The strategic management of operations system performance

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Abstract: The enterprises' operations systems environments, characterised by their complexity and dynamics, are challenging the strategic management models. This paper presents the development of a theoretical framework, organised as a set of design recommendations to guide the performance measurement system capabilities development. The developed theoretical construction is based on the literature review. A framework is constructed to represent the relationships between roles, capabilities and design recommendations of a performance measurement system. The measurement system is studied in the context of an Operations Strategic Management System (OSMS) and three different levels of analysis are used to organise the findings of this study. The results are presented in tables that identify the main roles that the measurement system should perform; establish the relationships between roles and required capabilities and generate a list of design recommendations. Based on the mediating function of the required organisational capabilities, the causal links are identified and the framework is generated.

Keywords: operations strategy; performance measurement; strategic management.

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1 Introduction

The increasing competitive pressure resulting from operations activities and markets globalisation are forcing enterprises to reorient their strategies, operations systems, processes and procedures to sustain their competitive positions. This changing process can be supported by an Operations Management (OM) system redesign, which establishes the development of a strategic management dynamic capability as its main orientation (Teece et al., 1997).

The process of Operations Strategic Management System (OSMS) redesign necessitates a more 'balanced', 'integrated', 'linked', 'flexible', 'multifaceted' and 'multidimensional' management system (Gomes et al., 2004). Such properties should reflect the performance measurement system specification when describing the whole strategic OM system. But these properties are currently not well developed and integrated to the strategic OM processes, and do not offer the opportunity for firms to better understand their operations systems environment and to increase their performance level (Platts, 1995; Slack, 2000).

Franco-Santos and Bourne (2003) identified that organisations devote time and effort developing strategic performance measurement systems. Their research is looking for an understanding about why some organisations are better able to 'manage through measures' than others. This question is related to the strategic dimension of the organisations' performance and needs an in-depth comprehension about the interplay between action and measurement, the performance information use in their decision-making processes and their subsequently actions. It is not clear what critical factors enable organisations to effectively use their strategic performance measurement system. This paper furthers this discussion in the level OM systems, developing an understanding about the relationships between performance and strategic management systems.

In issues associated with individual measures of performance, the research relates to the question "How can one ensure that the management loop is closed – that corrective action follows measurement?" The research also contributes to the understanding of what are the 'definitive' principles of performance measurement system design; and identify what techniques managers can use to reduce their list of possible measures to a meaningful set. Studying the issues associated with the system and its environment, questions such as "Why do firms fail to integrate their performance measures into their strategic control systems?" and "How can we ensure that the performance measurement system matches the firm's strategy and culture?" are orienting the development of our research.

It is also important to highlight that for improved performance OSMS that encompasses the measurement subsystem, should be conceived to deploy enterprise strategic Performance Management (PM) instead of performance measurement systems, develop dynamic rather than static strategic management systems and enhance the flexibility of performance measurement systems to improve the capability to cope with organisational changes (Neely, 2005).

The long-term perspective of the operations strategy is presented in the performance measurement system design, as an attempt to interconnect the resources utilisation with future performance. The capabilities models and the activities and processes play a role to mediate this relationship and give this study its focus (Flynn and Flynn, 2004; Flynn et al., 1999; Maslen and Platts, 2000; Neely et al., 2005; Slack et al., 2004).

This paper shows a theoretical development that articulates roles and design specifications of a strategic PM system. This task is carried out in the context of OSMS and it uses the performance measurement system capabilities to mediate the relationship between roles and design recommendations.

2 The operations strategic management approach

Frohlich and Dixon (2001) comment that the field of OM, particularly in strategic related themes, has done commendable work putting forward new ideas but has been less effective in validating the concepts after their introduction. Thus, the theoretical construction in this paper is conceived in the trajectory of a validating process, which will further test the developed framework, using refining and validating techniques.

It is important to understand the propositions of this research work in three levels. First, it will be related to the rationalities used in the OM – field, specifically in the domain of the PM – discipline, for producing knowledge that will be consolidated in theories, models, frameworks and processes. For this purpose, the theoretical constructions developed by Neely (2005) and Slack et al. (2004) are used to position this paper.

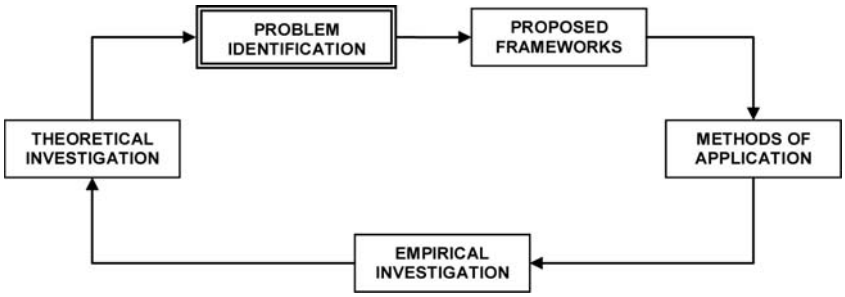
Slack et al. (2004) propose that the OM orientation that must be taken is to continually seek reconciliation between research and practice. In this sense, OM methods provide an important contribution in improving enterprises' operational and strategic activities. Accordingly, the research presented in this work assumes the role of research and practice reconciliation, contributing to the development and test of practical solutions for OSMS design, implementation and management.

Neely's (2005) theoretical construction, which is represented in Figure 1, may be used as a meta-framework to position the presented discussion in the evolutionary life

cycle process that found the PM discipline. There is a specific context that may be used to explain the approach of this paper in producing and testing the models and methodologies developed in the PM domain. The discussion presented in this paper embraces the 'proposed frameworks' and 'methods of application' phases. It identifies and proposes a reviewed set of design, implementation and management specifications for OSMS and seeks to understand the role of performance measurement subsystem in this reviewed strategic management system. Therefore, it should be recognised that the OM field is in a continuous, complex and dynamic evolution, which operations managers and professionals face in their day-to-day decision process situations (Slack et al., 2004; Zilbovicius, 1997).

For the purposes of this research, the specific context that represents its evolution is presented in Table 1.

Figure 1 The evolution of the field of performance measurement



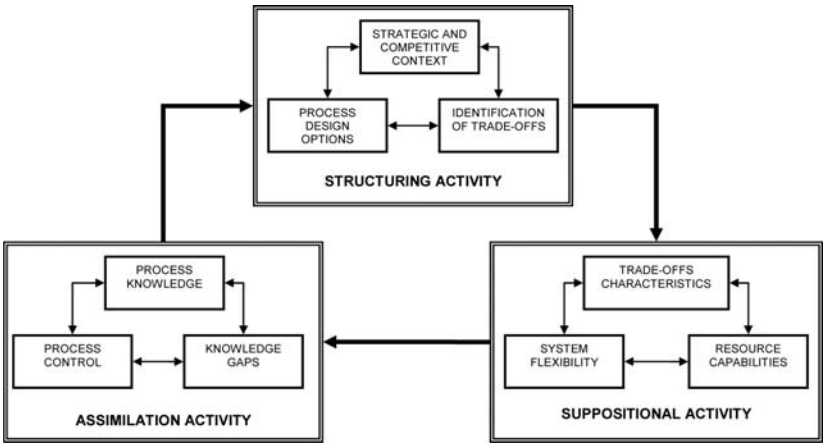
Source: Neely (2005).

