Performance Measurement and Management Systems: A Perspective from Complexity Theory

Abstract

Complexity negatively impacts the process of continually improving performance management systems (PMSs). The extant PMS literature considers complexity to be a result of the external environment rather than a user response to that environment. However, this paper argues that organizations generally face internal complexity when adopting PMSs. Introducing PMSs into an organization can have varied effects in th ose organizations based on the complexity of an organization's associated members and its interactions. This study aims to understand the emergence of complexities while implementing and using PMSs in organizations. From the complexity theory perspective, four system properties (ontological, teleological, genetic and functional) are used to understand complexity in PMSs. The paper builds on a systematic literature review comprising 76 papers and analyzes them in the light of exploring sources of complexity when implementing and using PMSs. From the outset, complexity is understood to be a result of the conflict between existing organizational practices and mechanisms and the organizational controls associated with PMSs. The key findings abstracted six sources of complexity in this study: role, task and procedural types of complexity associated with the social dimension and methodological, analytical and technological types of complexity associated with the technical dimension. The study findings contribute to the current discussion regarding why PMSs typically lag and are not responsive and resilient in emerging contexts. While understanding and exploring all organizational controls that moderate a PMS is useful, organizations should construct the necessary capabilities depending on their context and adapt to the changes associated with PMSs.

Keywords: Social complexity, technical complexity, performance measurement complexity, complexity theory

1. Introduction

Performance management systems (PMSs) have been posited as processes that help organizations set goals and track progress over time. However, growing environmental and organizational complexity has become a barrier in implementing efficacious PMSs (Harkness and Bourne 2015; Rahbek *et al*. 2012). While external environmental complexity has been a focus of several academic studies (Harkness and Bourne 2015; Melnyk *et al*. 2014; Nudurupati *et al*. 2016), internal organizational complexity has been ignored by scholars in the extant Performance measurement and management (PMM) literature (Braz *et al.* 2011; Franco-Santos *et al.* 2007). With the introduction of total quality management (TQM) in the 1980s and the revolution of traditional backward-looking accounting systems in the 1990s, teams of individuals, using performance measurement (PM) from within their functional area, became responsible for decision making. In essence, organizations adopted structures that are naturally distributed alongside hierarchies in which information is exchanged laterally through the organization. However, this distribution opposed the top-down flow of strict hierarchies of command and control structures that already existed to manage the organization, thus resulting in complexity (Adler 2011; Burnes 2005; Lin *et al.* 2014; Zellner 2008).

According to complexity theory, if organizations are considered to be complex and non-linear systems, their associated members and their interaction with subsystems will determine their current and future behavior through a self-organizing set of order-generating rules (Brown and Eisenhardt 1997). Even light and relatively insignificant turbulence can lead to a huge change with unpredictable consequences and vice versa. Hence, PMSs that are introduced into an organization can have varied effects on those organizations based on the complexity of their associated members and its interactions. According to Stacey (1995), there are three types of these varied effects. In the first type, the PMS has no impact on the organization, in which case the system soon becomes obsolete. In the second type, the PMS can bring uncontrolled instability into the organization, in which case it self-destructs. In the final type, the PMS can bring controlled instability, in which case the organization is able to adapt to the change in order to survive. Hence, to understand complexity in the PMS context, it is necessary to understand the role of PMSs as agents of change (Bourne *et al*. 2000; Nudurupati *et al*. 2011).

To begin understanding complexity of a PMS, it is necessary to understand its lifecycle from its design through implementation and use (including revisions) (Bourne *et al*. 2000). These process stages have been part of previous discussions in several studies (Bourne *et al.* 2003; Deng *et al.* 2012; Jääskeläinen and Sillanpää 2013; Lohman *et al.* 2004; Nudurupati *et al*. 2011; Suprapto *et al.* 2009). All three stages are equally important and key to a PMS's success or failure depending on the way organizations have adopted the PMS in different contexts (Bititci *et al.* 2012; Choong 2013; Folan and Browne 2005; Mason-Jones and Towill 2000; Neely 1999). Thus, by understanding how complexity evolves, organizations

can support the process stages by developing “best practices” in measuring and managing the performance (Bourne *et al.* 2000; Melnyk *et al.* 2014; Nudurupati *et al.* 2011).

Recently, a few studies have emerged to tackle complexity of PMSs in organizations. For instance, Melnyk *et al.* (2014) proposed a performance alignment matrix in an attempt to address complexity in the light of outcomes versus solutions. Nudurupati *et al.* (2016) presented a case addressing complexity due to external organizational factors in digital economies, which is also echoed by Harkness and Bourne (2015) as well as Roehrich and Lewis (2014). Smith and Bititci (2017) identified social and technical controls to address complexity in organizations. Although the majority of these and past studies proposed better frameworks, technical controls and management controls, only a few studies adopted a theoretical stance for understanding the complexity of PMSs. It is therefore necessary to understand complexity and to investigate how it emerges in the stages of PMSs and how organizations can manage it. Hence, the overall aim of this study is to understand the emergence of complexities while implementing and using PMSs in organizations. The purpose of this study is not to identify another list of social and technical (organizational) controls but to identify PMSs as systems by understanding how their associated properties emerge from a complexity theory perspective. This study seeks to understand the complexity of PMSs before educating practitioners in choosing the right organizational controls to moderate a PMS’s behavior based on the context.

Pettigrew views organisations as nonequilibrium systems and argues that understanding organizational change and political processes requires a systematic approach rather than a reductionist approach (Pettigrew 1977; Pettigrew 2014, p134). However, implementing PMSs in organizations bring in change. Hence, for understanding this change in organizations, a complexity theoretical view becomes important (Ladyman *et al.* 2013). From a complexity theory perspective, four system properties were examined to understand complexity in a PMS: *ontological*, *teleological*, *genetic* and *functional properties* (Anderson 1999; Morel and Ramanujam 1999; von Bertalanffy 1969). These four system properties are closely associated with the two separate but interdependent dimensions, technical and social controls, identified by Smith and Bititci's (2017) theoretical framework. Hence this framework is used as a basis for abstracting findings from this study.

To achieve the study’s overall aim, data were gathered from secondary sources relying on a systematic literature review (SLR). The SLR method filtered studies to examine the latent practices used by different organizations in different operational contexts at three core process stages. The four system properties of complexity are then mapped onto the two types of controls that exist for implementing and using PMSs. The findings suggest that the performance measurement complexity (PMC) emerges in six forms, namely, role, task, procedural, methodological, analytical and technical complexities that are mapped on to the two dimensions of organizational control theory, which is a significant contribution to the theoretical foundations of PMM literature. A major inference of understanding PMC is to refocus how organizations should systematically select from the multiple best practices by

examining the unique context in which a PMS is operating. The study findings also contribute to the current discussion on how PMSs should be responsive and resilient in emerging contexts (Bititci *et al.* 2012; Melnyk *et al.* 2014; Nudurupati *et al.* 2016).

The rest of the paper is organized as follows. The next section presents the background literature and complexity theory adopted from other fields (Briscoe *et al.* 2012; Geraldi *et al.* 2011). This informs the PMM literature regarding how PMSs can be viewed as complex systems. This is followed by presenting the method employed in gathering, filtering and analyzing the data. The study then presents the key findings obtained from the analysis, followed by a thorough discussion. Finally, a conclusion highlights a summary of the findings and key contributions, which is followed by the limitations of this study and future avenues of research.

2. Background Literature

Although the PMM domain has received adequate attention from researchers and practitioners, most of the PMSs are still not dynamic and resilient to changes in the internal and external environment of the firm (Melnyk *et al.* 2014; Nudurupati *et al.* 2011). As a result, some of organizations operating in dynamic markets are addressing static PMSs while working on dynamic strategies, resulting in complexity and a lack of efficiency in resource allocation. Hence, to understand the dynamics of complexity in PMM, it is useful to understand the lifecycle of PMSs, the technical and social controls for operating PMSs and the complexity theoretical lens through which PMSs are understood to be complex systems.

