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Designing and implementing performance measurement systems based on enterprise engineering guidelines

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Abstract

Purpose: This conceptual paper presents a proposal for improving a performance measurement (PM) system implementation process based on enterprise engineering (EE) guidelines, which gives the process a sense of completeness.

Design/methodology/approach: This paper analyzes a well-known process for PM systems implementation organized in 2 phases: identifying, designing and implementing the top-level performance measures; and cascading the top-level measures and identify appropriate lower-level performance measures. The proposed improvements to the studied process derive from the EE guidelines, which establish a basis for the structure of an organizational management system, the formalization and synchronization of processes, performance expectations, exception handling and change management.

Findings: The study reveals that not all EE guidelines are covered by the analyzed process, with 4 of them having no evidence of being adopted: involvement of people in process design and implementation; ensuring interoperability between different systems in the information structure; addressing of all possible exceptions; coherence and consistency of semantics across all processes.

Originality/value: By the lens of EE guidelines, this paper advances a how-to guide. This paper can support managers and researchers on PM system design and implementation, given the importance and relevance of EE recommendations having a consistent and well-structured procedure.

Keywords: performance measurement; performance measurement system; enterprise engineering; implementation

1. Introduction

Companies in a highly complex interactions business environment, organizational and management processes, people, and technology influence the use and application of Performance Measurement (PM) Systems. According to Tay et al. (2017), Nudurupati et al. (2011), and Binder and Clegg (2007), company success results from both the mobilization of internal competencies and the organization of external agents. The use of PM systems facilitates the comprehension of activities, and operational flows provide information about ongoing processes and strategy implementation, contributes to the monitoring of results and the environment (Pinheiro de Lima et al., 2013; Searcy et al., 2008) and the management of externalities (Poister et al., 2014). As company strategy is affected and influenced by external variations, performance indicators must be reviewed according to their relevance, requiring an efficient measurement system and considering current circumstances. In this sense, there is a need to develop a suitable method to measure organization performance that accounts for these dynamics. Neely et al. (2002) state that organizational performance is a function of its efficiency and effectiveness, so it needs a process through a metric or even a set of metrics. To be considered dynamic, a PM system must be a system that monitors the external and internal environments, reviewing internal and external changes to evaluate priorities and objectives, and promote internal development to revise the priorities and goals.

Sureka et al. (2021), Alosani et al. (2019), Hoque (2014), Reefek and Trocchi (2013), and Tangen (2004) point out that several PM systems have been developed throughout the years, with the most used the Balanced Scorecard (BSC). The BSC is a model that provides four perspectives: financial, customer, internal processes, and learning and growth. Its main characteristic resides in integrating four perspectives with goals defined by the managers, and specific measures ensure the achievement of objectives. Ghalayini and Noble (1996) observe that despite being simple, the BSC downside focuses on the top level, only providing a global view, not reaching the operational level. Suwignjo et al. (2000) consider that the BSC is only valid for a quantitative-based measurement model and processes when the internal and external environments are stable. It is necessary to acknowledge any alteration the soonest as possible so that the quantitative base of the model may be redefined and reflects the actual context; otherwise, the model loses its primary purpose. Some difficulty is noticed in the use of the model. It requires the attention of those in charge so that the purpose is not lost or simulated data is presented, harming the quality of decision-making.

There is still a lack of systems that allow high response capability and speed: most PM systems are historical repositories and static; they are not sensitive to organizational changes (Nudurupati et al. 2011). Few integrated systems result in primarily simplistic systems that are difficult to keep and use, with delays in classifying the information and generating results. These systems hardly ever have the support and commitment of the whole organization. They are, in general, not implemented through participative management but characterized by a mechanism of command and control of people. Bititci et al. (2012) suggest future research on PM to adopt a more interpretative approach to understanding the mediation of performance as a holistic, integrated system within an emerging context.

Also, some studies indicate a skepticism on the use of traditional PM systems depending on the organization structure (Moxham, 2009; Straub, Koopman, Van Mossel, et al., 2010; Moura et al., 2019; 2020), e.g., on projects and institutional planning (Moura, 2018) or different organizational structures (Abedin et al., 2021; Wang et al., 2021; Martins et al., 2018). Also, the industry 4.0 era represents a challenge to adopt some PM systems. This understanding is a significant demand to be reached by the performance measurement and management literature. How to measure in supply chain scenario and green logistics is a gap to be answered to the market (Frederico et al., 2020; Chhabra et al., 2021).

In this context, the view of enterprise engineering can help both the diagnosis and the re-design of PM systems incorporate missing functionalities that provide a dynamic model operating in a complex environment. Modeling systems to deal with organizational complexities is one of the focuses of enterprise engineering. Hoogervorst (2009) defines that enterprise engineering aims to understand the company in its complexity, from creation and conception throughout its development, seeking the generation of knowledge and methodologies. Enterprise engineering initiatives "define, structure, design and implement enterprise operations as communication networks of business processes, which comprise all their related business knowledge, operational information, resources and organization relations"(Kosanke et al., 1999, p. 85). Also, Barjis (2011) sees enterprises as a social system. Their study through enterprise engineering is seen as an interdisciplinary field, covering three theoretical bases: organizational sciences, information systems sciences, and systems engineering.

How to design and implement a PM system? Considering PM systems design and implementation requirements, their integration, responsiveness, adaptability, and readiness, how can one guarantee that a PM system does not become obsolete, keeping it updated in a complex and dynamic environment? Could enterprise engineering principles contribute to a 'complete' approach for designing a PM system?

Deschamps (2013) identifies 12 guidelines for enterprise engineering initiatives. These guidelines approach formalization, organizational structure, coordination and synchronization of processes, explicit considerations on performance expectations, treatment of exceptions, and incorporation of change mechanisms or improvement. Therefore, it establishes the base for a consistent structure of an organization system to reach the maximum potential of its objectives. Enterprise engineering defines a methodological approach; thus, the research strategy proposed in this paper consists of listing this set of guidelines to be used as a diagnosis and re-design tool for organizations, together with a process approach for the development of a PM system.

After reviewing the PM systems design approach, this study chose the PM design process proposed in the book "Strategy and Performance: Getting the measures of your business" by Neely et al. (2002) to be analyzed through the lens of the enterprise engineering guidelines. This study describes step-by-step how an organization, from its business strategy, can establish adequate organizational communication for checking the implementation of its design and reevaluate the adopted plan. A how-to guide presented in 10 parts defines the steps to provide the readers with a view and knowledge of their organizations and their PM systems characteristics.

This conceptual paper reviews a PM system implementation process based on EE guidelines. The chosen PM system implementation process is the how-to guide developed by Neely et al. (2002), regarding the relevance of the authors' research for the PM literature and PM systems design, implementation and review, and its process approach introducing a step-by-step (see Nappi, Kelly, 2021; Ravelomantsoa et al., 2019; Bititci et al. 2018; Bourne et al.; 2018). This paper aims to perform a holistic approach for developing a PM system according to enterprise engineering principles and an updated PM design process approach.

2. Theoretical background

This section precedes the analysis and application of enterprise engineering guidelines in PM systems. It presents insights about PM requirements and discusses how enterprise engineering recommendations can help diagnose an organizational system.

2.1 Performance measurement systems requirements

The features of a PM system can variate according to the company or approach. Franco-Santos et al. (2007, p. 796) argue two of them as the essence of any PM framework: "performance measures" and "supporting infrastructure." Bititci, Turner and Begemann, (2000, p. 704) had studied a set of PM models[1]. None of them presents an integrative model, but "current knowledge and technology in the field is sufficiently mature to facilitate the development of dynamic performance measurement systems, with the exception of the review mechanism where further research is required." Years later, Nudurupati et al. (2011, p. 281) identified some PM frameworks[2] that address how to design a PM system and "made significant impact in designing performance measures in practice."

