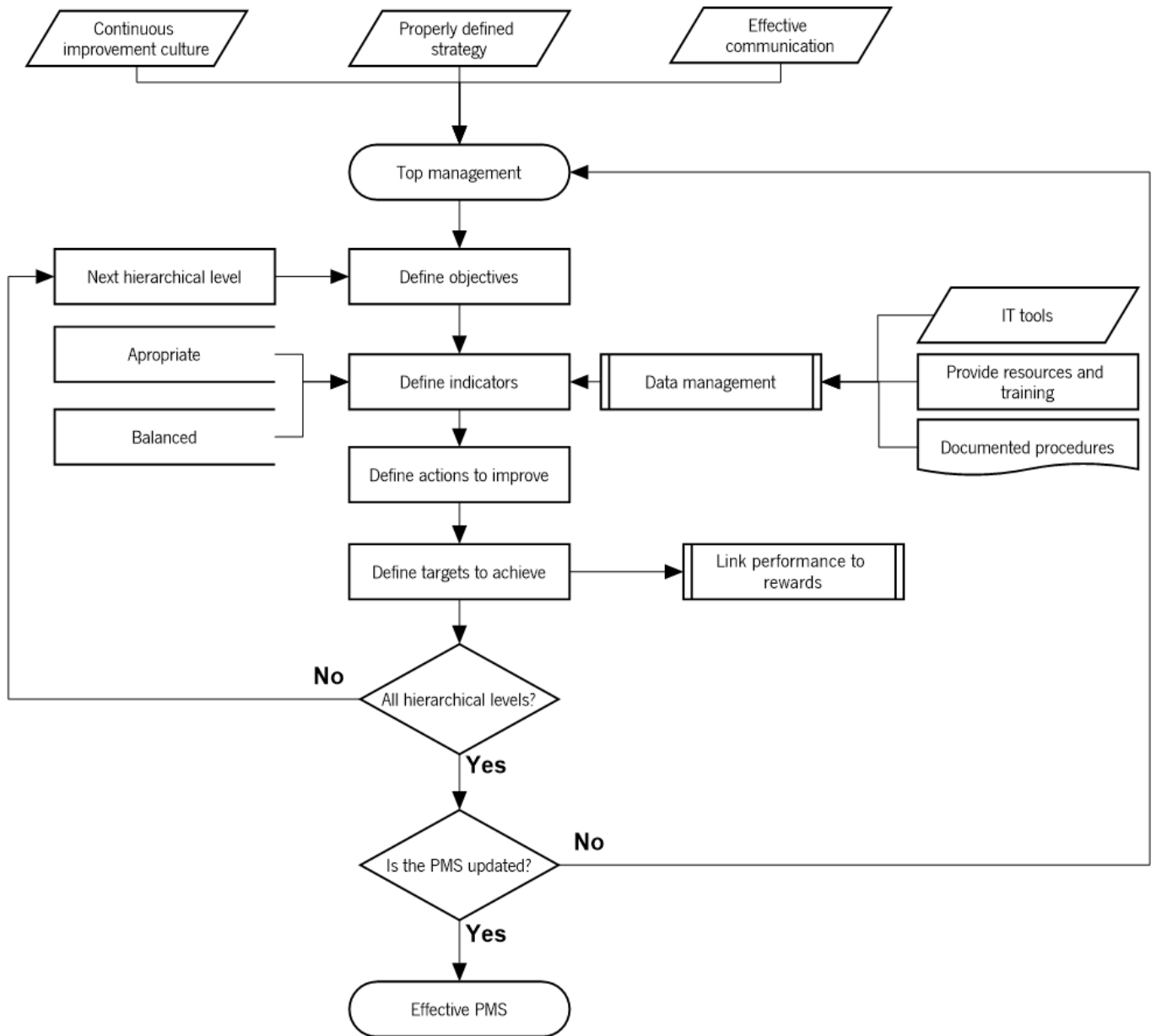


Fig. 3. Methodology to design and implement a PMS (Authors' own work)