2.1 Performance measurement and management literature

With the dissatisfaction in traditional backward-looking financial accounting systems, a number of frameworks and models have been proposed (see Bititci *et al.* 2000; Neely *et al.* 2000). However, few scholars have explored aspects of implementing PMSs, and a three-phase model proposed by Bourne *et al.* (2000) has been widely accepted in the literature. The first phase is designing the performance measures, which are aligned with the organization's strategy. The second phase is implementing the measures by putting appropriate systems and procedures in place to collect and process data that allow measurements to be made. The third phase is ensuring that the measures are used as part of decision making while challenging the validity of measures on a regular basis. Since the establishment of this model, a number of researchers from different disciplines have worked in this domain to identify the best practices in these three phases under different contexts (Bititci *et al.* 2012; Bourne *et al.* 2003; Choong 2013; Deng *et al.* 2012; Folan and Browne 2005; Garengo *et al.* 2005; Jääskeläinen and Sillanpää 2013; Lohman et al. 2004; Mason-Jones and Towill 2000; Neely 2005; Nudurupati *et al.* 2011; Suprapto *et al.* 2009).

Recently, Bititci (2015,pp.170-187) collated the majority of this work and synthesized it into two broad perspectives: social (art) and technical (science) controls. The *social controls* are posited to be the cultural and behavioral controls achieved through personal traits, structures or bureaucratic elements and interactions. Some of these controls may be implicit and informal. For instance, effective leadership can empower people and promote democratic and participative culture while using performance measures. The *technical controls* incorporate specific methodologies that are objective and rational and are employed to reach a specific goal. These are known to be scientific, objective and tend to be explicit in nature and include a variety of measures, information systems, data collection methods, analyses, and visual communication (Bititci *et al.* 2000; Kennerley and Neely, 2002).

In practice, when not used or implemented appropriately, these controls tend to amplify complexity during the process stages of PMSs (Bititci 2015 pp.170-187); Bititci *et al*. 2012; Kauppi 2013; Nudurupati *et al*. 2011; Pekkola and Ukko 2016), resulting in a significant misuse of resources. For example, while reinventing its PMS, Deloitte found that approximately 2 million hours a year were spent on the formalities of performance management (Buckingham and Goodall 2015). Smith and Bititci (2017) proposed a theoretical framework with the technical and social controls as two dimensions and identified a number of best practices for PMM as depicted in Figure 1.

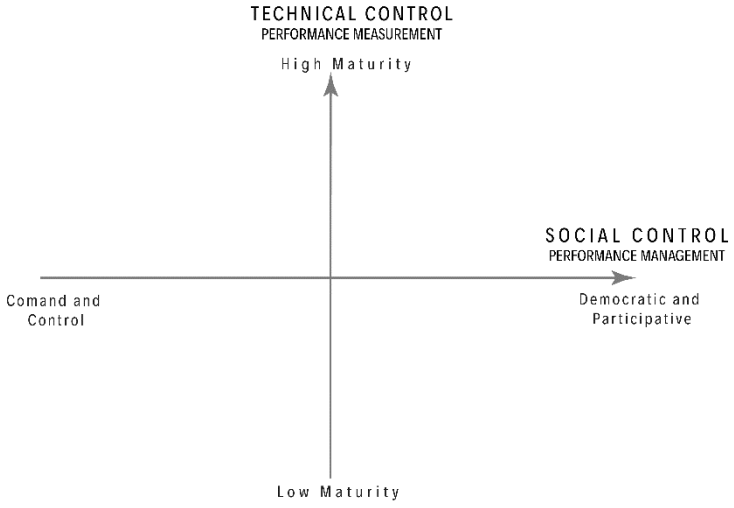

Figure 1. A framework that typifies social and technical controls (Smith and Bititci 2017)

2.2 The perspectives of complexity theory

Complexity theory has evolved from systems theory, which emerged from natural sciences that examined randomly emergent non-linear interactions in a system (Burnes 2005; Grobman 2005). Grobman (2005) argues that complexity theory goes beyond systems thinking and can be applied to understand the management and design of organizations. Complexity in an organization is usually triggered by change, whether small or large, and

can have varied levels of consequences, even when the organizations consist of similar components (Burnes 2005). As discussed earlier, it is useful to further explore how the change triggers instability in organizations and how they can control that change. According to Bititci *et al*. (2012), contemporary organizations operate in turbulent environments in which change can be triggered from a number of sources, i.e., globalization, open innovation, autopoietic networks, technological disruption, social media, process re-engineering, continuous improvement and PM.

While the literature exploring complexity defines it in several ways, the following descriptions are most commonly used. First, Simon (1996) conceptualizes complexity through a hierarchical model, arguing that when faced with a dilemma of many parts in the system, the system breaks down into subsystems until a lowest abstraction is reached. Second, Anderson (1999) extends complex adaptive systems by arguing that the strategic direction of a complex system consists of establishing and modifying environments within which effective, improvised, self-organized solutions can evolve. Based on these works, most attention has been focused on trying to determine all of the interactions within the system, why they interact and how they interact. These interactions remain influential when studying complexity. Third, Edmonds (1999) proposes that complexity is the model property that makes formulating its overall behavior in a given language difficult, even when given reasonably complete information about its atomic components and their inter-relations (Vidal and Marle 2008).

Sahin *et al.* (2013) defined complexity as a behavior that emerges from the way the components of the system are interconnected but not how the components of the system are themselves complex, although the components, people and/or firms, are indeed as complex themselves because they are generally complex adaptive systems (Wilkinson 2006). Similarly, Stacey (2011) argues that organizations are made up of complex non-linear systems interacting with a number of their associated members, which will exhibit a pattern of behaviors. Introducing the understanding of complexity in a PMS would influence the existing systems and their associated agents to produce a new pattern of behaviors, which should be controlled for an effective outcome. Thus, in its most basic form, the concept of complexity suggests that by understanding the structure and behavior of each component within a system, the system as a whole could be understood with inter-relations between several components.

According to Anderson (1999), a system has a number of interactions among its associated components and agents and with the environment in which it operates. Using the system perspective to characterize complexity is not new (Ladyman *et al.* 2013). For example, in understanding project complexity, a wide range of empirical studies uses the systems view to examine complexity (Geraldi *et al.* 2011; Vidal and Marle 2008). Similarly, by providing insights on procurement, a systemic complexity theory was applied (Roehrich and Lewis 2014). The system view means examining and categorizing the known system properties, *ontological*, *teleological*, *genetic* and *functional*, which are real world manifestations of a particular system. The ontological property represents the internal structures that include

leadership, organizational culture and behavioral factors. The teleological property represents an object in an environment that aims to reach an objective. The genetic property represents the system's evolution over time. The functional property represents the focal activity to be performed (Boulding 1956; von Bertalanffy 1969).

2.3 The complexity theoretical lens for characterizing complexity in PMM

The PMM literature does not contain many studies that explicitly examine complexity in depth. However, a few researchers have studied the impact of complexity on PM (Bourne 2015; Harkness and Bourne 2015; McAdam and Bailie 2002; Neely *et al.* 2000). Neely (2005) explores the different ways in which managers can make strategic decisions under complex situations; he also proposed different approaches to organizational learning. Bititci *et al.* (2006) explored the complex nature of causal links between PM, management styles and organizational culture. In a similar vein, Bititci *et al.* (2012) argue that practitioners have to address complexity by rethinking the future of measurement, but they do not explain what exactly amplifies complexity. Braz *et al.* (2011) and McAdam and Bailie (2002) highlight complexity in their work, but they mostly dismiss it as a minor issue. There are number of factors that portray complexity as a potential barrier to PMSs attaining efficacy (Bititci 2015, pp.170-187); Harkness and Bourne 2015; Paranjape *et al.* 2006; Sullivan 2011). The PMM literature also refers to complexity when it addresses the evolution of PMSs. For instance, Bititci *et al.* (2012) reveal business trends and how PMM is moving towards challenging operational contexts, thus suggesting that it is a self-learning system.

To understand the sources of complexity in PMSs, they must be considered complex systems, and the question of whether managing such systems exhibits system properties similar to those described in the literature must be explored (Ladyman *et al.* 2013; Morel and Ramanujam 1999). These goals are achieved by exploring the PMM literature for practices, processes, policies and mechanisms that are associated with the design, implementation and use process stages of PMSs that match the system properties as defined in the previous section. It is concluded that by their definition and use, PMSs exhibit similar properties when viewed as systems, i.e., as discussed in general system theory (von Bertalanffy 1969). A PMS is treated as an entity operating in an environment (Vidal and Marle 2008) with its four system properties: ontological, teleological, genetic and functional. Table 1 shows the system properties that are the attributes of a PMS.