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[1] IPMS - Integrated Performance Measurement Systems (Bititci et al, 1998), AM - Active Monitoring (Turner and Bititci, 1998), QMPMS - Quantitative Model for Performance Measurement Systems (Suwignjo et al, 1997), BSC - Balanced Score Card (Kaplan and Norton, 1996), SMART - (Cross K F and Lynch R L, 1998-1989), CPMS - Cambridge Performance Measurement Systems Design Process (Neely et al, 1996), PMQ - Performance Measurement Questionnaire (Dixon et al, 1990), IDPMS - Integrated Dynamic Performance Measurement Systems (Ghalayini, 1997), IPM - Integrated Performance Measurement Software - Lucidus Management Technologies, Oxford, UK.

[2] Strategic Measurement and Reporting Technique (SMART) (Cross & Lynch, 1988–1989), The Performance Measurement Matrix (Keegan et al., 1989), Results and Determinants Framework (Fitzgerald, Johnston, Brignall, Silvestro, & Voss, 1991), Balanced Scorecard (BSC) (Bhagwat & Sharma, 2007; Kaplan & Norton, 1992; Kaplan & Norton, 1996 and Kaplan & Norton, 2001), Cambridge Performance Measurement Systems (CPMS) Design Process, (Neely et al., 1996), Integrated Performance Measurement Systems (IPMS), reference model (Bititci & Carrie, 1998), Performance Prism (PP) (Neely & Adams, 2001), FFQM Business Excellence Model (EFQM, 1999).

Systems might vary regarding the way they integrate information, operations, and strategy. Wieland et al. (2015) carried out a systematic literature review about processes in performance measurement systems. According to them, aligning the strategy to PM provides content for goals, metrics, tools, and governance. In fact, as observed by Munir and Baird (2016) and Folan and Browne (2005), a PM system must have managerial support, involve employees in the development of indicators, present relevance to the workers' everyday practice, take part in the feedback of evaluation processes, contribute to strategic decision-making, planning, and control of assignments to succeed in its goals.

The study of Munir and Baird (2016) about the influence of institutional pressures on PM systems shows that enterprises and public organizations do not broadly use some systems with financial and non-financial metrics. Their empirical results point out that the studied organizations had to adapt their PM systems to meet stakeholders and regulatory requirements. Hence, in practice, the design of PM systems is influenced by internal and external factors, with more diverse and multi-dimensional performance measures used, as also highlighted by Ross et al. (2010).

According to Chenhall (2005), strategic feedback provided by PM systems is the basis to improve competitiveness, both by product differentiation and cost competition. According to Parida et al. (2015, p. 4), "two key components need to be considered to move from performance measurement to performance management: the right organizational structure, which facilitates the effective use of PM results; and the ability to use PM results to bring about change in the organization." Bourne et al. (2000) add that PM systems require an effective target and pattern revisions mechanisms, besides individual measurements, adaptable to circumstances and tools that periodically evaluate the set of measures and evaluate strategic assumptions.

It is challenging to present an adequate PM system considering all internal and external (when applied) requirements. Kennerley and Neely (2003) explained that a well-designed PM system follows an evolution cycle based on:

a) processes: for revision, changes, and measure implementation;

b) people: with competence to use, reflect, modify and implement measures;

c) systems: flexible and available for collection, analysis, and processing of information;

d) culture: bearing in mind the importance of measurements.

The literature review conducted by Bourne et al. (2005) reveals seven factors associated with critical processes in the use of performance measures:

a) the linking to strategic objectives;

b) the method of data capture;

c) data analysis;

d) interpretation and evaluation;

e) the provision of information and communication;

f) decision-making;

g) taking action.

According to Gomes et al. (2004), the focus on organizational effort must be seen from the perspective of continuous improvement, not only on productivity or employees' efficiency. Despite the advance in the PM literature, how to operationalize a PM system is still a gap. Some studies reveal how difficult it could be, especially when the organization wants to measure no-traditional financial measures, e.g., cooperatives, social enterprises, public administration, third sector, social indicators on private businesses (Moura, 2018; Cestari et al., 2018; Moura et al., 2019; Alosani et al., 2019; Treinta et al., 2020; Weber et al., 2020; Garengo and Sardi, 2020; Moura et al., 2020; Frederico et al., 2020; Wang et al., 2021; Munik et al., 2021, Sureka et al., 2021, Cestari et al., 2021).

The design of PM systems needs a consolidated basis that meets all required dimensions, drivers, and requirements. Among the models and frameworks, Neely et al. (2002) organized a handbook to facilitate the understanding, implementation, and operationalization of a PM system suitable to an organization in practical terms. This paper uses this approach as the basis of our discussion.

2.2 Enterprise Engineering guidelines

Deschamps (2013) considers that the study of enterprise engineering could help diagnose and re-design PM systems to incorporate missing functionalities considering a dynamic model. The enterprise engineering discipline includes several research topics and contribution areas, namely modeling, optimization, analysis, business processes, information systems, organizational design, structure, and organizational objectives, making the term very broad. According to Giachetti (2004, p. 1149), enterprise engineering initiatives work "to model, analyze and design enterprise systems." Beyond providing information for the design and re-design of businesses, enterprise engineering initiatives include learning how flowing of knowledge and material, supported by enterprise modeling. Bernus et al. (2016) Enterprise engineering concerns itself with the enterprise's whole operations to improve efficiency and effectiveness by integrating people, machines, and computers (Kosanke et al. 1999).

An "enterprise engineering guideline" is a design principle related to the definition, structure, conceptualization, or implementation of operations or business processes. The set of EE recommendations proposed by Deschamps (2013) established 12 guidelines (See Figure 1). The systematic literature review method, a Delphi study, and case studies characterize the methodologic approach in his research. In this way, the results of his work present a protocol suitable as a diagnosis method for organizational systems.

[INSERT FIGURE 1 ABOUT HERE]

The set of EE guidelines address issues related to the formalization of organizational process and structure, the coordination and synchronization of processes, the process performance, the handling of exceptions, and the establishment of change and improvement methods. They organize the bases for structuring an enterprise system to have the potential to accomplish its purpose (Deschamps, 2013).

An example of applying the 12 enterprise engineering guidelines is the research developed by Silveira et al. (2017), proposing a structured process for Hoshin Kanri implementation based on a strategic management framework that integrates strategy and operations execution. Another example is the study of the 'resource-based view' development process, which describes how a business can improve its competitive position and longevity, proposing a re-designed view of resource-based strategy design through Enterprise Engineering guidelines introduced by Moura et al. (2015). Deschamps et al.'s (2013) enterprise engineering guidelines contribute to this process design task by considering a more comprehensive approach.

3. Research design

In this paper, the process described in the book "Strategy and Performance: Getting the measure of your business" by Neely et al. (2002) is analyzed through the lens of the enterprise engineering guidelines identified by Deschamps (2013). The book is organized as a how-to guide to facilitate the understanding, implementation and operationalization of a PM system suitable to an organization. See Figure 2 to an overview of the research design.

[INSERT FIGURE 2 ABOUT HERE]

Figure 3 shows an overview of the process, indicating its main outputs organized in Phase 1 and Phase 2. Phase 1 reaches the identifying, designing, and implementation of the top-level performance measures. Phase 2 reaches the top-level measures and identification of appropriate lower-level performance measurements.

[INSERT FIGURE 3 ABOUT HERE]

Each phase consist of five parts in the PM system implementation process expressed as questions. (Neely et al., 2002) Phase 1 suggests identifying top-level objectives and how to measure progress towards them, while Phase 2 works at the level of individual team and functional business units. This stage of the process can include the sales team, manufacturing teams, product teams, functional management teams, and business process management teams. (Neely et al., 2002) Each part contains a set of objectives to be reached, as Table 1 exhibits.

[INSERT TABLE 1 ABOUT HERE]

This study focuses on the EE recommendations analysis in the summarized how-to guide a PM system implementation process - as you can see in Table 1. The objective is to identify the 12 EE guidelines in its process approach. This paper analyzes each missed guideline and, in the end, present a reviewed process. Figure 4 shows the procedures to examine the process approach through enterprise engineering guidelines.

[INSERT FIGURE 4 ABOUT HERE]

The following section presents the evidence of EE guidelines in the process approach. However, once there were not found four of the guidelines, the paper presents a reviewed how-to guide.