Table 1 The research context

Phase	*Description*
Problem identification	The real benefits of strategic PM systems are not being achieved
Proposed frameworks	The developed concepts, frameworks and theoretical assumptions area being reviewed
Methods of application	The design, implementation and management processes are being modified to attend the new specifications of the OSMS
Empirical investigation	These new methodologies and systems will be tested
Theoretical verification	A new cycle of knowledge producing will be started as results are consolidated in the OM and PM approaches and theories

The second level that the present research is related to explains how it addresses practical issues, in designing, implementing and managing OSMSs. The process approach (the Cambridge approach) may be used for implementing activities, integrating design and management processes (Platts, 1993, 1994; Platts et al., 1996). The underpinning rationality of the design process addresses the implementation and managing processes, creating the conditions for a double-loop learning process development. Slack (2000) identifies three main phases in the process of redesigning a manufacturing system, which are the structuring activity, the suppositional activity and the assimilation activity (Figure 2). The three interrelated activities play a special role in integrating design, implementation and management of OSMS.

Figure 2 A model of the underlying design activity



Source: Slack (2000).

The presented approaches were selected to provide some specific features for OSMS, which could be summarised as:

- The system will structurally provide organisational learning as an important outcome of the design process (Slack, 2000), the implementation process (Platts, 1993) and the management process, which is set by definition as a strategic management system.
- It will develop a better understanding of the operations processes dynamics, allowing companies to develop a strategic vision based on dynamic capabilities (Slack, 2000; Teece et al., 1997).
- The learning processes and the enhancing knowledge basis could lead to an improvement of the perception of having the strategic management system under control. This reinforces a continuous and virtuous cycle of learning and improvement (Slack, 2000).

The third level of analysis is defined by declaring theoretical assumptions that set the theoretical constructions. These assumptions act as recommendations (Folan and Browne, 2005) informing the theoretical development and delimiting their scope as a strategic management system (Henry, 2006). It is important to formally declare the theoretical assumptions about performance measurement systems, particularly when they are being studied in the context of OSMS:

- According to Neely et al. (2005), the performance measurement is the process of quantifying the efficiency and effectiveness of action. A performance measurement system is the set of metrics used to quantify both efficiency and effectiveness of actions. Central to these definitions is that action leads to performance and that there are internal and external factors that affect the efficiency and effectiveness of this relationship.
- Mintzberg (1978) argues that only through a consistent pattern of actions, a strategy could be identified. In fact, the strategy only exists if it is realised. It is assumed that there is an interplay between the actions' results and the consistency that is established over time; the performance measurement system could mediate that interaction.

- The performance measurement systems should be designed, implemented and managed as part of a strategic management system. The measures should be derived from strategy and should provide consistency for decision making and action. Particularly, the production function will be managed in terms of its own strategic management system (Neely et al., 2005; Skinner, 1969).
- The strategic management control systems should be used as a means to provide surveillance, motivation, monitoring performance, stimulating learning, sending signals, anticipating events, introducing constraints and managing scenarios to the operations system (Henry, 2006; Neely et al., 2005).
- The performance measurement systems should be able to manage the determinants and results of the operations systems outputs, exploring the causalities between them and developing a predictive approach for the whole OSMS (Fitzgerald et al., 1991; Kaplan and Norton, 1992; Keegan et al., 1989).

The strategic management system design approach may address different 'enterprise' definitions, especially those related to boundary definitions. The value chain, the virtual relationships and operations network could represent differently in defining the structure of the value creating processes. The operations strategic management is used to assess this process and could be designed to manage different domains of the enterprise definition (Binder and Clegg, 2007; Bititci et al., 2005; Folan and Browne, 2005; Jagdev and Browne, 1998).

This study is based on the practice versus theory reconciliation logic (Slack et al., 2004), using a process that continuously interplays empirical and theoretical assumptions (Neely, 2005). The practical application are delimited by the operational and management processes described by the rationalities developed by Slack (2000) and Platts (1993), respectively. The third level declares the theoretical assumptions underlying this research.

3 Content analysis

A strategic PM system may be defined as a system that uses the information to produce a positive change to organisational culture, systems and processes. This impact on organisations is realised through managerial agreement upon performance goals, allocation and definition of resources priorities and sharing of performance results (Amaratunga and Baldry, 2002).

The initial building blocks of performance measurement initiatives, as they are materialised in a performance measurement system, are performance measurement recommendations. These recommendations basically define the contents and structures of the measures; organising them in a framework that could inform the performance measurement system design (Folan and Browne, 2005).

The content definition of measures, their structure and the subsequent selection and organisation of those measures are strongly linked to their 'utility' which defines the measurement system. In this instance the focal point is the process of selecting measures to be included in the system design. A framework for the measures selection process may be founded in the competitive dimensions of manufacturing or service operations, as those dimensions are customised and refined for that purpose. The dimensions categories are organised around competitive patterns as price (cost/operational efficiency), quality

(process and product), time (dependability and agility), flexibility (process and product) and innovation (process and product). These competitive dimensions may be performance dimensions of the operation system (Leong et al., 1990; Platts, 1995; Slack, 1987).

Having defined the role of the performance measurement system in the context of OSMS, the core 'functionalities' associated to that system are identified next. The association between roles, functions and capabilities of the OSMS are very useful for its design specification by establishing causality between roles and organisational resources. Globerson's (1985) performance criteria define the system functionalities as: strategic orientation as performance criteria are chosen from the organisation's objectives; evaluated organisational unit has control over the performance criteria and the performance criteria definition should be a result of a participative interaction of the involved actors (e.g. customers, suppliers, employees, managers). There may be a strategic realisation function, as the criteria follow the organisation's objectives. Another function emerges from the management definitions, which state that the system should have a participative conception process and also have 'control' over the evaluated organisational unit. A strategic management function can be identified based on those assumptions.

The synthesis developed by Globerson (1985) states an implicitly role for the performance measurement system, which is to implement a strategic management capability in OSMS.

Maskell (1991) has also developed relevant principles for the performance measurement system design: a changing nature in measures; measures conceived as part of a fast feedback subsystem (the performance measurement subsystem) and measures designed to stimulate the development of a continuous improvement capability rather than simply monitor the operations strategy. Although a strategic management function is identified in the implementation of performance measurements, this role is related to continuous improvement development.

Although a strategic management function is identified by Maskell (1991) in the implementation of performance measurements, this role is related to a capability development of continuous improvement.

Blenkinsop and Davis (1991) expand the functional definitions of measurement systems when they identify properties that the system should have, especially, when those are related to organisational integration and differentiation. The properties cover improvements of management system integration and differentiation in both horizontal and vertical dimensions of the organisational structure. They also emphasise the importance of covering the long-, medium- and short-term perspectives of the life cycle of an organisation when designing the performance measurement system.

Based on a literature review, Gomes et al. (2004) identify several characteristics of performance measurement systems:

- Measures must involve relevant non-financial information based on key business success factors (Clarke, 1995).
- Systems should be implemented to articulate strategy and monitor business results (Grady, 1991).
- Measures and related systems should be based on organisational objectives, critical success factors and have a customer orientation. One of the main tasks should be monitoring both financial and non-financial aspects of the obtained results (Manoochehri, 1999a).

- Performance system must dynamically follow the strategy (Bhimani, 1993).
- Performance system should accomplish the requirements of specific situations in operations, be long-term oriented and be simple to understand and implement (Santori and Anderson, 1987).
- Performance system should be linked to reward systems (Tsang et al., 1999).
- Financial and non-financial set of measures should be coherent and consistent with the strategic framework (Drucker, 1990; McNair and Mosconi, 1987).