It is important to recognize that PMSs are complex adaptive social systems (Holland 1975), which means that they are systems in which users contribute to both creating and responding to their environment to achieve a goal. In this case, the goal is to monitor and measure performance in order to improve and control its components. The definition of complexity resonates with PMSs in that even though there are several frameworks available to guide a PMS through its lifecycle and explain exactly what organizations need to do, the system behavior as a whole is unpredictable due to the complex nature of the organizational interactions that are further aggravated by social and technical controls.

Table 1. Complexity dimensions associated with performance management systems

System property	Performance management system indicators
Ontological	The ontological property is internal structures such as the people component, varied staff, behavioral factors, leadership styles, variety of information, diversity in practices, number of stakeholders, trust, and different views on what to measure (Bititci *et al.* 2012; Nudurupati *et al.* 2016; Toor and Ogunlana 2010; Wijngaard *et al.* 2006) and organization culture (Aguinis *et al.* 2011; Bititci *et al.* 2006; Elzinga *et al.* 2009; Ukko *et al.* 2007).
Teleological	The teleological property specifies goals (Jääskeläinen and Laihonen 2013), objectives (Haponava and Al-Jibouri 2009; Mol and Beeres 2005) and managerial practices (Angelis and Jordahl 2015). Stakeholder goals (Beer and Micheli 2017).
Functional	The functional property considers need-specific methodologies and contingent factors (Lohman *et al.* 2004; Micheli and Kennerley 2005; Micheli and Mari 2014; Nudurupati *et al.* 2011) as well as PMS frameworks (Ferreira and Otley 2009).
Genetic	The genetic property considers the time factor, evolution of measures (Mol and Beeres 2005), phases of product lifecycles, time factors (Caniato *et al.* 2014), maturity of key performance indicator, and continuous improvement (Braz *et al.* 2011; Elg *et al.* 2014).

The overall aim of this study is to understand the emergence of complexities while implementing and using PMSs in organizations. Hence, the background literature has provided some insights on complexity theoretical perspective and identified four system properties that are closely associated with social and technical (organizational) controls (Smith and Bititci 2017) when implementing PMM. Most of the organizational controls identified in literature are generic although support PMM in organizations. However, the purpose of this study is to explore the sources of complexity, so that specific organizational controls can be identified or developed to increase the usefulness of PMM. As PMM is a mature field with a number of empirical studies emerging every year, collecting evidence from extant literature will be a good starting point for this study. Using SLR approach, this study gathers more data from secondary sources to abstract sources of complexity when implementing and using PMM.

3. Method

A SLR approach was applied to identify and synthesize the most relevant academic literature in this field. Our work, therefore, differs from traditional narrative reviews because it adopts a detailed, replicable and transparent scientific process that aims to minimize bias

through exhaustive bibliographical searches of published studies (Cook *et al.* 1997; Moustaghfir 2008). An SLR approach provides useful guidelines that can be followed by other researchers in different fields (Cook *et al.* 1995; Petticrew and Robert 2006). The chronological evolution of the research on PMM is examined to understand whether there is growing interest in academia and hence in the results presented on the chronological development of publications related to this subject. An SLR analysis allows researchers to focus on the purpose rather than on the utility of publications (Ginieis *et al.* 2012) and it provides a structured way to summarize various findings with minimum bias (Cook *et al.* 1997). This study has adopted the guidelines proposed by Tranfield *et al.* (2003) and Moustaghfir (2008), and presented six stages as demonstrated in Figure 2.

Figure 2. Step-by-step process for sample selection

Stage 1: The keywords words associated with PMM are identified from the background literature, scientific publications and the authors' previous experience in the field (Tasca *et al.* 2010). In line with the suggestion of Tranfield *et al.* (2003), more than one researcher participated in the decisions regarding keyword selection as well as their combination to generate effective search strings. Emphasis was placed on the degree to which the control factors interactively impact the process phases of a PMS throughout its lifecycle as defined in the literature, the design phase (Deng *et al.* 2012; Lohman *et al.* 2004), the implementation phase (Bourne *et al.* 2003; Jääskeläinen and Sillanpää 2013; Suprapto *et al.* 2009) and the use phase, and as adopted by different organizations in different sectors (Bititci *et al.* 2012; Choong 2013; Folan and Browne 2005; Mason-Jones and Towill 2000; Neely 1999). Hence, different performance-related strings are used as primary sources, which are concatenated with the secondary keywords "design", "implementation" or "use".

1. "performance management" AND use OR design OR implementation
2. "performance measurement" AND use OR design OR implementation
3. “perfonmance assessment” AND use OR design OR implementation
4. "performance indicators" AND use OR design OR implementation
5. "performance appraisal" AND use OR design OR implementation
6. "performance control" AND use OR design OR implementation
7. "performance complexity" AND use OR design OR implementation
8. "performance strategy" AND use OR design OR implementation
9. "supply chain performance" AND use OR design OR implementation
10. "performance measurement system" AND use OR design OR implementation
11. "performance management system" AND use OR design OR implementation
12. "performance measurement and management" AND use OR design OR implementation
13. "organisational performance" AND use OR design OR implementation
14. "organizational performance" AND use OR design OR implementation

To perform the keyword search, the databases Web of Science (WOS) from Thomson Reuters and Scopus from Elsevier were used because they provide a wide coverage of areas within this discipline and provide different searching, browsing and filtering options (Ginieis *et al.* 2012; López-Illescas *et al.* 2008). These keyword combintions are searched in the title, keywords and/or abstract of the paper. Table 2 presents the number of articles published in different journals in a chronological order.

Stage 2: As demonstrated in Figure 2, the initial keyword combination search yielded 10,589 outputs in the previous stage, which are further filtered in this and subsequent stages in a process that incorporates the exclusion criteria established by the research protocol (Jones and Gatrell 2014). The use of two databases resulted in duplicates, which are removed in Stage 2, resulting in 9,251 outputs. As demonstrated in Figure 3, until the late 1990s, only 952 publications of PMM (only 10% of total of studies analyzed) had been published. The noteworthy increase in publications in this field is observed since the beginning of the year 2000. More specifically during the period 2000-2008, 2,213 documents have been published (24%). Finally, it is important to remark that in the last few years (2009-2017) 6,086 studies on PMM (66%) have been published. This demonstrates the growing importance that this topic has had in the academic literature in recent years. This is one of the fundmental reason why this study adopted SLR approach.

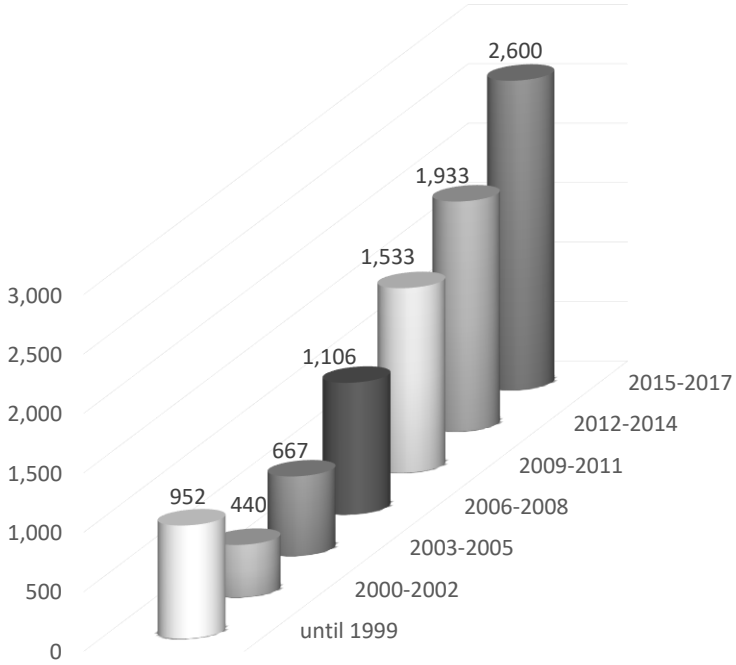

Figure 3. Number of all publications on PMM until 2017

Stage 3: The papers are further filtered to include only peer-reviewed journal articles, which reduced the number to 6,091 articles. For instance, Table 2 presents the number of articles retreived using different keyword search strings in chronological order.