4. Results

The analysis described in Research Design identifies the evidence of EE guidelines #1, #3, #4, #6, #7, #8, #10, #12, i.e., eight of twelve in an interpretive method. Figure 5 exhibits the identified EE guidelines, pointing out why that guideline is evident, following the analyzed process's structure with phases, parts, and objectives.

[INSERT FIGURE 5 ABOUT HERE]

The analysis of the process approach did not find evidence of EE guidelines #2, #5, #9, and #11. The following section reviews these guidelines individually.

5. Discussion

This section examines each EE guideline not identified in the PM system process approach in Section 4 and provides literature evidence on how to consider them for PM system implementation. Building from this literature, the following section proposes a reviewed PM system implementation process covering all guidelines.

Guideline #2 People involved in a process, including interested parties, must participate in its design

Deschamps et al. (2013, p. 812) point out the involvement of people as one principle of excellent models, and their engagement influences transformation initiatives. In this way, the involvement of workers in the modeling systems process is a meaningful guideline. The organizational effort to measure performance must be approached as a complete system, mainly because it affects motivation (Gomes et al., 2004). It is necessary to comprehend each individual as a fundamental part of organizational development and identify the ideal system for each organization (Couturier and Sklavounos, 2019; Sena Ferreira, 2012).

Nudurupati et al. (2011) observe that the success of a PM system is in the change in behavior that it generates towards a progressive performance improvement and organizational culture change. A PM system might have positive behavior by the people who use it, showing proactivity and commitment to continuous improvement; if it is not, it is followed by resistance and inadequate use of information.

Strategically, different organizational structures or contexts could have a personalized PM system design. (Pekkola et al., 2016; Rikhardsson et al., 2020) For example, the study of Taylor and Taylor (2014) presents a research agenda for PM systems design for the third sector based on a stakeholders' perspective. A PM system needs to include learning and continuous improvement. In this way, the participation of employees is essential to minimize the resistance to use a PM system because, very often, the staff tends to resist the introduction of new or complex software (Yin et al., 2011; Cordery and Sinclair, 2013; Arvidson and Lyon, 2014). Also, stakeholders usually have their requirements for PM as the third sector, public sector, social enterprises, and the like, for instance, tend to mold their systems to what is acceptable concerning accountability and legitimacy practices (Karwan and Markland, 2006; Amado and Santos, 2009; Arvidson and Lyon, 2014; Um, 2017, Moura, 2018; Moura et al., 2020; Cestari et al., 2021).

Arena et al. (2015) and Kinder (2012) suggest that the process for designing or re-designing a PM system could be triggered by the intention to improve technologically, provide innovation, or increase usability. Still, there is no commitment to provide adequate human and financial resources for system design in many cases because of the lack of positive evidence, which can also impact people's resistance.

In the studied process, some moments require the participation of people. During the Phase 1, Objective 4.1, people should determine whether they agree or not with the proposed measures. Phase 2 includes the involvement of people in using and reviewing performance measures. In the end, the organizational objectives must be able to these people and measure progress. However, guideline #2 suggests broader and more effective participation, considering people's involvement from system conception, starting from Phase 1. The participation of employees of earlier stages enhances competencies and helps them grow and develop as organization members.

In this sense, it is necessary to identify a more effective involvement of participants. Somehow, the "facilitator" could bridge the organizational objectives and everybody's vision in the organization without hindering participation, but encouraging collective effort, creating cohesion, improving morale, and administering interpersonal conflicts.

Guideline #5 Information structure must ensure interoperability with different systems

Interoperability is one of the main aspects of EE recommendations, with a vital role in any business considering the advance of cyber-physical systems and other technologies. According to Panetto et al. (2016, p. 47), "although industry has responded to the interoperability challenges with the development of collaboration interfaces and integration mechanisms, such development may become unsustainable with the rapid growth in the variety of system architectures." Interoperability guarantees that all involved actors share information through the same structure, minimizing errors and facilitating communication and learning. In the context of software engineering, "interoperability means that cooperating pieces of software can easily work together without any interfacing effort" (Chen and Vernadat, 2004, p. 249). Furthermore, interoperability means playing information among software applications, organizations, stakeholders, and processes in a standard way. As summarized by Panetto (2007, p. 728), "interoperability is the ability of different types of computers, networks, operating systems, and applications to work together effectively, without prior communication, in order to exchange information in a useful and meaningful manner." So, when the system is interoperable, it can obtain and share data efficiently.

However, open pattern systems are necessary to leverage interoperability once they are more accessible compared to others. According to Deschamps et al. (2013, p. 812), "the use of open standards is a strong catalyst to interoperability, as it ensures that both parties involved in an exchange will have the same information structure, facilitating it. Enterprise reference models are open-standards per se and most of them have information as one of their standardized elements". Some barriers might appear that hamper interoperability, such as those regarding the incompatibility of systems (platforms, architectures, infrastructure). Organizational particularities also might present barriers, for example, when the company has confidential information that might alter the quality or integrity of available data. Therefore, as observed by Whitman et al. (2006), the components in the system must permit the exchange of data, resources, and information regarding the organizational processes so that a defined semantics, regardless of the administrative particularities such as data format or interfaces, can be presented. Thus, more than only data exchange, interoperability enables the execution of operations in another system.

There are many different ways to assess the interoperability of a system. The LCIM (Levels of Conceptual Interoperability Model) defines seven levels to characterize interoperability described by Turnitsa (2005). The first one, level 0, refers to "no interoperability"' Level 1 refers to 'technical interoperability,' which means exchanging data from one application to another. Level 2 refers to "syntactic interoperability" when a protocol is created to exchange information. Level 3 refers to "semantic interoperability" when the system uses a common information exchange reference model. Level 4 is "pragmatic interoperability" when there is a concern with the applied methods and procedures. Level 5 refers to "dynamic interoperability"; at this level, the system can work on data over time. Level 6, "conceptual interoperability," refers to the highest level of interoperability when the system works based on engineering methods. For Panetto et al. (2016, p. 52), "enterprise interoperability maturity can be measured in two ways: a priori, where the measure relates to the potential of a system to be interoperable with a possible future partner whose identity is not known at the moment of evaluation, and a posteriori, where the measure relates to the compatibility measure between two (or more) known systems willing to interoperate or to the measurement of the performance of an existing interoperability relationship between two systems."

In this way, the PM systems must provide an information structure that guarantees interoperability with different systems (Ben, 2013). Poister et al. (2014) affirm that PM systems contribute with information for managers monitoring performance. Pekkola (2013) finds that the network-level performance measurement system's relevance contributes to communication, trust, and commitment, and its measures and indicators improve the partners' and companies' networks. Kim (2013) and Toni and Tonchia (2001) consider that a suitable PM system is an essential factor in the sustainable development of companies involved in the integration process since it helps to verify the achievement of common objectives, at the same time it promotes alignment of goals. Thus, a synergy effect can be created by seeking global performance improvement of the integrated companies, leaving background the solo performance of each company. In this scenario, Alfaro et al. (2009) argue that the correct design of the lifecycle of a PM system is essential to enhance interoperability of the extended business processes characterizing a collaborative environment. For the authors, the definition of interoperability criteria is crucial to analyze if business processes are efficient and effective.

No part of the reviewed PM system implementation process presents an objective that covers interoperability. Although some research regards performance measurement in a collaborative environment, as the Extended Enterprise Performance Measurement model (Bititci et al. 2005), studies about PM systems that investigate business process interoperability is not common in the literature, as indicated in the literature review performed by Alfaro *et al.* (2009).

Guideline #9 Processes must address all possible exceptions

According to Deschamps et al. (2013, p. 813), "there should not be exceptions throughout the process execution, but when one exception is considered, a procedure should be established to deal with this circumstance. Dealing with the unpredictable must be considered in organizational systems". For Kurz et al. (2013, p. 123), "while the term exception suggests that these deviations from business processes are only occurring rarely, exceptions are a normal part of business process execution. However, so far documented and applied methodologies, IT systems and procedure models seem inadequate for their effective and efficient management."