It can be seen from Gomes et al. (2004) analysis that there is a changing nature in the (re)design and management of performance systems. These should be integrated with the business strategy, adapting to and monitoring its financial and non-financial aspects. The performance measurement system is an integrative management system that interrelates the business performance dimensions with the function's action plans (e.g. strategy of operations, human resources, technology, marketing and finance). Hence, the performance system is defined in an organic way, developing an adaptative behaviour.

Band (1990) indicates that the measures should be useful and relevant for managers and employees in performing their daily activities. Therefore, the measures must be part of a feedback loop that links them to manager and employee performance evaluations and analyses. Such feedback functionality helps the managers and employees to understand the utility of the performance in conducting their activities and relating them to the functional strategy. Interaction and participation are properties founded in the feedback functionality.

The role of a performance measurement subsystem is summarised in Table 2.

Table 2 The structural roles of a strategic performance measurement system

Role	*Perspective*	*Author*
Produce positive change in organisational culture, systems and processes, in order to contribute to the strategic vision realisation	Strategic PM system definition	Bourne et al. (2005); Neely (2005); Amaratunga and Baldry (2002); Manoochehri (1999a); Bhimani (1993); Blenkinsop and Davis (1991)
Performance measurement system should provide a closer understanding of customer needs, in order to create a perceived value for customers	Customer driven strategy	Neely et al. (2005); Bourne et al. (2005); Kennerley and Neely (2002, 2003); Neely et al. (2000, 2002); Johnston et al. (2002); Kaplan and Norton (1992, 2001); Manoochehri (1999a); Lingle and Schiemann (1996); Ghalayini and Noble (1996); Band (1990); Globerson (1985)
Implement strategic management functionality in the strategic OM system, providing the system with the jointly improvement of operational efficiency and overall business effectiveness	Strategic management function	Henry (2006); Neely (2005); Gomes et al. (2004); Kaplan and Norton (1992); Band (1990); Globerson (1985)

Table 2 The structural roles of a strategic performance measurement system (continued)

Role	*Perspective*	*Author*
Develop a continuous improvement capability through implementation and management of an integrated OSMS	Continuous improvement capability development	Neely (2005); Gomes et al. (2004); Kennerley and Neely (2002, 2003); Johnston et al. (2002); Kaplan and Norton (2001); Neely et al. (2000); Medori and Steeple (2000); Noci (1995); Ghalayini and Noble (1996); Lynch and Cross (1991); Maskell (1991); Johnson and Kaplan (1987)
Ensure that the PM system covers long-, medium- and short-term perspectives	Life cycle orientation for performance system design	Henry (2006); Neely et al. (2005); Chenhall (2005); Bourne et al. (2005); Flynn and Flynn (2004); Gomes et al. (2004); Slack et al. (2004); Maslen and Platts (2000); Flynn et al. (1999); Simons (1991); Blenkinsop and Davis (1991)
Performance measurement system result of measures definitions and performance frameworks recommendations (this assumption explain the performance measurement design process role)	The systemic and hierarchical approach	Folan and Browne (2005); Gomes et al. (2004); Blenkinsop and Davis (1991); Maskell (1991); Globerson (1985)
Performance responsible for articulating strategy and monitoring business results	Strategy realisation through the monitoring of the organisation's results	Gomes et al. (2004); Neely et al. (2005); Bhimani (1993); Kaplan and Norton (1992); Oge and Dickinson (1992); Blenkinsop and Davis (1991); Grady (1991); Santori and Anderson (1987)
Measurement of business results implemented using financial and non-financial aspects of business performance (in fact the performance design should guarantee)	Financial and non-financial nature of the organisation's performance	Gomes et al. (2004); Neely et al. (2002); Manoochehri (1999a); Clarke (1995); Kaplan and Norton (1992); Blenkinsop and Davis (1991); Drucker (1990); Maskell (1991); McNair and Mosconi (1987)

Having discussed the performance measurement system's role, the study next explores system implementation and management. It develops an understanding of the performance through the lens of process vision, and then the 'content' and the 'process' visions are interrelated in a strategic management system.

4 Process analysis

There are four main processes related to performance measurement: design, implementation, use and refreshing. The refreshing process could be broadly understood as the continuous system redesign or review (Bourne et al., 2000, 2005; Neely et al., 2000). This section discusses the relationships between those processes and OSMS.

Kaplan and Norton (1992) developed a procedural framework to manage the organisation strategy, through the processes of design, implementation, use and refresh. The proposed four stages to implement the balanced scorecard could be stated as follows:

1 'Translating the vision' is closely related to the design process, developing and operationalising the organisation's strategic vision.

2 'Communicating and linking' is the process associated with implementation, linking the vision to functional objectives.

3 'Business planning' is the process of assessing the value creation through the integration of business and financial plans. The process of managing and 'using' or realising the vision.

4 'Feedback and learning' process develops the capability of strategic learning, and it could be used to refresh the conception of the strategic management system.

It is important to visualise the interplay between the processes in a strategic management system. This comprehension allows articulation of the system capabilities with the defined roles for the performance measurement system. The performance measurement system is an important part of the strategic management system, as it governs the dynamics of the whole system.

The recent literature on performance measurement systems is looking for an in-depth understanding of why performance measurement initiatives fail (Bourne, 2005; McCunn, 1998; Neely, 2005), to improve the understanding of the main role of a performance measurement system, which is in the last instance the development of a strategic management system (Henry, 2006; Kaplan and Norton, 1992; Lynch and Cross, 1991). The implementation process highlights the importance of the change process enabler of the performance measurement system, especially when related to changes in culture, systems and processes. The continuous improvement role would be played managing the factors that enables and blocks the implementation process.

Factors identified by that Franco-Santos and Bourne (2003) have a direct relationship with the following roles:

- to produce a positive change in organisational culture, systems and processes
- to implement the strategic management functionality in OSMS
- to develop a continuous improvement capability through the implementation and management of OSMS
- to provide that the PM system will cover the long-, medium- and short-term perspectives.
- the performance measurement system is a result of the measures definitions and performance frameworks recommendations.

A performance measurement system may lose its effectiveness over time if it is not redesigned to better attend new environmental and organisational demands. Three of the processes presented by Neely et al. (2000) – design, implementation and refreshing processes – deal with changes in the measurement system. Managing through measures could be an approach to develop and implement that role (Bourne et al., 2005; Franco-Santos and Bourne, 2005). The strategic management of the performance measurement system will enable an organisation to develop continuous improvement and

organisational learning capabilities through continuous reviews of the measurement system (Ghalayini and Noble, 1996; Johnston et al., 2002; Kaplan and Norton, 2001; Kennerley and Neely, 2002, 2003; Neely et al., 2000). The measurement system should sustain their importance and utility for the organisation and its users (Manoochehri, 1999b). The refreshing process can be settled as an embedded functionality of a strategic management system. Its main role is to coordinate review or redesign of the performance measurement system as a result of its use and interaction with its environment.

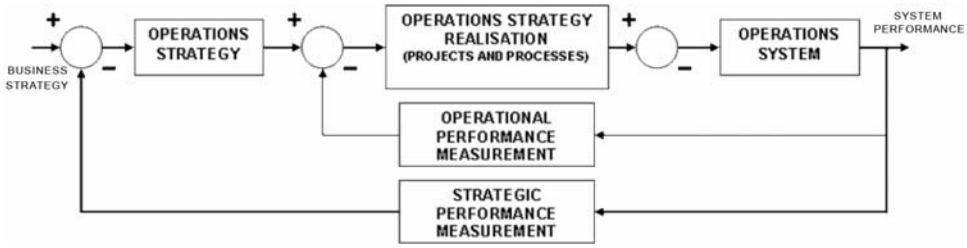
The following section presents the strategic management view of an operation system.