Stage 4: Articles are further filtered by specific journals that are listed in the categories Management/Business (WOS), Business, Management and Accounting (Scopus), Operations and Technology Management, General Management, Ethics and Social Responsibility. With the increase in the number of journals emerging every year, it is becoming difficult to judge the quality of papers. Hence, the Chartered Association of Business School (ABS) journal ranking guide as well as Australian Business Deans Council (ABDC) journal quality list was used to further filter the articles. All journals (irrespective of their rank or rating) listed in these guide were used to filter the list. By using this search strategy in these databases and guides, the study intends to locate the most recognized academic journals by the scientific community in the different fields of knowledge. Furthermore, this filtering ensures that a high standard is maintained in the performance of the SLR and in its output. Similarly, McGovern (2014) conducted a systematic review based on only four leading academic journals. Among other reasons, he justified this decision by noting that all four journals were "considered to be leading journals and, as such, might reasonably be expected to exert some influence over their respective subfields" (p. 23). This SLR followed a similar path and was organized to consider only journals that are relevant to this discipline and that have published at least 10 articles on PMM. This resulted in 1,496 articles. The initial data analysis of 1,496 articles revealed some useful information that shed light on the research trends and direction. For instance, Table 3 presents the journals that most articles have published on PMS in chronological order.

Stage 5: The papers were screened by reading the title and abstract for assessing their relevance and fit with the research scope, which resulted in 205 papers. Similar steps have been employed in previous SLRs (Bonato *et al.* 2015; McGovern 2014; Tasca *et al.* 2010; Turner *et al*. 2012). Where an abstract is not clear, it is included for full appraisal.

Stage 6: It is an iterative process at this stage where the 205 papers are fully appraised to assess its suitability to this study by using filtering criteria. Firstly the study has included only empirical articles where the observations are grounded in practice. Secondly the focus of this study is the exploration of sources of complexity while implementing and using a PMS. Hence from the outset, complexity can be understood to be a result of the conflict between organizational practices and mechanisms with social and technical controls associated with PMSs. Hence this stage included papers that discussed organizational controls that are used to manage PMS in organizations. Finally a total of 76 papers were thoroughly analysed and evaluated. These papers are further supplemented by additional papers obtained through citation tracking as well as the authors' previous experience where appropriate. The selected papers from the SLR covered a wide range of aspects such as human resources, manufacturing, measurement systems in SMEs, financial and non-financial operations, leaderships styles, and motivation at work associated with PMSs.

Data Analysis: The data obtained from these multiple sources was synthesized, and the key research findings were abstracted. Multiple sources were examined for common patterns. The explanations obtained from the triangulation of consistent patterns, comparable meanings or common aims were integrated into themes. The synthesis, pattern matching and integration has promoted the development of six theoretical presentations of complexity, which are further presented in findings section. While the authors emphasized triangulation, the identification of common patterns and the development of integrated explanations, they did not attempt to quantify any occurrences for use in the analysis. The papers appraised were grouped by the author(s), purpose, research method adopted, PMS lifecycle stages explored and finally the understanding of the type of complexity abstracted in each study (see Table 4). To identify the emerging complexity, the authors independently reviewed each of the manuscripts with the four system properties that were described in Table 1 in the light of social and technical controls.

4. Key Findings

The findings reveal that most of the studies identified either social or technical controls as a foundation for an effective PMS. For example, after analyzing 76 empirical studies, Franco-Santos *et al.* (2012) classified unique contemporary PM features into three categories: people's behavior, organizational capabilities, and performance consequences. They highlighted the necessity of understanding how organizations respond to dynamic situations. Similarly, Braz *et al.* (2011) studied the process of reviewing and updating a company's existing PMS to reflect changes in the environment. They identified PMS users, assessing of performance indicators, and the establishment of goals is key. Many other

researchers indicated that supporting frameworks, information systems, data collection methods, analysis and visual communication were technical controls for effective PMSs. However, none of these studies had a critical view of the complexity theoretical lens. Hence this study aims to understand the emergence of complexities while implementing and using PMSs in organizations. Smith and Bititci's (2017) theoretical framework has identified social and technical controls to assess the maturity of PMM in organizations using an organizational theory perspective. This study has identified six sources of complexity that are closely associated with the social and technical dimensions of Smith and Bititci's (2017) framework and hence used it as a reference model. As demonstrated in Figure 4, six sources of complexity were abstracted from this study: role, task, and procedural types of complexity were associated with social dimension, while methodological, analytical and technological types of complexity were associated with technical dimension.

4.1 Social complexity

The SLR analysis abstracted the first theme, social complexity which is associated with leadership, hierarchical structures, empowerment, trust, motivation at work, employee behavior, training, skills, trust and culture. These characteristics closely match the ontological property of complexity. With the evolution of a PMS, some of these social controls improve, become more fine-tuned and mature, thus connecting to the genetic property of complexity. Most of the studies that explored social controls identified them as foundational for PMSs at every process stage. For example, Elzinga *et al.* (2009) sets out to identify factors that influence the use stage of PMSs and argue that behavioral factors in different roles within an organization are the most important factors at the use stage of a PMS. In another study (Shin and Konrad 2017) on human resource management, social controls were also identified as high-performance work practices (HPWS), high involvement practices that help organizations gain better performance.

Role complexity

According to command and control theory, organizations are established on the basis of hierarchical relationships with a clear flow of authority to allow their entities to achieve economic performance and goals (Rizzo *et al.* 1970). When a PMS with a democratic culture is adapted to an organization, it can lead to conflict, incompatibility and ambiguity regarding existing roles, thus creating role complexity. From theoretical perspective, if organizations do not control behavioral factors such as empowerment, autonomy, trust, communication and training, role complexity could develop. From the analysis, role complexity can be further explained as the relationship/conflict between different team roles and individual roles and how they should be appropriately allocated. Toor and Ogunlana (2010) highlighted the complexity of social controls in the construction industry. They revealed the differing perceptions on a construction project, leading to conflicting requirements regarding what to measure. Furthermore, in another study, Beer and Mictheli (2017), gave a contribution on how Performance Management influences the attention and actions at an individual micro level which also reveals social controls at an individual level.

Task complexity

Organizations establish the knowledge, skills and resources needed for an entity to demonstrate satisfactory performance (Wood 1986). Hence, a task in an organization must be clearly defined; without this definition, there is often substantial ambiguity and conflict leading to task complexity. From our sample, this is also echoed by Ardler (2011), who argued that clarity regarding a task and task efficiency are particularly essential to organizations that are trying to be price minimizers or cost leaders. However, the introduction of new measures or new ways of measuring and managing often bring ambiguity and conflict with existing knowledge, skills and resources, thus leading to task complexity. Task complexity emerges not only from a lack of clarity on tasks but also from inter-relationships and the conflicts between them; hence, it is necessary to explore mature social controls associated with task complexity. Adler (2011) studied the design of PMSs for confrontation strategies and found that programs that focus on developing empowered, multi-skilled teams of self-governing and well-coordinated individuals leads to task efficiency.

Procedural complexity

While many authors (Bititci 2015, pp.170-187); Smith and Bititci 2017) acknowledge the need for social controls for an effective PMS, there is little consensus regarding how to strike the proper balance between the level of control over individuals and the level of freedom or autonomy given to them. While organizations have a number of rules to control the way they operate, an introduction of a PMS will initiate turbulence and will create substantial ambiguity and conflict. Procedural complexity emerges when there is a lack of information regarding priorities or the course of action when there is a change in the routine. This complexity occurs when the new processes and their impact are not explained to employees (Gilliland *et al.* 2005). With mature social controls such as autonomy, empowerment, communication and multi-skills (the benefits of PMS), organizations can self-organize and adapt to this change while also creating new rules, regulations and policies for operating an effective PMS, without which procedural complexity would develop. Social controls were also mainly identified in the study by Dewettinck and Vroonen (2017) by drawing from signaling theory, theory of planned behavior and social exchange theory, they investigated social controls such as attitudes, employee concern, job satisfaction and engagement. It was found that the antecedents and the outcomes of front-line management's enactment of performance management (PM) activities was moderated by manager´ span of control.