For Schildt and Skrien (2013), there is the concept of exceptions treatment in systems programming, which implies identifying unusual situations during systems execution and treating them. It is essential to consider what an exception is to understand this guideline. Kurz et al. (2013, p. 147) distinguish an exception in three types of events: "the type of events that must be handled in a process which are known and for which the corresponding reactions are also well-defined (routine exceptions); the types of exceptions which are known, but for which the corresponding reactions cannot be strictly defined (minor exceptions); or the type of exceptions that are not known and for which the reactions are not defined in advance (major exceptions)." Larman (2007) distinguishes exceptions in defect, error, and fault:

a) Defect: origin or cause of bad behavior, e.g., a programmer mistyped the database name in a program's source code.
b) Error: the appearance of a defect during execution, e.g., when calling the program to obtain a reference for the database (wrongly typed), points to the error.

c) Fault: denial of service due to an error, e.g., a seller cannot register an order in the system because when writing it, it cannot link to the correct database.

According to Larman (2007), the distinction between exception launch and exception treatment must approach different exceptions. Where the error occurred and the context involved is related to exception launch. The register of a failure (either centralized or distributed) and the user notification influence the exception treatment. In fact, data treatment as performance measures is a challenge, especially when it involves big data analysis, as discussed by Sardi et al. (2020). It is necessary to consider preventing errors, faults, defects, and other undesirable situations in an organizational system. Thus, according to Calazans and Oliveira (2005), systems maintenance must be provided. Maintenance is classified as corrective (removal of design, logic and codification errors or faults in the system), adaptive (making necessary changes regarding the external environment), evaluative (improving functionalities already in use according to the data gathered by developers and users) and preventive (considering changes of internal and external environments in advance). Antunes (2011) analyzes the exception treatment in BPM (Business Process Management), focusing on resilience, and argues the importance of automated exception handling as a crucial capability to face exceptions. However, human intervention is always required when other types or unexpected exceptions occur, so staff becomes a necessary component supporting organizational resilience.

Despite the existence of Objective 4.1: verify whether everybody agrees with all high-level performance measures; Objective 9.1: verify whether all members of the organizational teams agree with the measures they will use; and Objective 10.2: set a mechanism for the revision of performance measurement system, they do not comprise the verification and improvement of the system and exception handling. The focus of these objectives is limited to the performance measures. Guideline #9 encompasses a broader vision of review and system improvement from when the organization realizes exceptions, i.e., situations that would need intervention to be corrected.

Guideline #11 Process semantics must be coherent and consistent throughout all processes

Deschamps et al. (2013, p. 813) explain how proper semantic embedded into a process impacts its execution: "for a process to be consistently executed, proper terminology must be used among all processes and throughout the life cycle of a process. This enhances communication and the interaction among involved people. This guideline is supported by most reference models, which establish these semantics in their definitions".

Folan and Browne (2005) explain the relevance of a formal language in PM system design, particularly a comprehensible one. The proper language supports the knowledge of *what* is being measured and *how* it is being measured. As with any business system, the job routine plays in a dynamic environment. In this way, the system features need an interface that allows a high-speed measuring process and correct application.

Therefore, semantics and interfaces must be understandable and objective without losing their essence and not generalizing data crucial to decision-making. Appropriate vocabulary and terminology must be used in all processes and throughout the whole life cycle of an operation to consistent execution, improving communication and interaction of people. Sardi et al. (2020) explain that a well-designed management information system is crucial for performance management, confirming how relevant a semantic feature is during the PM system design.

Some organizations face difficulties dealing with intangible data, goals, and results, making it challenging to find appropriate semantics. It is the case of public sector organizations, third sector organizations, and social enterprises. According to Jung (2011), these organizations, especially the public sector, present ambiguous objectives. Cordery & Sinclair (2013) and Moxham (2009) affirm that the complex terminology and intangible factors make it difficult for these organizations to design, implement, and use a PM system. For instance, measuring social performance that affects these organizations is an intangible dimension to be managed and better investigated. Additionally, these organizations must deal with different stakeholders' requirements, systems, and metrics, each with diverse backgrounds and knowledge.

No phase of the studied PM system implementation process presents an objective that covers the semantic issue. There is a particular tendency to consider evaluations of physical and tangible resources, which comprise a common language, as observed by Folan and Browne (2005). However, it is also essential to bear a critical view of the intangible elements, with a suitable treatment of those elements and the definition of standard terminology for referring to them.

6. Reviewed how-to guide a PM system implementation

After examining the whole process approach through the lens of EE guidelines, it is possible to propose a reviewed process approach. As a diagnosis tool, this review provides the possibility to improve any organizational system. In the context of PM systems, the characterization of the organizations, e.g., a private company, public, nonprofit, social, or hybrid ones, can be crucial in the PM system and measures definition. A generalist framework can be a barrier to efficient system use, team engagement, and making-decision.

This section introduces new details and features to the analyzed process approach covering the missing guidelines. Following the same how-to guide structure proposed by Neely et al. (2002), the whole design in Table 1 is shifted accordingly, i.e., Phases, Parts, and Objectives.

Guideline #2 People involved in a process, including interested parties, must participate in its design

Regarding the involvement of people in the PM system process design, Phase 1 introduces new elements, i.e., a new part and new objectives (See Figure 6). This new part is to be Part 2, once the first one, about the main customer groups, is related to specific management information. So, the process can follow with the last Part 2 as Part 3 for the definition of organizational objectives with the participation of all people involved already guaranteed.

[INSERT FIGURE 6 ABOUT HERE]

Guideline #5 Information structure must ensure interoperability with different systems

Regarding interoperability, Figure 7 displays the updates suggesting a new Part 4, supporting the following parts that might require an information system to collect information, process it, and offer it back in the form of the measures and other necessary reports.

[INSERT FIGURE 7 ABOUT HERE]

Guideline #9 Processes must address all possible exceptions

Concerning the process of handling all possible exceptions, despite objective 10.2 (sets a mechanism for the performance measurement system review), the proposal is to withdraw this objective and incorporate a broader and more descriptive part in Phase 2 (See Figure 8). This is a new Part 13, placed at the end of the process because its objectives complement the process by evaluating system effectiveness, technology advancement, and organizational changes.

[INSERT FIGURE 8 ABOUT HERE]

Guideline #11 Process semantics must be coherent and consistent throughout all processes

Additionally, incorporating two more objectives in the new Part 4 is suggested to cover guideline #11, which refers to the semantics of the process (See Figure 9). This is important in Part 4, with the objectives related to interoperability, as proper semantics are essential to guarantee a common understanding of the terminology throughout the other parts.

[INSERT FIGURE 9 ABOUT HERE]

To sum it all up, Table 2 exhibits the complete reviewed and re-designed PM system implementation process covering the set of EE guidelines.

[INSERT TABLE 2 ABOUT HERE]

7. Conclusion

How to implement a PM system? This research focuses on presenting a how-to guide. Despite PM literature and several available frameworks, how can one guarantee that a PM system does not become obsolete so that capabilities are developed for keeping it updated in a complex and dynamic environment? Could EE principles contribute to a 'complete' approach for designing a PM system? This paper review Neely et al.'s (2002) PM system implementation process according to enterprise engineering guidelines (Deschamps, 2013). Although some researchers describe the roles of a PM system, as Franco-Santos et al. (2007) indicating five of them, i.e., "measure performance, strategy management, communication, influence behaviour, and learning and improvement", few of them present a step-by-step approach on how to design and implement a PM system. Also, the authors in the analyzed process approach are significant researchers in the performance management research area. It is not frequent to find a step-by-step approach with that expertise. The literature points none framework represents a complete approach if we consider all aspects in a dynamic environment, the complexity and diversity of the organizations.

This paper checks each EE guideline present on PM how-to guide and determines which related ones, building a correspondence association. In this way, it is possible to see where the gaps in the process are. The twelve EE guidelines cover critical aspects for diagnosing, designing, and re-design organizational systems, including PM systems. These guidelines address critical issues such as stakeholders' involvement, formalization, the structure of the process, and interoperability.

The process does not fully cover four guidelines. The literature review allows a better comprehension of each missing guideline contextualizing its importance and relevance. The paper proposed incorporating new parts and objectives to accomplish a revised PM implementation process covering these absent guidelines. In this way, it is possible to guarantee that a PM system will not become obsolete, considering its complex and dynamic environment. Also, EE guidelines contribute to a 'complete' approach for designing a PM system.