5 Developing the strategic management view

The concept of a strategic control system was presented when performance measurement systems were introduced. The measurement system is a part of a wider system, which includes goal setting, feedback and reward functions (Neely et al., 2005).

The developed theoretical construction presented in this section aims to organise and frame the rationality that rules the OSMS. Figure 3 shows the elements that could be seen as subsystems of OSMS. The 'plant' or the real-world system is the operations systems, which is strategically managed by the operations strategy subsystem, the planning subsystem and the performance measurement subsystem. The double feedback loops intends to represent the monitoring (operational feedback loop) and the refreshing (strategic feedback loop) functions.

Figure 3 The operations strategic management system



Source: Pinheiro de Lima and Gouvea da Costa (2006).

Questions that emerge at this point are: "Why rely on feedback control systems to strategically manage the operations system?" Does this not recede to the mechanistic view of organisational systems, deny the continuous changing nature of strategy scenery and consider the operations systems as a closed system?

This section explores causality of the main elements of a strategic management system that may enable the operations system to attend its organic role through the development of the refreshing process. The operations system and the organisation as a whole would develop through an organic way of conducting their design and operation, integrating in the same system a short- and long-term perspective of operations strategy.

Gomes et al. (2004) refine and expand on the two evolutionary phases proposed by Ghalayini and Noble (1996), which are based on productivity improvement and market differentiation, respectively. The evolution of the performance measurement systems are

analysed in three main dimensions: systems orientation; nature of the approach or control logic and utility of the system. Evolution is defined by a trajectory that shows orientation changing from cost through financial to a balanced system. Rationality of the control system changes from a retroactive to a proactive approach. Results used to improve operational efficiency are employed to enhance the effectiveness and responsiveness of the overall business, using the cascade mechanism for the business strategy implementation through the enterprise's functions. The last stage that proposes some future challenges for the performance systems design and management represents a cumulative process that is based on the retroactive and proactive approaches, oriented to jointly improve efficiency and effectiveness.

One well known performance measurement framework is Kaplan and Norton's (1992) 'balanced scorecard'. The balanced scorecard provides in the same system a planning technique and a performance measurement framework. It can be classified as a strategic management framework, as it integrates strategic map processes with a performance dimensions. The system creates customer focused value through improvement and development of business processes. The balanced scorecard is based on 'innovation action research' and through this approach develops a methodology that integrates design, implementation and operation of a strategic management system (Kaplan, 1998).

Through the conception and evolution of the performance measurement frameworks, it could be traced an expansion of the balanced integrated approach to a total integrated approach. There are some evidences of this evolutionary or coevolutionary process when the following frameworks are analysed together:

- The performance measurement matrix integrates different dimensions of performance, employing the generic terms 'internal', 'external', 'cost' and 'non-cost'. It could be seen that the matrix enhances the perspective to the external factors (Keegan et al., 1989).
- The Strategic Measurement, Analysis, and Reporting Technique (SMART) developed by Cross and Lynch (1988–1989). They proposed a performance of pyramid, which uses a hierarchic structure to represent the integration between the organisational vision and the operations actions. There is an interplay between external and internal orientations to improve the internal efficiency and the external efficacy.
- The performance measurement model proposed by Fitzgerald et al. (1991) integrates determinants and results of the operations systems performance, exploring the causalities between them. The measures could be related to results (competitive position, financial performance), or they are focused on the determinants of the results (cost, quality, time, flexibility and innovation).
- The Integrated Dynamic Performance Measurement System (IDPMS) conceived by Ghalayini et al. (1997) incorporates to the performance the dynamic features and the integrative properties. The integration process involves the management function, the process improvement teams and the factory shop floor. The system creates a dynamic behaviour that articulates its specification and the reporting process.
- The dynamics feature are also presented in the Neely's et al. (2002) performance prism. They develop a scorecard-based system for measuring and managing stakeholder relationships. The framework is conceived to cover the

stakeholder satisfaction, strategies, processes, capabilities, stakeholder contribution dimensions. The main objective of the strategic management system is to deliver stakeholder value.

The evolutionary process that the performance measurement system is passing through, brings up two complementary ways of running the strategic management system. The first is oriented to the competitive dimensions, established by the industry competitive environment and it is focused on the short-term perspective of the planning systems, which is a market-based approach applied to the design, implementation and management of the operations strategy. The second way is developed in the medium to long term and is oriented to build and develop capabilities. These are the main foundations of the operations vision realisation. The measurement systems are developing a strategic management capability to set up and appropriately run those two complementary roles, the market and resource-based approaches for the strategy development.

To understand processes related to the application of performance measurement systems, one may refer to the work of Simons (1991) and Henry (2006). They found two patterns in managing a measurement system: simple feedback control or diagnostic, and 'interactive control'. Bourne et al. (2005) use Simons' (1991) framework to compare the results of average- and high-performing business units. In the former, the logic of the strategic management system is adherent to the simple feedback control approach. In the latter, the strategic management systems are based on the interactive control approach, which also employs the simple feedback control approach. The diagnostic use defines the role of the performance measurements system as a measurement tool and the interactive use defines the role of the performance measurements system as a strategic management tool.

The management of a strategic performance measurement system defines its use, stating how the data are acquired, analysed, interpreted, communicated and acted upon the organisational business processes. The literature indicates that the intensity of engagement and interaction with the performance measurement processes could have a great impact on the business overall performance (Bourne et al., 2005).

Henry (2006) and Simons (1991) models have common approaches that may be used in a normative way to develop some special dynamic properties as:

- The diagnostic use or the simple feedback control systems represent the single-loop learning process proposed by Argyris and Schön (1978). They state that the development of a single loop learning process is a prerequisite for developing a double-loop learning process. Thus, the strategic management process combines both types of learning processes.
- The strategic management control system creates a dynamic tension when jointly using both approaches to manage the performance measurement system. Dynamic tension is defined by a 'competitive' and 'cooperative' behaviour stated between interrelated elements (English, 2001; Lewis, 2000).
- Control systems should develop a strategic capability not to be reduced to an implementation role, but to contribute to the emergence of strategies (Simons, 1991).
- Strategic performance measurement system could be operated focusing organisational attention on strategic priorities. In that way, the organisational model could be seen as 'knowledge creating company' (Nonaka and Takeuchi, 1995).

- Market orientation, entrepreneurship, innovativeness and organisation learning capabilities developments are closely related to the strategic management approach used to manage the PM system. Thus, the use of the measurement system could specifically contribute for capability development (Henry, 2006).

The presented pieces of the literature review and preliminary theoretical analysis and constructions, clearly defined that the line of causality between organisational capabilities and performance is important for the understanding of the role of a performance measurement system. The capabilities or competence-based approaches are positioned inside a modern view of the resource-based theories. The strategic control features of the long-term perspective of the operations strategy, and the predictive approach of the control system could be realised through organisational capabilities development. According to that approach, the performance measurement system should evaluate the capabilities development. Table 3 gives the relationships between the performance measurement system role and the organisational capabilities required.