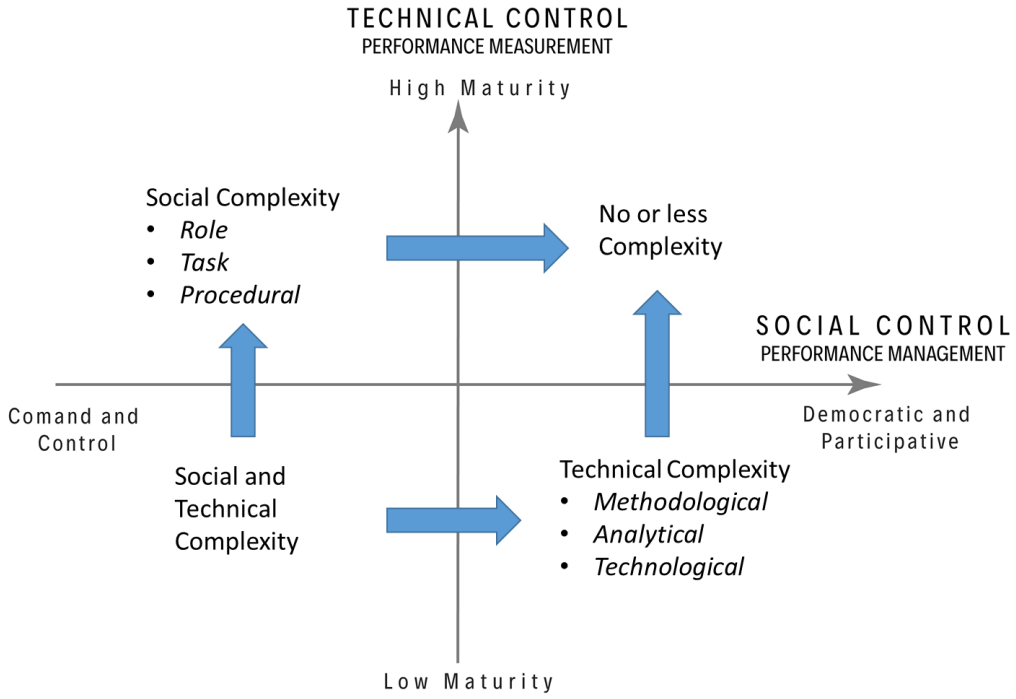

Figure 4. Sources of complexity in PMM dimensions (Adapted from Smith and Bititci 2017)

4.2 Technical complexity

The analysis from the SLR abstracted the second theme, technical complexity, which is associated with frameworks or models, information systems, data collection methods, analysis and visual communication. These characteristics are closely associated with the functional and teleological properties of complexity. The teleological property represents an objective of the system, while the functional property represents the methods of achieving that objective. With the evolution of PMSs, some of these technical controls improve and mature, thus mapping onto the genetic property of complexity. Technical controls are formal and more explicit than social controls. PMSs have a specific goals such as improving performance, learning or control, and hence, they use specific methodologies, technology and analyses to reach these goals (Bititci 2015, pp.170-187).

Methodological complexity

When implementing PMSs in organizations, there is often conflict between its objectives and associated measures. In most of these cases, organizations are less informed regarding which method should be used in choosing measures (often using subjective measures) and which philosophy to use in selecting the type of measures (often using objective measures). These situations usually lead to methodological complexity. Methodological complexity often relates to a conflict between an approach to choosing measures (such as quantitative vs qualitative) and the difficulty encountered in selecting the type of key performance indicators (KPIs), their calculations and the number of KPIs to be used. Santos *et al.* (2002)

investigated how system dynamics and multicriteria decision analysis can enhance the effectiveness of selecting measures during the design and implementation of a PMS while taking input from all stakeholders. From their findings, they recommended that the use of such approaches provides a means for addressing methodological complexity in organizations.

Analytical complexity

When implementing PMSs in organizations, there is often difficulty in understanding each measure, its influence on other measures and its impact on the organization's strategy as a whole. These relationships are often undermined in organizations, leading to analytical complexity (Suwingnjo *et al.* 2000) Analytical complexity is often associated with a lack of understanding regarding cause and effect relationships between measures, data presentation, sophisticated charts and graphs, and visual screens. Hence, organizations should use more scientific and objective methods such as mathematical and simulation modeling, systems dynamics, cause and effect analysis, correlations and regression for designing and using specific measures. These analytical approaches restrict subjectivity, ambiguity and conflict between measures (Santos *et al.* 2002). While studying the use of PMSs in the public sector, Spekle and Verbeeten (2014) identified technical controls, such as contractibility, clarity of goals, and undistorted performance metrics, that create performance effectiveness. In another study by Hwang *et al.* (2017) the workability of internet of things (IoT) for capturing real time data was investigated, technical controls such as simulation results, planned and actual productions data, timestamp data acquired by IoT were identified leading to analytical complexity. In an attempt to improve supply chain performance in another study (Govindan *et al.* 2017), technical controls such as Collaborations and Information Exchanges; Customer Relationship Management Competitiveness; Organizational Level Innovation; and supply chain reliability were found to using fuzzy AHP method for analysis which is purely technical control leading analytical complexity.

Technological complexity

The way in which we are operating in digital economies is changing with the advent of technological developments (Nudurupati *et al.* 2016). While the way customers are engaging with businesses is changing, the way organizations are gathering data using advanced technologies is also evolving. The implementation of a PMS in this context is no exception, and organizations' failure to use technology appropriately leads to technological complexity. Technological complexity often emerges when there is no effective coordination and tighter integration between the selection of and investment in technology such as IT systems and the needs of the business. Turner *et al.* (2005) examined the implementation of performance measures and recommended that PMSs could enhance business performance if the implementation is well structured, resourced and focused on improving the capability of technical controls. In another study, technical controls such as measurement frameworks, information systems and reporting mechanisms using balance scorecards took greater precedence (Lohman 2004).

5. Discussion on Performance Measurement Complexity (PMC)

From a complexity theory perspective, a PMS is considered a complex adaptive social system (because it consists of a large number of elements whose interactions create new behaviors that cannot be predicted by a complete analysis of the individual elements (Sahin *et al.* 2013). A PMS has its own lifecycle, and it interacts with a number of other elements exemplifying the levels of complexity at different times. Hence, coercively controlling such an adaptive system can have a negative impact on the process of measurement and management (Bititci 2015, pp.170-187). However, the SLR reveals abundant literature arguing the need for different factors, controls and best practices to measure and manage performance. Overall, the analysis from the SLR suggest that complexity exists in a PMS through its lifecycle but varies based on how many combinations of organizational controls and elements interact with it. At one extreme, an overly controlled process can leave individuals unable to cope with a complex situation due to rigidity. On the other extreme, if individuals are not given enough guidance (or too much autonomy) to measure and manage performance, the process may be adversely affected due to variability.

Adler (2011) found that both technical and social controls were necessary to address the implementation of a confrontational strategy. The technical controls included strategies for cost leadership, differentiation, confrontation, etc. The social controls included training, development, multiskilling, and collective responsibility. In studying the advantages and disadvantages of using PMM tools and techniques, de Waal and Kourtit (2013) identified two main reasons for their use, which focused on controls and strategy. They recommend that management needs to take the explicit advantage of PMM when designing a PMS, and they stress the advantages of social controls during and after implementation. However, in another study, Sharma and Bhagwat (2006) explore PMS implementation at both small and large firms. They present a framework that suggests information systems as a foundation for growth and a way to drive strategy. The study focused on technical control factors and neglected to address the influence of social factors. While Smith and Bititci (2017) broadly divided most of these controls under the classification of technical and social controls, striking a balance between the two is important to mitigating complexity. Performance measurement complexity (PMC) is a type of complexity that emerges internally, breeds within and through the short and long-term routines of managing PMS and sustains unnoticed. Hence, it is necessary to systematically understand how PMC emerges to identify its root causes before prescribing a solution. As demonstrated in Figure 4, the goal of an organization is to mitigate PMC by striking the right mixture and balance of technical and social controls to move into the top right quadrant of the theoretical framework.