This paper advances the strategic performance management study, proposing a PM system process approach incorporating EE principles as a diagnosis tool. It still demands exhaustive tests to understand its application better and use in the PM context. Besides that, the revised process contributes to implementing a PM framework adapting to organizational routine in a dynamic environment. Moreover, the process can contribute to quantitative and qualitative analysis, valuing people, including their experience and perspectives, involving them with a more outstanding commitment.

This research perceives a future opportunity to assess other management processes to meet the requirements of a dynamic management system adapted to the environment and the group of people involved by the lens of EE guidelines. Also, the design and implementation study of new PM systems can follow the how-to guide in this paper.

Notwithstanding the advance in the PM literature, how to operationalize a PM system is still a gap. There is a challenge to handle as some managers resist applying traditional PM systems and the advance of industry 4.0. So, there is an opportunity to perform this how-to guide to organizations like cooperatives, social enterprises, public administration, direct-to-do consumers, online to offline, franchising, outsourcing, buy one give one, crowdsourcing, marketplace, and low-cost private label.

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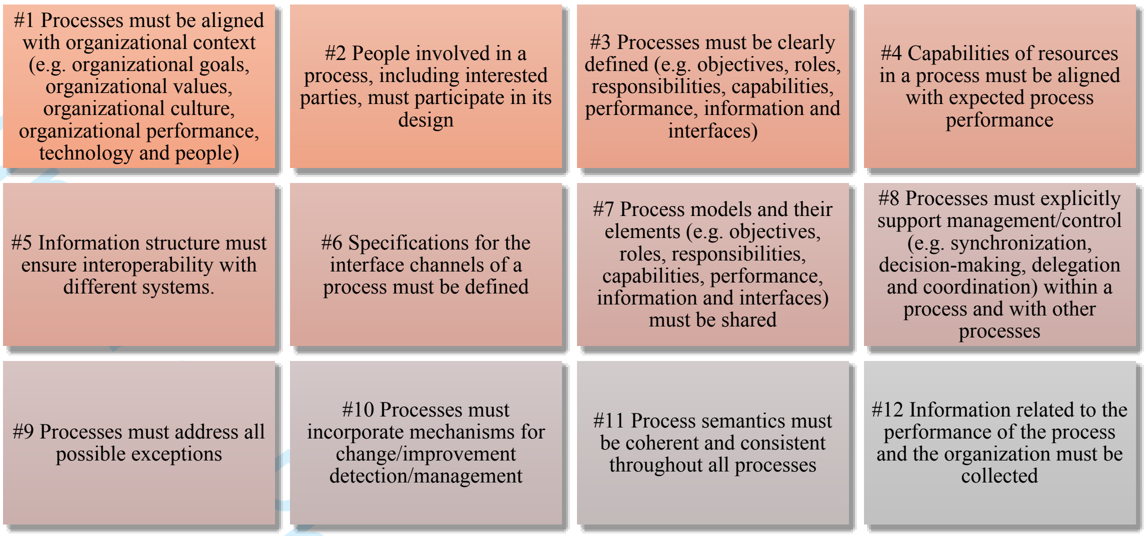

Figure 1: Enterprise Engineering Guidelines

Source: Deschamps (2013)