Table 3 The strategic management role of a performance measurement framework

Role	*Organisational processes capabilities*	*Author*
Produce positive change in organisational culture, systems and processes, in order to contribute to the strategic vision realisation	– Change management process capability – Strategic management capability	Bourne et al. (2005); Neely (2005); Amaratunga and Baldry (2002); Manoochehri (1999a); Bhimani (1993); Blenkinsop and Davis (1991)
Performance measurement system should provide a closer understanding of customer needs, in order to create a perceived value for customers	– Organisational learning capability	Neely et al. (2005); Bourne et al. (2005); Kennerley and Neely (2002, 2003); Neely et al. (2000, 2002); Johnston et al. (2002); Kaplan and Norton (2001); Manoochehri (1999a); Lingle and Schiemann (1996); Ghalayini and Noble (1996); Kaplan and Norton (1992); Band (1990); Globerson (1985)
Implement strategic management functionality in the strategic OM system, providing the system with the jointly improvement of operational efficiency and overall business effectiveness	– Retroactive capability (closed loop control logic) to support the strategy realisation – Proactive capability (predictive control logic) to support the operations vision realisation	Henry (2006); Neely (2005); Gomes et al. (2004); Kaplan and Norton (1992); Band (1990); Globerson (1985)
Develop a continuous improvement capability through implementation and management of an integrated OSMS	– Agregation capability – Integration capability – Continuous improvement capability	Neely (2005); Gomes et al. (2004); Kennerley and Neely (2002, 2003); Johnston et al. (2002); Kaplan and Norton (2001); Neely et al. (2000); Medori and Steeple (2000); Noci (1995); Ghalayini and Noble (1996); Lynch and Cross (1991); Maskell (1991); Johnson and Kaplan (1987)

Table 3 The strategic management role of a performance measurement framework (continued)

Role	*Organisational processes capabilities*	*Author*
Ensure that the PM system covers long-, medium- and short-term perspectives	– Strategic management capability	Henry (2006); Neely et al. (2005); Chenhall (2005); Bourne et al. (2005); Flynn and Flynn (2004); Gomes et al. (2004); Slack et al. (2004); Maslen and Platts (2000); Flynn et al. (1999); Simons (1991); Blenkinsop and Davis (1991)
Performance measurement system result of measures definitions and performance frameworks recommendations	– Strategic management capability – PM system design capability	Folan and Browne (2005); Gomes et al. (2004); Blenkinsop and Davis (1991); Maskell (1991); Globerson (1985)
Performance responsible for articulating strategy and monitoring business results	– Retroactive capability (closed loop control logic) to support the strategy realisation – Agregation capability – Integration capability	Gomes et al. (2004); Neely et al. (2005); Bhimani (1993); Kaplan and Norton (1992); Oge and Dickinson (1992); Blenkinsop and Davis (1991); Grady (1991); Santori and Anderson (1987)
Measurement of business results implemented using financial and non-financial aspects of business performance (in fact the performance design should guarantee)	– Strategic management capability	Gomes et al. (2004); Neely et al. (2002); Manoochehri (1999a); Clarke (1995); Kaplan and Norton (1992); Blenkinsop and Davis (1991); Drucker (1990); Maskell (1991); McNair and Mosconi (1987)

The presented developments integrate in a strategic management framework the elements that were responsible for the operations strategy realisation. This integrated approach should be tested and validated to complete the knowledge cycle of the operations strategic management models (Marr and Schiuma, 2003). The presented arguments were developed articulating the available literature on operations strategy and performance measurement systems, and they were used to identify and to justify the strategic management rationality that governs the dynamic and structure of OSMS.

The following section presents a design specification for the operations strategic system, delimiting features that the system should have.

6 The strategic management features

What are the main features that a performance measurement system should have to develop its strategic role in the strategic management system? This is the main question that will animate the discussion in this section.

Gomes et al. (2004) question if the state-of-the-art in performance measurement system is ready to offer to the practicing managers a really integrated solution. This integrated solution should have characteristics and features like inclusiveness, completeness, timeliness, universality, measurability, consistency, integrity, flexibility and ethical.

Table 4 presents a selection from Folan and Browne (2005) work; a set of recommendations for the design and development of performance measurement system. These recommendations could be used to specify the measurement system design. It is not intended to have a complete set of design recommendations, but to select some special features for the system, which could in fact operate as necessary conditions for the strategic management capabilities development.

Table 4 A set of performance measurement system design recommendations

Recommendation	*Author*
PM should be based upon the strategic role of the company	Kennerley and Neely (2003); Bititci et al. (2000); Medori and Steeple (2000); Kaplan and Norton (1992); Azzone et al. (1991); Eccles (1991); Grady (1991); Dixon et al. (1990)
Data should be collected, where possible, by those whose performance is being evaluated	Crawford (1988)
Data should be available for constant review	Crawford (1988)
Emphasis is upon evolving, dynamic, continuous improvement and learning in PM system design	Kennerley and Neely (2003); Bititci et al. (2000); Medori and Steeple (2000); Eccles and Pyburn (1992); Lynch and Cross (1991); Dixon et al. (1990); Crawford (1988); Fortuin (1988)
PM systems should be mutually supportive and consistent with the business's goals, objectives, critical success factors and programmes	Dixon et al. (1990)
PM systems should reveal how effectively customers' needs and expectations are satisfied	Dixon et al. (1990)
Provide measures that allows all members of the organisation to understand how they affect the entire business	Dixon et al. (1990)
Routines must be established so that measures can be measured	Globerson (1985)
Feedback from PM systems should report at numerous levels of the organisation	Sieger (1992); Grady (1991)
Feedback from PM systems must be linked cross-functionally to ensure it supports and not inhibit strategy implementation	Grady (1991)
Should enable managers to view performance in several areas simultaneously	Kaplan and Norton (1992)
Should measure the entire product delivery system from the supplier to the customer	Lockamy (1991)

Table 4 A set of performance measurement system design recommendations (continued)

Recommendation	*Author*
PM system designed, so that at divisional level, the evaluation of PM standards is consistent with manufacturing objectives of the facility	Lockamy (1991)
PM system designed, so that at plant and divisional level, the evaluation of PM standards is consistent with the manufacturing environment	Lockamy (1991)
PM system designed, so that information on the strategic objectives of the firm are shared at plant and division level to provide organisational focus between them	Lockamy (1991)
PM system information on the strategic objectives of the division must be shared across functional areas to provide organisational focus within plants and divisions	Lockamy (1991)
PM system should be used to challenge strategic assumptions	Bititci et al. (2000); Bourne et al. (2000)
PM system design should be viewed as a coordination effort to understand current metrics in detail, to identify shortcomings and to include ongoing initiatives that affect PM	Lohman et al. (2004)

The performance measurement system should be designed as part of a management system. This management could operate in a strategic management way, developing in the system learning capabilities. The scope of the management depends on boundaries definitions that are used to define the input and output interfaces, as well as suppliers and customers. The enterprises systems could be organised as encapsulated systems and this could give to the measurement an hierarchic structure (Binder and Clegg, 2007; Bititci et al., 2005; Folan and Browne, 2005; Jagdev and Browne, 1998).

Based on the theoretical developments presented it is possible to establish some lines of causality that relates roles, capabilities and design recommendations for the performance measurement system. Figure 4 shows the relationships that could be identified in the performance measurement system when developing its strategic management function.