Although it is widely accepted that complexity is a result of several external influences and factors that affect the organization and the PMS, this study has demonstrated that complexity is generated through the interaction of PMSs with several internal elements during its evolution. Harkness and Bourne (2015) identified internal factors such as ambiguity, a lack of control, unpredictability, and information issues, which interact with PMSs as a precursor to complexity. Furthermore, research into PMM has been limited to

the interplay between what is measured (Micheli and Mari 2014) and how it is controlled (Canonico *et al.* 2015; Mol and Beeres 2005) and the process of updating, analyzing, and acting on performance data (Bititci 2015, pp.170-187); Bourne *et al.* 2000; McAdam and Bailie 2002). Hence understanding complexity from its ontological, functional, teleological and genetic properties will identify new dimensions in moderating complexity in PMM. From this perspective, this study identified six sources of complexity using a theoretical framework from complexity theory in the context of PMM. As discussed earlier, complexity may emerge in varying forms and in varying intensities at different stages of a PMS depending on the context.

While studying the state-of-the-art of PM, Greiling (2005) suggests that in order to keep the motivation and participation rate high with a PMS, it is necessary to concentrate on a few relevant indicators and that measurement for measurement's sake is not a goal in itself. Hence, motivation acts as an important social control, particularly during the use stage of a PMS. A lack of motivation in employees can lead to role complexity, as they do not effectively perform their jobs. This role complexity is also exemplified by conflicting interests, different ambitions, and different measures of success. Similarly, several studies have recognized that a lack of standardization generates task and procedural complexity (Jääskeläinen and Sillanpää 2013; Nudurupati and Bititci 2005; Ukko *et al.* 2007). While the three complexities discussed in the previous section, i.e., role, task, and procedural, appear to be technical at first, the maturity of social controls such as motivation, leadership, training and skills, empowerment, self-regulation, trust and hierarchy plays a significant role in addressing the ontological property of PMSs, thus moderating social complexities. Ukko *et al.* (2007) found that it was the role of leadership skills and the manager's commitment as social controls that were crucial in aligning the manager's and employees' perspectives on the strategy and improving performance.

When measures are selected with lack of clarity or are poorly and ambiguously defined at the design stage, they may not reflect the strategy of the organization at the use stage, resulting in a complex situation (Courty and Marschke 2003). Kelman and Friedman (2009) argue that resources are usually deployed for actions related to improving measures while neglecting other aspects of the business, which eventually manifests in a vague complex situation. Nudurupati *et al*. (2016) argue that a lack of strategic intent in resource allocation for a PMS may create a technological mismatch with the business needs and result in a complex situation. The teleological and functional properties associated with such PMSs may be affected, leading to methodological, analytical or technological complexities. Mature technical controls such as a balanced set of metrics, a high degree of defined casual relationships, strategic measures deployed to lower levels, targets and incentives linked to strategic objectives, measures and their trends reported in an accessible manner, and regular and frequent performance reviews play a significant role in moderating technical complexities.

From complexity theory, the genetic property of a PMS represents how it evolves over time. From the SLR and its analysis, the genetic property is more associated with exploring the

maturity and validity of KPIs over time. This property also incorporates the interaction of PMSs with other elements such as continuous improvement, changing programs and external fluctuations that influence the organization. For example, Angelis and Jordahl (2015) studied the maturity of various performance management practices at the use stage, which maintains the evolution of the system. As a PMS matures, it provides standard management practices; however, as Kennerly and Neely (2002) state, "measurement systems should be dynamic; they have to be modified as times change". In this study, the authors examined the factors that affect the evolution of PMSs over time, including both social and technical controls, which are both internal and external to the system. The interaction of the continuous improvement framework for PMSs was studied at the design stage (Hudson *et al.* 2001). Similarly, Garengo *et al.* (2005) presented a model of how PMSs evolve over time. This study also explored all three process stages and found that "the models developed in the last 20 years are more horizontal, process-oriented and focus on stakeholder needs". This demonstrates and validates the genetic property of PMSs, and understanding this property is vital to their success. Similarly, the business trends in the external context also influence organizational strategy, leading to the need for change in the PMS over time (Bititci *et al.* 2012; Melnyk *et al.* 2014). Hence, the moderation of complexity that stems from a PMS is not a linear task and needs to be controlled over time with feedback loops.

From the findings, social controls employed in PMS also appear to create a versatile condition for adapting technical controls. Managing PMSs is largely socially constructed rather than technically constructed and operated (Johnston 2005, p.514). Social controls are assumed to be purely concerned with the human aspects, such as group dynamics, relationships, commitment, leadership, authenticity, behaviors, values, and trust. Hence, as more organizations become democratic, the focus of control should shift from command and control to something more participative (Bititci *et al.* 2012; Bourne *et al*. 2000; Mol and Beeres 2005). Then, through democratic freedom, a new way of thinking can be encouraged among the employees.

This study attempted to shed light on the reasons why PMSs become successful in some organizations while failing in others, even if they consist of similar components. Hence, changes to these organizational controls and their interaction with PMSs and other elements will give rise to new and unpredictable behaviors. This signals that the system is exhibiting complex properties that are unique and grow organically in that particular context, which ultimately requires unique monitoring and control. The lack of predictability of the usefulness of organizational controls also may exhibit unintended complexity.

6. Conclusion

The key motivation for this study was the PPM literature's attribution of a majority of complexity issues to the external environment while neglecting internal environmental perspectives. The purpose of this study is to identify the PMS as a system by understanding

how its associated properties emerge from a complexity theory perspective. The study focuses on understanding the complexity of a PMS over its lifecycle in order to shed light on moderating its behavior. From the background literature, this study presented the PMM literature, which is dominated in with organizational controls and best practices regarding what to measure, how to control and how to manage the process of updating, analyzing, and acting on performance. The study also explored how social and technical controls amplify complexity at the three core PMS process stages, and it presented new perspectives of complexity theory, i.e., the *ontological, teleological, functional and genetic characteristics* of a PMS.

Through a review of 76 PMM papers, the study described how complexity reproduces in a PMS over its lifecycle. More specifically, the study showed that PMSs consist of a large number of interconnected and interdependent elements, which evolve over time and adapt to changes in the internal environment, making them a complex social adaptive system. Changes in the internal environment such as plurality in practices may negatively impact the PMS process, the number of controls that interact at each process stage, and the nature of these interactions. This makes it difficult to predict what will be important to measure in the future and how to measure and manage it. There is greater unpredictability and ambiguity in the system, often lacking the relevant information for decision making. The results seem to emulate the issues of fit, as shown by Melnyk *et al.* (2014), in which the organization's measures are not synchronized with its strategy and its environment, leading to a complex situation. Hence, organizations require more tools and techniques to survive complex situations.

The four characteristics identified in the study were used in examining the PMM literature and resulted in six forms of complexity, namely, role, task, procedural, methodological, analytical and technical complexities, which is a significant contribution to theory. A major implication of understanding PMC is to recast how organizations should systematically respond to the plurality of best practices by examining the unique context in which a PMS is operating. The study findings contribute to the current discussion addressing why PMSs typically lag and are not responsive and resilient in emerging contexts (Bititci *et al.* 2012; Melnyk *et al.* 2014; Nudurupati *et al.* 2016). While it is useful to understand and explore all organizational controls in moderating PMC, the organizational controls may have varying impacts on organizations even when they consist of similar components and are operating in the same industry. Using the insights from this paper, organizations should build the capabilities to choose the appropriate organizational controls depending on the context and should adapt to the changes associated with PMSs.