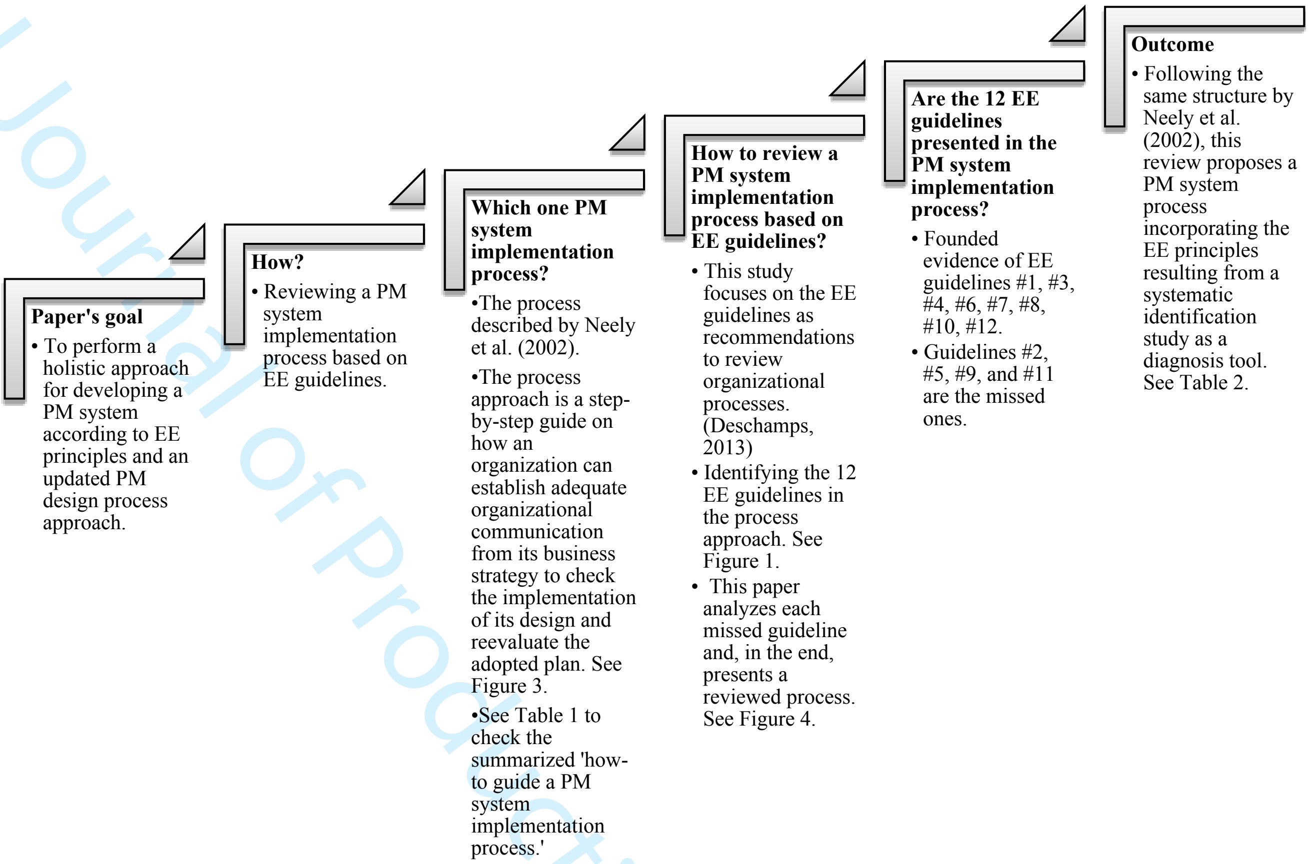

Figure 2: Overview of the research design

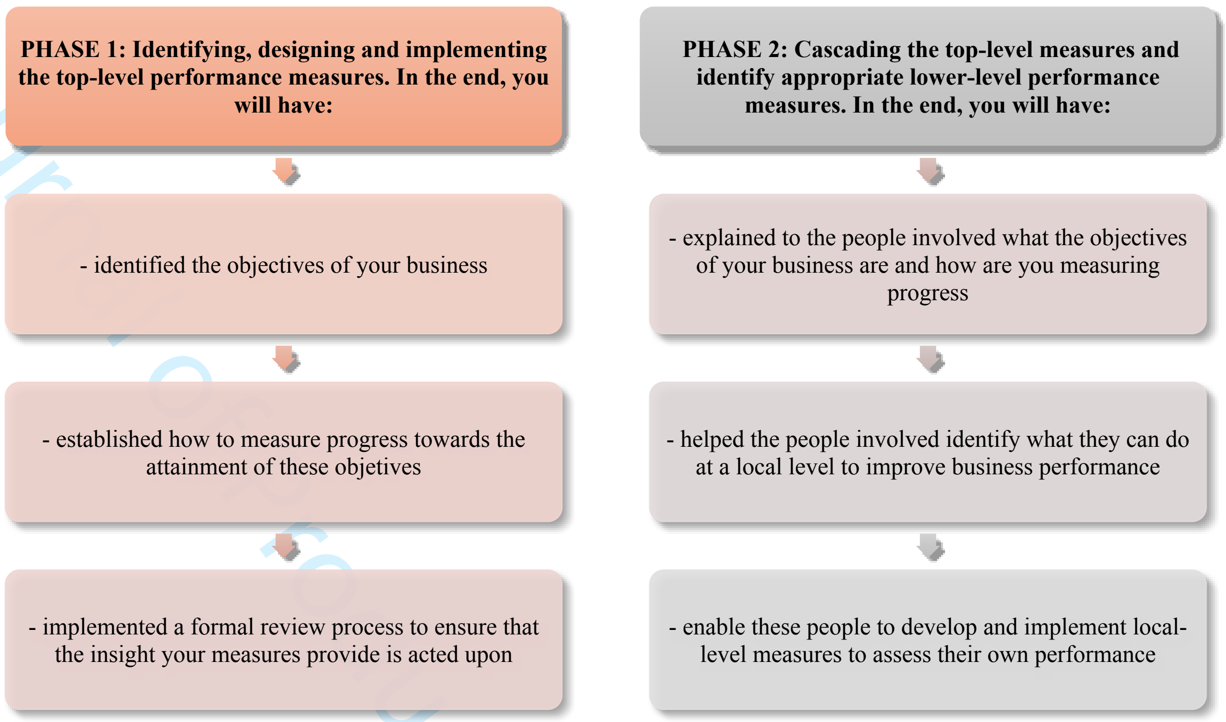

Figure 3: Overview of the PM system implementation process approach by Neely et al. (2002)

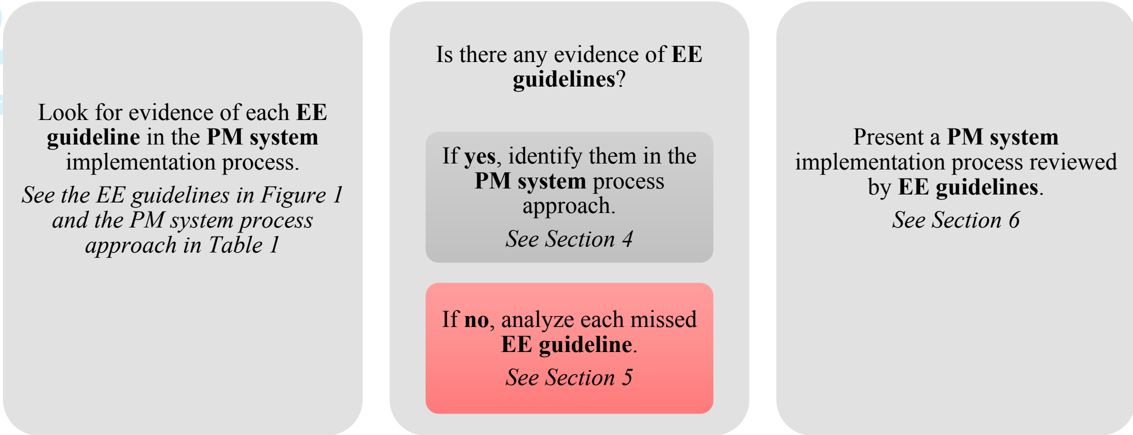

Figure 4: Procedures to analyze the PM system implementation through EE guidelines

EE Guideline	Evidence of the EE guideline in the PM system implementation process	Why?
• #1. Processes must be aligned with organizational context (e.g. organizational goals, organizational values, organizational culture, organizational performance, technology and people).	• Phase 1 - Part 2: What are our business objectives? • Phase 1: Part 4: Have we chosen the right measures? • Phase 2 - Part 9: Have we chosen the right measures for the key drivers?	• The objectives set 2.1-2.8 describes how you can organize the PM focusing on the business. Objectives 4.1-4.3 lead to the alignment of the process to top-level measurement. Objectives 9.1-9.3 lead to the alignment of chosen measures and teams.
• #3. Processes must be clearly defined (e.g. objectives, roles, responsibilities, capabilities, performance, information and interfaces).	• Phase 1 - Part 2: What are our business objectives? • Phase 1: Part 3: Are we achieving our business objectives? • Phase 2 - Part 7: Which performance drivers are most important? • Phase 2: Part 9: Have we chosen the right measures for the key drivers?	• The set of objectives 2.1-2.8 guide you to clear up the business. • Objectives 3.1-3.2 guide the development of performance measures. • Objectives 7.1-7.4 conduct to the definition of key aspects to measurement. • Objectives 9.1-9.3 lead to the alignment of chosen measures and teams.
• #4. Capabilities of resources in a process must be aligned with expected process performance.	• Phase 2 - Part 8: How do we know these drivers are working? • Phase 2 - Part 10: Using these measures to drive business performance?	• Objectives 8.1-8.2 guide you to check the top-level measures and procedures defined in Phase 1. • Objectives 10.1-10.3 support the continuous improvement practice.
• #6. Specifications for the interface channels of a process must be defined.	• Phase 1 - Part 2: What are our business objectives? • Phase 2 - Part 6: What can we use to drive performance towards our objectives?	• The objectives set 2.1-2.8 describes how you can organize the PM focusing on the business. Objectives 6.1-6.3 guide the plan and control of drivers of performance.
• #7. Process models and their elements (e.g. objectives, roles, responsibilities, capabilities, performance, information and interfaces) must be shared.	• Phase 1 - Part 4: Have we chosen the right measures?	• Objectives 4.1-4.3 lead to the alignment of the process to top-level measurement.
• #8. Processes must explicitly support management/control (e.g. synchronization, decision-making, delegation and coordination) within a process and with other processes.	• Phase 1 - Part 4: Have we chosen the right measures? • Phase 2 - Part 7: Which performance drivers are most important?	• •Objectives 4.1-4.3 lead to the alignment of the process to top-level measurement. •Objectives 7.1-7.4 conduct to the definition of key aspects to measurement.

EE Guideline	Evidence of the EE guideline in the PM system implementation process	Why?
• #10. Processes must incorporate mechanisms for change/improvement detection/management.	• Phase 1 - Part 2: What are our business objectives? • Phase 1 - Part 5: Using our measures to manage the business • Phase 2 - Part 9: Have we chosen the right measures for the key drivers? • Phase 2 - Part 10: Using these measures to drive business performance?	• The objectives set 2.1-2.8 describes how you can organize the PM focusing on the business. Objectives 5.1-5.3 suggest the mechanisms for reviews. Objectives 9.1-9.3 lead to the alignment of chosen measures and teams. Objectives 10.1-10.3 support the continuous improvement practice.

EE Guideline	Evidence of the EE guideline in the PM system implementation process	Why?
• #12. Information related to the performance of the process and the organization must be collected.	• Phase 1 - Part 2: What are our business objectives? • Phase 1 - Part 3: Are we achieving our business objectives? • Phase 1 - Part 5: Using our measures to manage the business • Phase 2 - Part 6: What can we use to drive performance towards our objectives? • Phase 2 - Part 10: Using these measures to drive business performance?	• The objectives set 2.1-2.8 describes how you can organize the PM focusing on the business. Objectives 3.1-3.2 guide the development of performance measures. Objectives 5.1-5.3 suggest the mechanisms for reviews. Objectives 6.1-6.3 guide the plan and control of drivers of performance. Objectives 10.1-10.3 support the continuous improvement practice.