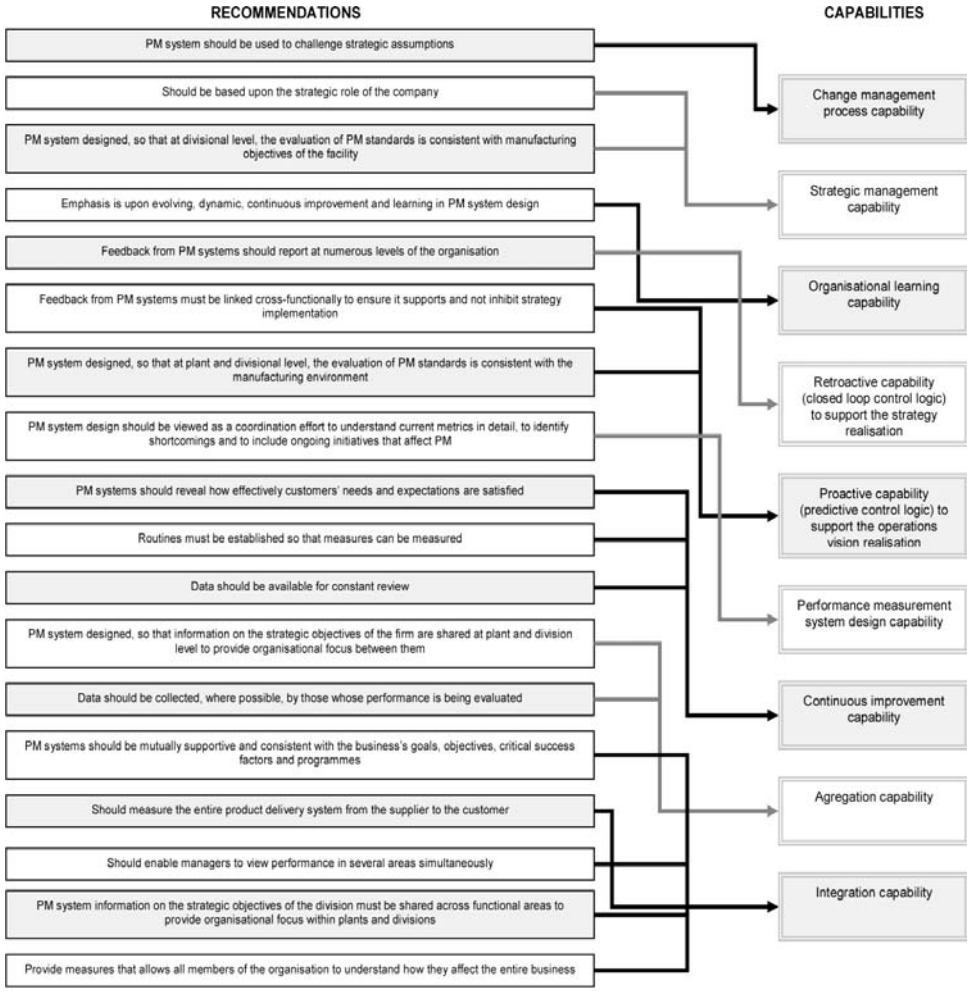
It could be seen through Figure 4 the causal link that is proposed to link design recommendations and the roles that a performance measurement system should perform. The capabilities are mediating factors that explain how the organisational resources could be deployed and integrated to support some specific behaviour, which is specified by the roles. The theoretical framework could be used to inform the strategic performance measurement system design and also as an audit tool to evaluate the quality of a measurement system design.

Figure 4 allows for the following observations:

- Capabilities act as mediating variable, linking the design recommendations to the strategic performance measurement roles.
- Design recommendations, capabilities and roles could be organised in strategic management/performance measurement system design, continuous improvement/organisational learning/change management and systemic (aggregation/integration) clusters.

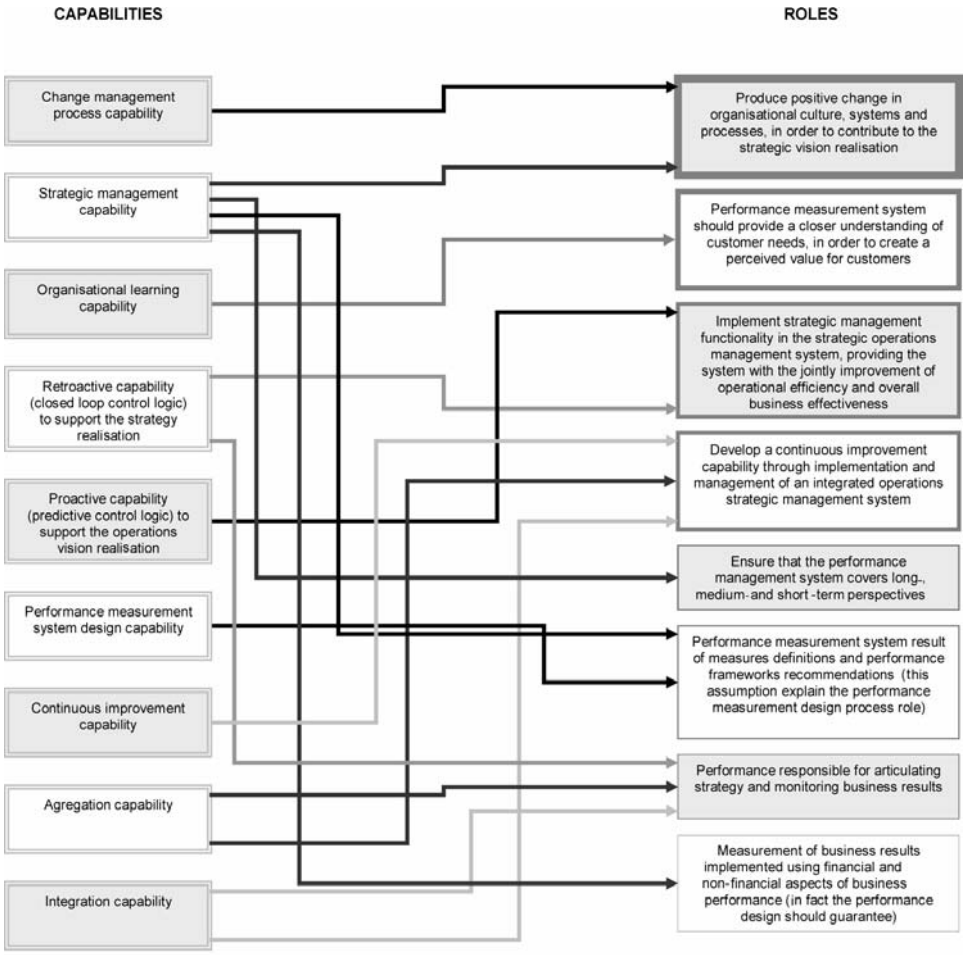
- Causal links form a complex network that suggests a more in-depth internal construct analysis (recommendations, capabilities and roles), to have a manageable set of constructs and relationships. Pictorial representations could organise the categories relationships (Mills et al., 2003).
- Identified roles have complementary characteristics.
- Design recommendation set has an intrinsic evolutionary definition.
- Refresh, use, implementation and design processes are managed and give to the system a complete and systemic view of the strategic performance measurement system.

Figure 4 Strategic management and performance measurement relationships (a) recommendations versus capabilities and (b) capabilities versus roles



(a)

Figure 4 Strategic management and performance measurement relationships (a) recommendations versus capabilities and (b) capabilities versus roles (continued)



(b)

7 Conclusion

Comprehension of the role of the performance measurement system is essential for the understating of the OSMS dynamics. The feedback function and the refreshing process are realised through the measurement system and govern the operations performance, updating the entire strategic management system.