This study sets new directions for PMM researchers and practitioners as it identifies sources of complexity, which will be complementary in prescribing social and technical controls in organizations for mitigating complexity. This study opens several avenues for future research on PMS complexity as well as on PMM in general. First, the definition of PMC, as outlined in this paper, challenges the PMM literature by defining the foundations of complexity in performance management, which also calls for a unique definition of

complexity in performance measurement. Future research should also seek to explore PMC in its two streams, i.e., social complexity and technical complexity. Second, this study investigated the mix between social and technical controls and how such a mix should be treated. As a continuation of this research, further studies may explore which specific factors and interactions between them induce complexity and to what extent. Additionally, more empirical research may unlock critical events from the external environment that are contingent on the practice of measurement and tend to induce complexity in the internal environment.

While interactions between the social and technical dimensions are difficult to manage, their divisions and interactions are quite crucial to facilitating responsiveness and dynamism in organizations. Having explored PMC, the study results suggest that complexity theory is an essential element for studying PMM complexity. PMC in this paper was explored using the system perspective in vast complexity theory. For future studies, more perspectives can be explored, for example, using the hierarchical model by Simon (1996) that could break down PMM system into subsystems. It also suggests that by understanding how complexity emerges, managers may rethink how they can better organize their use of controls to manage a PMS over its lifecycle. Based on the SLR, the study has demonstrated how complexity emerges and is amplified in organizations, and it has attempted to identify ways of moderating complexity. Just like any research, SLR has its own limitations of which some papers will be missed out despite selecting comprehensive list of search strings. Hence in order to mitigate this limitation, we followed citation tracking to ensure important missed papers are recovered. The SLR in this study is completely reliant on previous published papers that may have different purpose. Hence we focused more on the objective of each paper to see its relevance to this study. Similarly, articles are filtered based on the appropriateness of the selection criteria. This study has attempted to mitigate this limitation by following thorough research protocols (Moustaghfir 2008; Tranfield *et al.* 2003). Hence, we urge more empirical studies to understand how organizational controls and their interaction can actually moderate complexity over time. While many authors such as Johnston (2005) and Bititci *et al.* (2012) acknowledge the need for social controls at each process stage, there is little consensus regarding how to strike the proper balance between the level of control and the level of freedom or autonomy given to individuals.

Table 2. Keyword analysis and articles until 2017

Keywords	until 2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
performance management	79	16	22	19	32	28	34	40	37	44	65	65	48	529
performance measurement	313	41	58	66	70	77	63	67	61	90	108	102	99	1,215
performance appraisal; performance control; performance complexity; performance strategy; supply chain performance; performance measurement system; performance management system; performance measurement and management; organisational performance; organizational performance	308	36	46	50	65	81	81	90	81	96	122	153	155	1,364
performance assessment; performance indicators	595	80	104	112	127	156	154	213	213	238	305	332	354	2,983
Total	1,295	173	230	247	294	342	332	410	392	468	600	652	656	6,091

Table 3. Evolution of the number of PMM publications in journals WOS/Scopus/ABS/ABDC

Journal	until 2010	2011	2012	2013	2014	2015	2016	2017	Total
International Journal of Operations & Production Management	53	6	2	2	4	-	3	4	74
Energy and Buildings	7	4	4	5	3	5	8	8	44
International Journal of Human Resource Management	21	6	2	3	3	2	2	5	44
Journal of Cleaner Production	8	-	2	1	1	7	9	14	42
International Journal of Production Research	18	-	1	2	3	8	5	4	41
Public Performance & Management Review	7	11	4	3	2	7	5	2	41
International Journal of Production Economics	21	3	2	2	3	5	2	-	38
Energy Conversion and Management	5	1	-	4	5	7	8	4	34
Reliability Engineering & System Safety	22	-	2	-	7	1	1	1	34
Production Planning & Control	15	-	-	4	7	2	2	3	33
Total Quality Management & Business Excellence	21	1	2	1	2	-	2	3	32
Expert Systems with Applications	15	6	2	-	4	2	1	-	30
Industrial Management & Data Systems	19	1	3	2	1	-	-	3	29
Public Administration Review	18	-	1	3	-	2	4	1	29
International Journal of Productivity and Performance Management	-	-	-	-	-	11	8	9	28
Journal of Business Research	15	1	1	2	2	3	4	-	28
Applied Thermal Engineering	4	-	1	2	2	4	7	6	26
Other Journals	384	58	62	64	61	80	76	84	869
Total	653	98	91	100	110	146	147	151	1,496

Table 4. The interaction between control factors at different process stages

Key Publication	Research Question/Purpose	Research Approach	PMS Lifecycle Stages	Complexity Type
Bititci *et al.* (2000)	Develops a model for integrated and dynamic PMS, provides a critical review of existing system	Case study	Use, Design	Technological
Neely *et al.* (2000)	Describes the process of designing a performance measurement system and testing	Action research	Design, Implementation	Procedural, Analytical
Hudson *et al.* (2001)	To develop measures that drive operational performance towards the achievement of strategic objectives	Action research	Design, Use	Methodological, Procedural
Ngai and Cheng (2001)	To understand how PMS perform as a result of applying knowledge based system	Case Study	Design, Implementation, Use	Task, Role
Bourne *et al.* (2002)	To investigate the contribution of business PM and human resource management practices to business performance	Case study	Design, Implementation, Use	Role, Task
Bourne *et al.* (2002)	To investigate the success and failure of performance measurement system design interventions in ten companies	Case study	Design	Technological, Procedural
McAdam and Bailie (2002)	To explore longitudinal alignment between performance measures and business strategy	Literature review on PMM	Use	Procedural
Santos *et al.* (2002)	To show the role of system dynamics and multicriteria decision analysis	Analysis of frameworks	Design, Use	Analytical, Methodological

Lewis (2003)	To develop a model of competence as a transformation process, combining resource and activity inputs into operational processes that result in specific competitive performance outcomes	Case study	Design, Implementation, User	Methodological, Analytical, Task , Role
Lohman *et al.* (2004)	To show how KPIs at various levels in the organisation can be incorporated into one system convince potential user for its use	Case study	Design, Implementation, Use	Methodological, Analytical
Bititci *et al.* (2005)	To demonstrate how existing performance measurement may be adopted to measure and manage performance in extended enterprises	Literature in PMM	Use	Procedural, Methodological
Sacristán-Díaz *et al.* (2005)	To identify the performance measurement systems that are used to test their correspondence with the objectives that motivated the investments	Survey	Use	Methodological, Analytical
Folan and Browne (2005)	To develop of a performance measurement system specifically designed for the requirements of the extended enterprise	Analysis of Frameworks	Design, Use	Methodological, Analytical, Procedural
Garengo *et al.* (2005)	To clarify whether changes in PMS are due to the evolution of the generic models or an attempt to introduce models suited to the needs of SMEs	Literatura Search	Design, Use	Procedural, Methodological
Greiling (2005)	The use of performance measurement within the German public sector	Literature search	Use, Implementation	Procedural

Johnston (2005)	How the conflicts related to economic and social agency within particular public sector performance measurement arrangements can work for and against the application of balanced scorecard style systems	Case study	Use	Role, Task , Procedural
Micheli and Kennerley (2005)	To review frameworks currently developed and implemented in public and non- profit organisations and to identify the requirements of a framework for new contexts	Case study	Design, Use	Methodological, Analytical
Mol and Beeres (2005)	To stress out the need to adjust performance management to the deficiencies inherent in the output controls	Action research	Use	Role, Task, Procedural
Nudurupati and Bititci (2005)	To implement IT-PMS: assess the impact of IT-PMS on management and business, identify the factors supporting IT-PMS that were impacting management and business, establish the pattern of occurrence of the factors impacting on management and business	Case study	Design, Implementation, Use	Role, Task, Procedural, Methodological, Analytical
Turner *et al.* (2005)	This paper describes how performance measures were selected and then implemented in two small to medium size enterprises (SMEs) in Central Scotland	Literature Review	Use	Analytical
Wouters and Sportel (2005)	To investigate the role of existing, local performance measures in the process of developing and implementing an integrated performance measurement system	Case study	Use, Implementation	Role, Task, Procedural