Figure 5: Evidence of the EE guidelines in the PM system implementation process

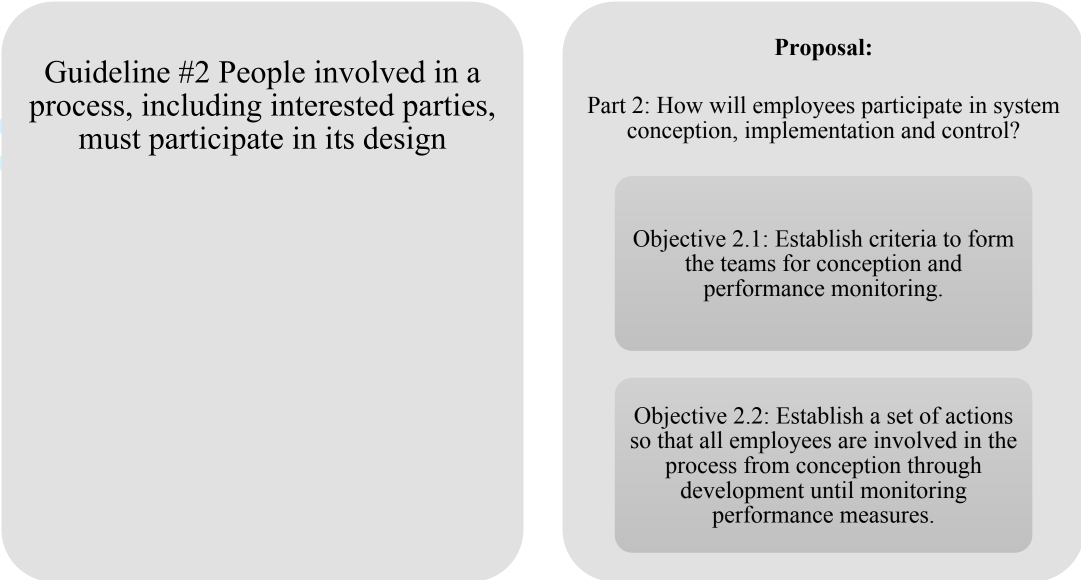

Figure 6: Guideline #2

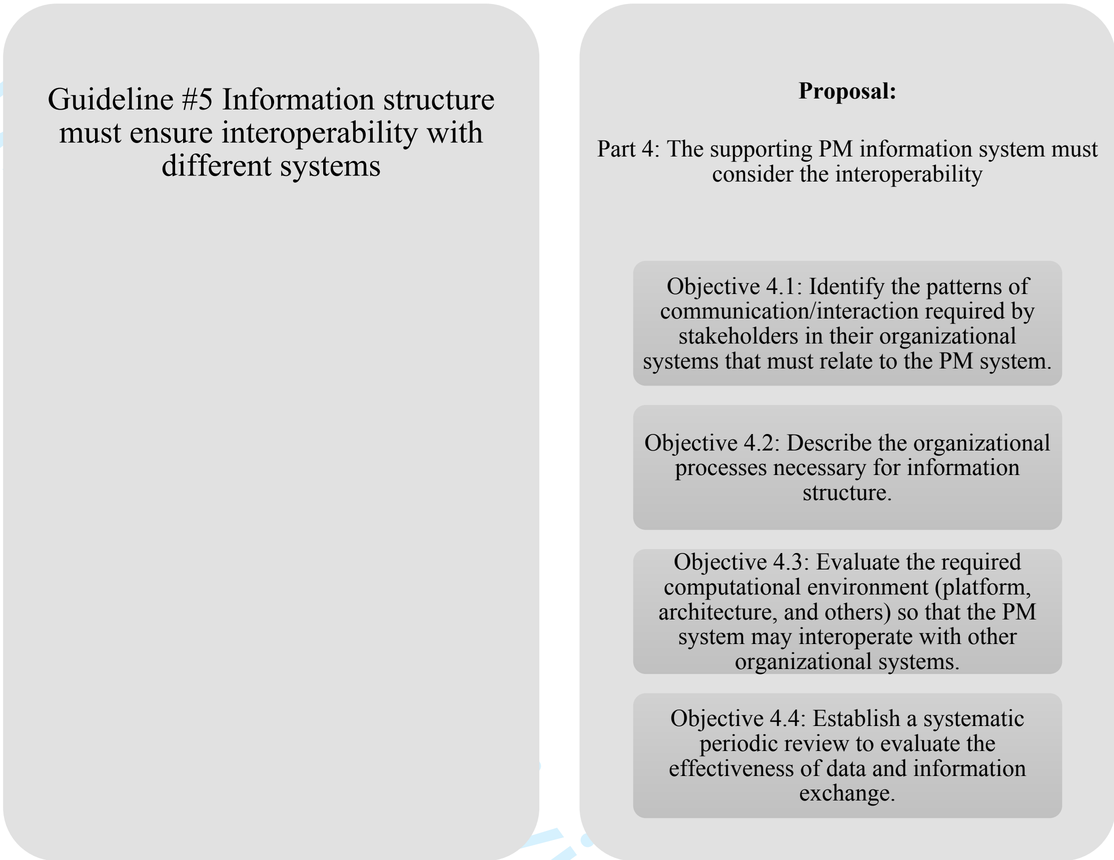

Figure 7: Guideline #5

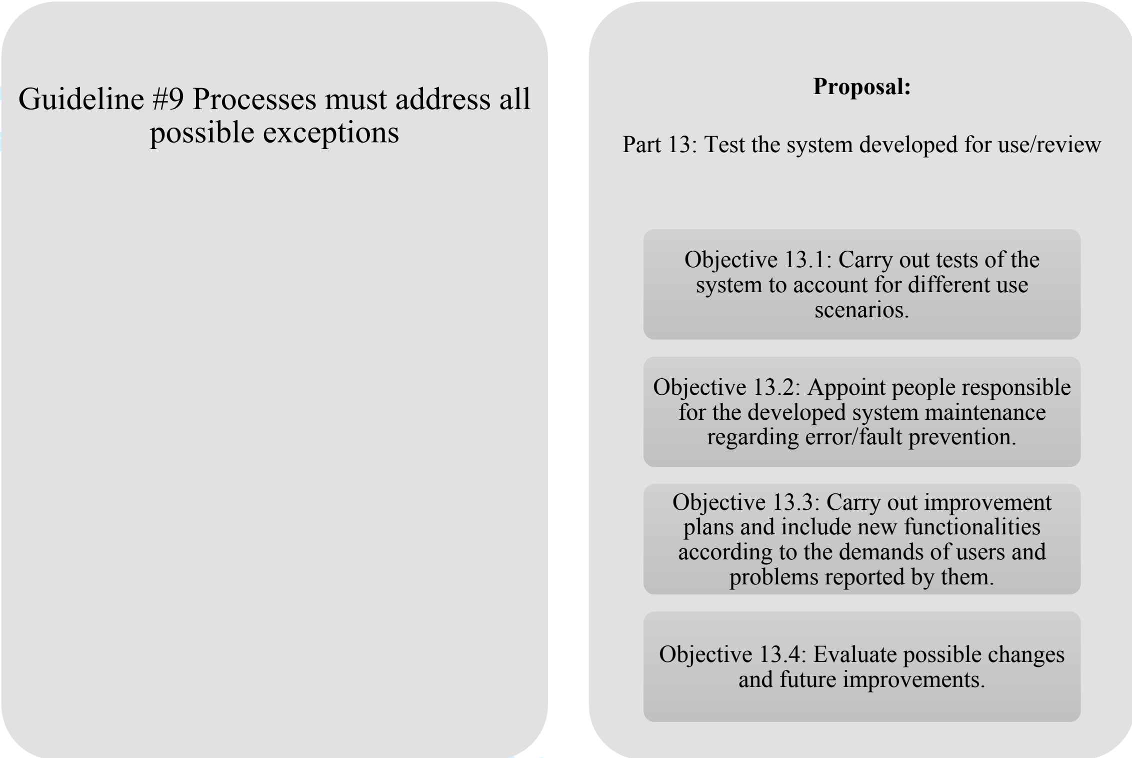

Figure 8: Guideline #9

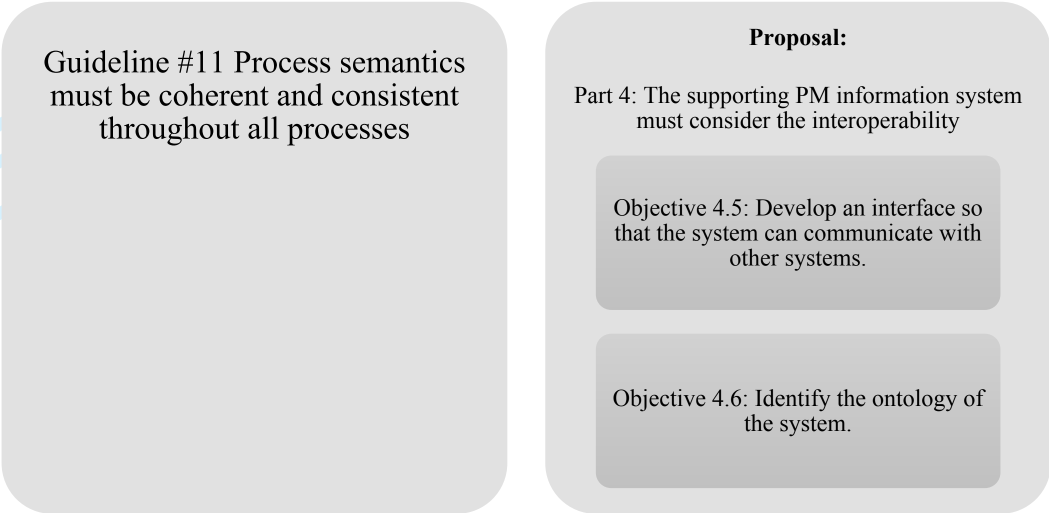

Figure 9: Guideline #11

Table 1: The summarized how-to-guide proposed by Neely et al. (2002)

Phase	Part	Objectives
Phase 1: Identifying, designing and implementing the top-level performance measures	Part 1: What are our main customer-product groups?	Objective 1.1: to identify customer-product groups with distinct competitive requirements. Objective 1.2: to identify customer-product groups. Objective 1.3: to collect data on identified customer-product groups.
	Part 2: What are our business objectives?	Objective 2.1: to agree a balanced set of business objectives (business objectives = business implications + target + timescale) for each customer-product group. Objective 2.2: to identify the customer needs for each customer-product group, starting with the most important group. Objective 2.3: to identify other stakeholder needs for and from each customer-product group. Objective 2.4: to identify business objectives. Objective 2.5: to check that a balanced set of objectives has been developed. Objective 2.6: to agree targets and check against business strategy. Objective 2.7: to assess contributions. Objective 2.8: to define responsibilities for checking or developing performance measures for each business objective.
	Part 3: Are we achieving our business objectives?	Objective 3.1: to develop a performance measure for each business objective. Objective 3.2: to complete one performance measure record sheet for each business objective.
	Part 4: Have we chosen the right measures?	Objective 4.1: to check that everyone agrees with all the top level performance measures. Objective 4.2: to establish a process for tracking progress with the implementation of each measure. Objective 4.3: to check whether there are any barriers to implementation.
	Part 5: Using our measures to manage the business	Objective 5.1: To agree an agenda for future performance reviews. Objective 5.2: To agree a mechanism for reviewing the performance measurement system. Objective 5.3: to conduct performance successful performance reviews.
Phase 2: Cascading the top-level measures and identify appropriate lower-level performance measures	Part 6: What can we use to drive performance towards our objectives?	Objective 6.1: to identify drivers of performance. Objective 6.2: to populate the polar fishbone chart. Objective 6.3: to summarize the polar fishbone chart.
	Part 7: Which performance drivers are most important?	Objective 7.1: to identify which drivers are key so that appropriate performance measures can be developed. Objective 7.2: to identify key activities. Objective 7.3: to evaluate key activities. Objective 7.4: to agree responsibilities for developing performance measures for each key activity.
	Part 8: How do we know these drivers are working?	Objective 8.1: to identify a performance measure for each key driver. Objective 8.2: to complete one performance measure record sheet for each key driver.
	Part 9: Have we chosen the right measures for the key drivers?	Objective 9.1: to check all members of each business team agree with all the performance measures that their team will use. Objective 9.2: to establish a process for tracking progress with the implementation of each measure. Objective 9.3: to check whether there are any barriers to implementation.
	Part 10: Using these measures to drive business performance?	Objective 10.1: to agree an agenda for future performance reviews.

		Objective 10.2: to agree a mechanism for reviewing the performance measurement system. Objective 10.3: to conduct successful performance reviews.

Table 2: Proposed PM system implementation and operationalization process

(a)

Phase	Part	Objectives
Phase 1: Identifying, designing and implementing the top-level performance measures	Part 1: What are our main customer-product groups?	Objective 1.1: to identify customer-product groups with distinct competitive requirements. Objective 1.2: to identify customer-product groups. Objective 1.3: to collect data on identified customer-product groups.
	Part 2: How will employees participate in system conception, implementation and control?	Objective 2.1: Establish criteria to form the teams for conception and performance monitoring. Objective 2.2: Establish a set of actions so that all employees are involved in the process from conception through development until monitoring performance measures.