The evolutionary process that a performance measurement system passes through brings up two complementary ways of running a strategic management system. The first is oriented towards competitive dimensions and is focused on the short-term perspective of planning systems, which is a market-based approach applied to the design, implementation and management of the operations strategy. The second is medium- to long-term oriented and pursues develop core strategic

capabilities. The measurement systems develop a strategic management capability to set up and appropriately run those two complementary roles, the market and resource-based approaches for the strategy development.

The dialectics of the roles played by performance measurement systems, acting as medium for operations strategy realisation or as enabler for strategic management system redesign, is the key foundation for organisational learning. Capabilities were identified to support measurement system design, implementation and management. In particular, organisational learning capability, continuous improvement capability and strategic management capability were highlighted.

It was identified some capabilities to support the measurement system design, implementation and management. Particularly, it could be highlighted the organisational learning capability, the continuous improvement capability and the strategic management capability. It is also important to develop a more complete understanding about the relationships between continuous improvement and organisational culture, learning and management leadership, corporative education and OSMSs, information system design and OSMS specification, organisational communication processes and the use of the feedback function of the performance measurement system, industry competitive patterns and the measurement system refreshing process.

The market and resources based approaches used in the operations strategy conception could be integrated in the strategic management system through different feedback loops that implement the retroactive and predictive strategic control strategies. Structurally the strategic management system could integrate the long- and short-term perspectives. The process of performance measurement creation and operation is related to a life cycle model of interplay between design and implementation. The strategic control system architecture should represent the multidimensions of the operations performance, approaching them with multivariable techniques. It is also important to manage the hierarchy that is established between the business performance dimensions (e.g. price, quality, time, flexibility, innovativeness), according to the competitive patterns and set by the operations strategy. The operations strategy formulation process analyses the qualifying and the winners competitive dimensions, dealing with the trade-offs and planning the paths and trajectories for capabilities development. The predictive control could be realised through capabilities development, which belongs to the operations vision definition. Supported by concepts like positions, processes, paths and trajectories, the framework for the predictive control strategy could be conceived.

The process of a performance measurement system creation is related to a life cycle that represents an interplay between design and implementation (synthesis and analysis). The academic performance measurement frameworks should be tested and refined, before a validation process takes place. All the theoretical assumptions or constructions need to be tested, and the results used to feedback the models and theories development.

The literature review shows that the attempts for producing a general performance measurement structural framework floundered because of the complexity of the variables and relationships involved. If the structural and procedural frameworks are developed together, it could be possible to generate general recommendations for performance measurement systems design.

The discussion presented in this paper seeks to clarify the functionalities that a performance measurement system should develop when operating in a strategic

management system. Carrying out that task some recommendations emerge and could be organised in the following categories or themes:

- The measurement system should develop a balanced approach in designing and running their monitor and control functions and their continuous improvement capability development.
- The measurement systems should be designed, implemented and managed as dynamic systems.
- The structural conception of the measurement system should be based on the retroactive and predictive control strategies.
- The measurement system should be conceived to monitor and improve the actual shop floor value creation process. It is important to integrate the measurement system to operational activities, thus the activities could be modelled, controlled, monitored and improved.

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References

Amaratunga, D. and Baldry, D. (2002) 'Moving from performance measurement to performance management', *Facilities*, Vol. 20, Nos. 5/6, pp.217–223.

Argyris, C. and Schön, D.A. (1978) *Organizational Learning*, Reading: Addison-Wesley.

Azzone, G., Masella, C. and Bertele, U. (1991) 'Design of performance measures for time-based companies', *International Journal of Operations and Production Management*, Vol. 11, No. 3, pp.77–85.

Band, W. (1990) 'Performance metrics keep customer satisfaction programmes on track', *Marketing News*, Vol. 24, No. 11, p.12.

Bhimani, A. (1993) 'Performance measures in UK manufacturing companies: the state of play', *Management Accounting*, Vol. 71, No. 11, pp.20–22.

Binder, M. and Clegg, B. (2007) ''Enterprise management: a new frontier for organisations', *International Journal of Production Economics*, Vol. 106, No. 2, pp.409–430.

Bititci, U., Turner, T. and Begemann, C. (2000) 'Dynamics of performance measurement systems', *International Journal of Operations and Production Management*, Vol. 20, No. 6, pp.692–704.

Bititci, U.S., Mendibil, K., Martinez, V. and Albores, P. (2005) 'Measuring and managing performance in extended enterprises', *International Journal of Operations and Production Management*, Vol. 25, No. 4, pp.333–353.

Blenkinsop, S. and Davis, L. (1991) 'The road to continuous improvement', *Insight*, Vol. 4, No. 3, pp.23–26.

Bourne, M.C.S. (2005) 'Researching performance measurement system implementation: the dynamics of success and failure', *Production Planning and Control*, Vol. 16, No. 2, pp.101–113.

Bourne, M.C.S., Kennerley, M. and Franco-Santos, M. (2005) 'Managing through measures: a study of impact on performance', *Journal of Manufacturing Technology Management*, Vol. 16, No. 4, pp.373–395.

Bourne, M.C.S., Mills, J.F., Wilcox, M., Neely, A.D. and Platts, K.W. (2000) 'Designing, implementing and updating performance measurement systems', *International Journal of Operations and Production Management*, Vol. 20, No. 7, pp. 754–771.

Chenhall, R.H. (2005) 'Integrative strategic performance measurement systems, strategic alignment of manufacturing, learning and strategic outcomes: an exploratory study', *Accounting, Organisations and Society*, Vol. 30, No. 5, pp.395–422.

Clarke, P. (1995) 'Non-financial measures of performance in management', *Accountancy Ireland*, Vol. 27, No. 2, pp.22–24.

Crawford, K. (1988) 'An analysis of performance measurement systems in selected just-in-time operations', PhD Thesis, University of Georgia.

Cross, K.F. and Lynch, R.L. (1988–1989) 'The SMART way to define and sustain success', *National Productivity Review*, Vol. 9, No. 1, pp.23–33.

Dixon, J., Nanni, A. and Vollmann, T. (1990) *The New Performance Measurement Challenge: Measuring Operations for World-Class Competition*, Homewood: Dow Jones-Irwin/APICS.

Drucker, P.E. (1990) 'The emerging theory of manufacturing', *Harvard Business Review*, pp.94–102.

Eccles, R.G. (1991) 'The performance measurement manifesto', *Harvard Business Review*, Vol. 69, No. 1, pp.131–137.

Eccles, R.G. and Pyburn, P.J. (1992) 'Creating a comprehensive system to measure performance: financial results should not generate the most rewards', *Management Accounting*, Vol. 74, No. 4, pp.41–44.

English, T. (2001) 'Tension analysis in international organizations: a tool for breaking down communication barriers', *International Journal of Organizational Analysis*, Vol. 9, No. 1, pp. 58–83.

Fitzgerald, L., Johnston, R., Brignall, S., Silvestro, R. and Voss, C. (1991) *Performance Measurement in Service Business*, London: CIMA.

Flynn, B.B. and Flynn E.J. (2004) 'An exploratory study of the nature of cumulative capabilities', *Journal of Operations Management*, Vol. 22, pp.439–457.

Flynn, B.B., Schroeder, R.G. and Flynn, E.J. (1999) 'World class manufacturing: an investigation of Hayes and Wheelwright's foundation', *Journal of Operations Management*, Vol. 17, pp.249–269.