Sharma and Bhagwat (2006)	To develop a framework that measures and evaluates performance	Survey	Use	Analytical
Wijngaard *et al.* (2006)	To link concepts from organisational and social psychology to production planning and control	Action research	Use	Task, Procedural
Yilmaz and Bititci (2006)	To compare the performance measurement of manufacturing and tourism industries from a value chain perspective	Conceptual	Use	Analytical
Ukko *et al.* (2007)	To investigate the impacts of performance measurement (PM) on management and leadership	Case study	Use	Roles, Task, Procedural
Ribeiro-Carpinetti *et al.* (2008)	To model for performance measurement and management of a cluster based on the concepts of the Balanced Scorecard and other models	Action research	Design, Use	Methodological, Technological
Pongatichat and Johnston (2008)	To explore the possibility that some degree of misalignment between performance measures and strategy, far from being counterproductive	30 interviews	Use	Procedural, Methodological, Roles, Task
Broadbent and Laughlin (2009)	Studies the interrelationships among strategy systems, PMMs and organisational change programmes within Pettigrew's model	Conceptual	Design, Implementation, Use	Analytical, Procedural, Methodological
Haponava and Al-Jibouri (2009)	To identify process-based KPIs for use in control of the pre-project stage	Case study and Literature review	Design, Use	Analytical, Technological

Elzinga *et al.* (2009)	The role of behavioural factors in the use of performance management systems	Case study	Use	Role, Task, Procedural
Ferreira and Otley (2009)	To describe the structure and operation of performance management systems (PMSs) in a more holistic manner	Observation	Design, Implementation, Use	Procedural, Methodological, Roles, Task
Hansen (2010)	The paper presents an analysis of the resolution of organisational externalities through the use of nonfinancial performance measures for planning	Comparative Case study	Use	Procedural, Methodological
Toor and Ogunlana (2010)	To investigate the perception of the key performance indicators (KPIs) in the context of a large construction project in Thailand	Survey	Use	Analytical
van Veen-Dirks (2010)	To examine the importance that is attributed to a variety of financial and non-financial performance measures	Survey	Design, Use	Analytical
Adler (2011)	To examine how performance management systems are designed to meet and support the implementation of a confrontation strategy	Case Study	Use, Implementation	Role, Procedural
Braz *et al.* (2011)	To show difficulty and complexity of reviewing and updating an energy company's PMS for its maritime transportation area	Action research	Design, Implementation, Use	Analytical, Methodological
Jain *et al.* (2011)	Presents a data envelopment analysis (DEA) based approach for performance measurement and target setting of manufacturing systems	Case study	Use	Analytical

Pavlov and Bourne (2011)	To propose a theoretical model of measurement on performance	Review of PM Systems	Use	Technological
Sillanpää (2011)	To identify the focal elements of performance in Finnish welfare service organisations	Case study	Use	Methodological
Tung *et al.* (2011)	To examine the association between the use of multidimensional performance measures and factors that affect the effectiveness of PMSs	Survey	Use	Procedural, Role, Tasks
Valmohammadi and Servati (2011)	To design and implement a performance management system using third-generation Balanced Scorecard (BSC) to compare and evaluate some strategic measures of the company against those of a leading company	Case study	Design, Implementation, Use	Technological, Methodological
Chalmeta *et al.* (2012)	To propose a methodology for designing and implementing PMS adapted to the characteristics of SMEs	Case study	Implementation	Methodological, Analytical
Rahbek and Sudzina (2012)	To outline the anatomy of firms which adopt comprehensive performance measurement systems in order to gain an understanding of how internal (organisational capabilities) and external (perceived environmental uncertainties) factors shape performance measurement practices	Survey	Use	Technological, Analytical
Taticchi *et al.* (2012)	To provide research guidelines for building a PMM system through a reference framework, and to identify major design challenges	Citation and co-citation analysis	Design, Use	Methodological

Ben Hadj Salem-Mhamdia (2013)	On performance and healthiness measurement practices in a Tunisian software ecosystem	Survey	Use	Procedural, Analytical
de Waal and Kourtit (2013)	The benefits experienced by organisations in practice after introducing PMM	Case study	Implementation, Use	Roles, Procedural
Elg *et al.* (2013)	To contribute to the knowledge base on how performance measurement drives improvements in healthcare practice	Case study	Design, Use	Analytical, Methodological
Jääskeläinen and Laihonen (2013)	To identify practical ways to overcome the specific performance measurement challenges of knowledge-intensive organisations	Action research	Use	Role, Task
Jääskeläinen and Sillanpää (2013)	To evaluate factors affecting the success of the measurement system implementation in the context of two case services with a specific measurement object	Case study	Design, Use	Role, Task
Vernadat *et al.* (2013)	To propose new performance measurement and management framework based on value and risk	Case study	Design, Use	Methodological
Caniato *et al.* (2014)	Understanding what are the most adopted indicators, what are the key elements characterising the implementation process and what are the differences	Case study	Use	Analytical
Garengo and Sharma (2014)	To investigate the role of corporate governance structure as a PMS contingency factor	Case study	Use	Roles, Tasks, Procedural
Laihonen *et al.* (2014)	To investigate the implications of the networked and open nature of the service business on performance measurement	Case study	Design, Implementation, Use	Procedural

Melnyk et al. (2014)	To resolve the issue of "Fit" of the revised measures to the needed strategy	Delphi approach	Use, Implementation	Analytical, Methodological
Upadhaya *et al.* (2014)	To investigate the role of performance measurement systems in organisational effectiveness in the context of the financial services sector within a developing country	Survey	Use	Role, Task
Taylor and Taylor (2014)	Investigates the influence of organisation size on the effective implementation of performance measurement systems (PMSs)	Case study	Implementation	Procedural
Spekle and Verbeeten (2014)	To study the use of performance measurement systems in the public sector	Survey	Use	Analytical
Angelis and Jordahl (2015)	To compare management practices in private and publicly owned elderly care home	Survey	Use	Methodological, Procedural
Bititci *et al.* (2015)	To explore how visual strategy and performance management techniques impact performance measurement and management practices of organisations	Action research	Use	Methodological
Canonico *et al.* (2015)	To consider how and to what extent it is possible to interpret a PMS as a typical control mechanism	Case study	Design, Use	Roles, Tasks, Analytical
Pekkola and Ukko (2016)	To examine how PMS can facilitate collaborative work dynamics in network	Case study	Design	Methodological, Analytical
Carlsson-Wall *et al.* (2016)	To explore the role of PMS in the co-existence of different institutional logics in a football organisation.	Case study	Use	Role
Laihonen and Pekkola (2016)	To examine how utilisation of performance measures influences supply chains	Action research	Use	Procedural, Role, Task

Zhang *et al.* (2016)	To proposes a model in which the production and use of performance information are separated.	Survey	Use	Methodological, Analytical
Pellinen *et al.* (2016)	To identify tensions and contradictions in situations where the benefits of both vertical and horizontal integration as strategies for prophit	Case study	Use	Methodological, Analytical
Zhang *et al.* (2016)	To explore the role of ICT intergration between inter and intra roles	Survey	Use	Technological, Methodological
Kang *et al.* (2016)	To propose a multi-level structure for identification and analysis of KPIs and their intrinsic relationships in production systems.	Document Analysis	Use, Design	Task, Analytical
Nudurupati *et al.* (2016)	To explore practitioner thoughts on how PMM should be improved in digital economies	Case study	Design, Use	Role, Analytical, Methodological
Forcada *et al.* (2017)	Presents the role of communication key performance indicators	Survey	Use	Role, Task
Beer and Micheli (2017)	To examine the influences of PMS among not-for-profit (NFP) organisations	Case study	Use	Role, Task
Pavlov *et al.* (2017)	To investigate how PMS interact with human resource	Survey	Design	Role, Task, Procedural
Smith and Bititci (2017)	To present the importance of the interplay between PMS, employee engagement and overall performance.	Action research	Use	Role, Task, Procedural, Analytical, Methodological, Technological
Govindan *et al.* (2017)	To investigate which indicators need priority	Document analysis	Design, Use	Analytical
Shin and Konrad (2017)	To investigate if high-performance work and organisational. Performance indicates causality	Survey	Use	Task, Roles, Procedural
Hwang *et al.* (2017)	To investigate the workability of internet of things for capturing real time data for PMS	Case study	Design	Technological, Analytical, Methodological

Dewettinck and Vroonen (2017)	To the consequences of line managers decisions on PMS	Survey	Use, Implementation	Role, Task, Procedural

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