Appendix J

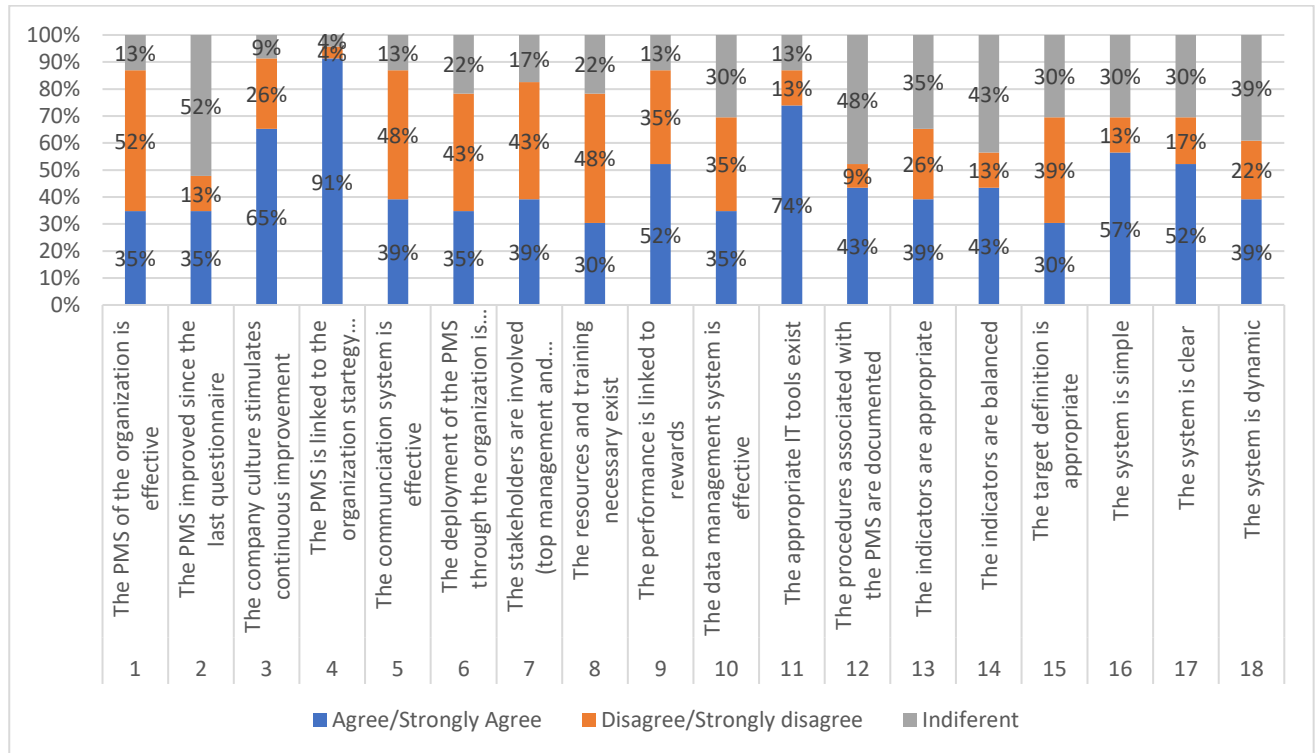


Fig. 9. Likert classification of the existence of the characteristics in the organization (Authors' own work)

Appendix K

Table 4. Questionnaire chi-square hypothesis results and p-value (Authors' own work)

Question	Education	Gender	Shift	Department	Role
The PMS of the organization is effective?	H1(0.007)	H0(0.590)	H1(0.034)	H1(0.033)	H0(0.177)
The PMS improved since the last questionnaire?	H0(0.502)	H0(0.960)	H0(0.722)	H0(0.378)	H0(0.258)
The company culture stimulates continuous improvement?	H0(0.356)	H0(0.955)	H0(0.304)	H0(0.987)	H0(0.468)
The PMS is linked to the organization strategy?	H0(0.659)	H0(0.527)	H0(0.538)	H0(0.616)	H0(0.934)
The communication system is effective?	H1(0.022)	H0(0.720)	H0(0.250)	H0(0.237)	H0(0.210)
The deployment of the PMS through the organization is effective?	H1(0.049)	H0(0.927)	H0(0.242)	H0(0.354)	H0(0.319)
The stakeholders are involved (top management and employees)?	H1(0.031)	H0(0.772)	H0(0.059)	H0(0.133)	H0(0.469)
The resources and training necessary exist?	H0(0.066)	H0(0.442)	H0(0.241)	H0(0.548)	H0(0.119)
The performance is linked to rewards?	H0(0.068)	H0(0.513)	H0(0.283)	H0(0.268)	H0(0.551)
The data management system is effective?	H1(0.010)	H0(0.488)	H1(0.033)	H1(0.040)	H0(0.131)
The appropriate IT tools exist?	H0(0.124)	H0(0.527)	H0(0.335)	H0(0.452)	H0(0.516)
The procedures associated with the PMS are documented?	H1(0.040)	H0(0.867)	H0(0.100)	H0(0.418)	H0(0.872)
The indicators are appropriate?	H0(0.052)	H0(0.426)	H0(0.087)	H0(0.123)	H0(0.768)
The indicators are balanced?	H1(0.039)	H0(0.476)	H0(0.099)	H0(0.104)	H0(0.355)
The target definition is appropriate?	H0(0.090)	H0(0.948)	H1(0.033)	H0(0.600)	H1(0.049)
The system is simple?	H1(0.023)	H0(0.931)	H0(0.107)	H0(0.299)	H0(0.568)
The system is clear?	H1(0.008)	H0(0.857)	H1(0.018)	H0(0.314)	H0(0.365)
The system is dynamic?	H1(0.008)	H0(0.931)	H1(0.808)	H0(0.808)	H0(0.243)