	Part 3: What are our business objectives?	Objective 3.1: to agree a balanced set of business objectives (business objectives = business implications + target + timescale) for each customer-product group. Objective 3.2: to identify the customer needs for each customer-product group, starting with the most important group. Objective 3.3: to identify other stakeholder needs for and from each customer-product group. Objective 3.4: to identify business objectives. Objective 3.5: to check that a balanced set of objectives has been developed. Objective 3.6: to agree targets and check against business strategy. Objective 3.7: to assess contributions. Objective 3.8: to define responsibilities for checking or developing performance measures for each business objective.
	Part 4: The supporting PM information system must consider the interoperability	Objective 4.1: Identify the patterns of communication/interaction required by stakeholders in their organizational systems that must relate to the PM system. Objective 4.2: Describe the organizational processes necessary for information structure. Objective 4.3: Evaluate the required computational environment (platform, architecture, and others) so that the PM system may interoperate with other organizational systems. Objective 4.4: Establish a systematic periodic review to evaluate the effectiveness of data and information exchange. Objective 4.5: Develop an interface so that the system can communicate with other systems. Objective 4.6: Identify the ontology of the system.
	Part 5: Are we achieving our business objectives?	Objective 3.1: to develop a performance measure for each business objective. Objective 3.2: to complete one performance measure record sheet for each business objective.
	Part 6: Have we chosen the right measures?	Objective 6.1: to check that everyone agrees with all the top level performance measures. Objective 6.2: to establish a process for tracking progress with the implementation of each measure. Objective 6.3: to check whether there are any barriers to implementation.
	Part 7: Using our measures to manage the business	Objective 7.1: To agree an agenda for future performance reviews. Objective 7.2: To agree a mechanism for reviewing the performance measurement system. Objective 7.3: to conduct performance successful performance reviews.

(b)

Phase	Part	Objectives
Phase 2: Cascading the top-level measures and identify appropriate lower-level performance measures	Part 8: What can we use to drive performance towards our objectives?	Objective 8.1: to identify drivers of performance. Objective 8.2: to populate the polar fishbone chart. Objective 8.3: to summarize the polar fishbone chart.
	Part 9: Which performance drivers are most important?	Objective 9.1: to identify which drivers are key so that appropriate performance measures can be developed. Objective 9.2: to identify key activities. Objective 9.3: to evaluate key activities. Objective 9.4: to agree responsibilities for developing performance measures for each key activity.
	Part 10: How do we know these drivers are working?	Objective 10.1: to identify a performance measure for each key driver. Objective 10.2: to complete one performance measure record sheet for each key driver.
	Part 11: Have we chosen the right measures for the key drivers?	Objective 11.1: to check all members of each business team agree with all the performance measures that their team will use. Objective 11.2: to establish a process for tracking progress with the implementation of each measure. Objective 11.3: to check whether there are any barriers to implementation.
	Part 12: Using these measures to drive business performance?	Objective 12.1: to agree an agenda for future performance reviews. Objective 12.2: to agree a mechanism for reviewing the performance measurement system. Objective 12.3: to conduct successful performance reviews.
	Part 13: Test the system developed for use/review	Objective 13.1: Carry out tests of the system to account for different use scenarios. Objective 13.2: Appoint people responsible for the developed system maintenance regarding error/fault prevention. Objective 13.3: Carry out improvement plans and include new functionalities according to the demands of users and problems reported by them. Objective 13.4: Evaluate possible changes and future improvements.