Folan, P. and Browne, J. (2005) 'A review of performance measurement: towards performance management', *Computers in Industry*, Vol. 56, No. 7, pp.663–680.

Fortuin, L. (1988) 'Performance indicators – Why, where and how?', *European Journal of Operational Research*, Vol. 34, No. 1, pp.1–9.

Franco-Santos, M. and Bourne, M.C.S. (2003) 'Factors that play a role in managing through measures', *Management Decision*, Vol. 41, No. 8, pp.698–710.

Franco-Santos, M. and Bourne, M.C.S. (2005) 'An examination of the literature relating to issues affecting how companies manage through measures', *Production Planning and Control*, Vol. 16, No. 2, pp.114–124.

Frohlich, M.T. and Dixon, J.R. (2001) 'A taxonomy of manufacturing strategies revisited', *Journal of Operations Management*, Vol. 19, No. 5, pp.541–558.

Ghalayini, A.M. and Noble, J.S. (1996) 'The changing basis of performance measurement', *International Journal of Operations and Production Management*, Vol. 16, No. 8, pp.63–80.

Ghalayini, A.M., Noble, J.S. and Crowe, T.J. (1997) 'An integrated dynamic performance measurement system for improving manufacturing competitiveness', *International Journal of Production Economics*, Vol. 48, No. 3, pp.207–225.

Globerson, S. (1985) 'Issues in developing a performance criteria system for an organisation', *International Journal of Production Research*, Vol. 23, No. 4, pp.639–646.

Gomes, C.F., Yasin, M.M. and Lisboa, J.V. (2004) 'A literature review of manufacturing performance measures and measurement in an organizational context: a framework and direction for future research', *Journal of Manufacturing Technology Management*, Vol. 15, No. 6, pp.511–530.

Grady, M.W. (1991) 'Performance measurement: implementing strategy', *Management Accounting*, Vol. 72, No. 12, pp.49–53.

Henry, J.F. (2006) 'Management control systems and strategy: a resource-based perspective', *Accounting, Organizations and Society*, Vol. 31, No. 6, pp.529–558.

Jagdev, H.S. and Browne, J. (1998) 'The extended enterprise: a context for manufacturing', *Production Planning and Control*, Vol. 9, No. 3, pp.216–229.

Johnson, H.T. and Kaplan, R.S. (1987) *Relevance Lost: The Rise and Fall of Management Accounting*, Boston: Harvard Business School Press.

Johnston, R., Brignall, S. and Fitzgerald, L. (2002) 'Good enough performance measurement: a trade-off between activity and action', *Journal of the Operational Research Society*, Vol. 53, No. 3, pp.256–262.

Kaplan, R.S. (1998) 'Innovation action research: creating new management theory and practice', *Journal of Management Accounting Research*, Vol. 10, No. 1, pp.89–118.

Kaplan, R.S. and Norton, D.P. (1992) 'The balanced scorecard – measures that drive performance', *Harvard Business Review*, Vol. 70, No. 1, pp.71–79.

Kaplan, R.S. and Norton, D.P. (2001) *The Strategy Focused Organization: How Balanced Scorecard Companies Thrive in the New Business Environment*, Boston, MA: Harvard Business School Press.

Keegan, D.P., Eiler, R.G. and Jones, C.R. (1989) 'Are your performance measures obsolete?', *Management Accounting*, Vol. 70, No. 12, pp.45–50.

Kennerley, M.P. and Neely, A.D. (2002) 'A framework of the factors affecting the evolution of performance measurement systems', *International Journal of Operations and Production Management*, Vol. 22, No. 11, pp.1222–1245.

Kennerley, M.P. and Neely, A.D. (2003) 'Measuring performance in a changing business environment', *International Journal of Operations and Production Management*, Vol. 23, No. 2, pp.213–229.

Leong, G.K., Snyder, D.L. and Ward, P.T. (1990) 'Research in the process and content of manufacturing strategy', *OMEGA International Journal of Management Science*, Vol. 18, No. 2, pp.109–122.

Lewis, M.W. (2000) 'Exploring paradox: toward a more comprehensive guide', *Academy of Management Review*, Vol. 25, No. 4, pp.760–776.

Lingle, J.H. and Schiemann, W.A. (1996) 'From balanced scorecard to strategy gauge: is measurement worth it?', *Management Review*, March, pp.56–62.

Lockamy III, A. (1991) 'A study of operational and strategic performance measurement systems in selected world class manufacturing firms: an examination of linkages for competitive advantage', PhD Thesis, University of Georgia.

Lohman, C., Fortuin, L. and Wouters, M. (2004) 'Designing a performance measurement system: a case study', *European Journal of Operational Research*, Vol. 156, No. xx, pp.267–286.

Lynch, R.L. and Cross, K.F. (1991) *Measure Up – The Essential Guide to Measuring Business Performance*, London: Mandarin.

Manoochehri, G. (1999a) 'The road to manufacturing excellence: using performance measures to become world-class', *Industrial Management*, pp.7–13.

Manoochehri, G. (1999b) 'Overcoming obstacles to developing effective performance measures', *Work Study*, Vol. 48, No. 6, pp.223–229.

Marr, B. and Schiuma, G. (2003) 'Business performance measurement – past, present and future', *Management Decision*, Vol. 41, No. 8, pp.680–687.

Maskell, B.H. (1991) *Performance Measurement for World Class Manufacturing: A Model for American Companies*, Cambridge: Productivity Press.

Maslen, R. and Platts K.W. (2000) 'Building manufacturing capabilities', *International Journal of Manufacturing Technology and Management*, Vol. 1, Nos. 4/5, pp.349–365.

McCunn, P. (1998) 'The balanced scorecard: the eleventh commandment', *Management Accounting*, Vol. 76, No. 11, pp.34–36.

McNair, C.J. and Mosconi, W. (1987) 'Measuring performance in an advanced manufacturing environment', *Management Accounting*, Vol. 69, No. 1, pp.28–31.

Medori, D. and Steeple, D. (2000) 'A framework for auditing and enhancing performance measurement systems', *International Journal of Operations and Production Management*, Vol. 20, No. 5, pp.520–533.

Mills, J.F., Platts, K.W. and Bourne, M.C.S. (2003) 'Competence and resource architectures', *International Journal of Operations and Production Management*, Vol. 23, No. 9, pp.977–994.

Mintzberg, H. (1978) 'Patterns in strategy formulation', *Management Science*, Vol. 24, No. 9, pp.934–948.

Neely, A.D. (2005) 'The evolution of performance measurement research: developments in the last decade and a research agenda for the next', *International Journal of Operations and Production Management*, Vol. 25, No. 12, pp.1264–1277.

Neely, A.D., Adams, C. and Kennerley, M.P. (2002) *Performance Prism: The Scorecard for Measuring and Managing Stakeholder Relationships*, London: Financial Times/ Prentice Hall.

Neely, A.D., Gregory, M.J. and Platts, K.W. (2005) 'Performance measurement system design: a literature review and research agenda', *International Journal of Operations and Production Management*, Vol. 25, No. 12, pp.1228–1263.

Neely, A.D., Mills, J.F., Platts, K.W., Richards, H., Gregory, M.J., Bourne, M.C.S. and Kennerley, M.P. (2000) 'Performance measurement system design: developing and testing a process-based approach', *International Journal of Operations and Production Management*, Vol. 20, No. 10, pp.1119–1145.

Noci, G. (1995) 'Accounting and non-accounting measures of quality-based performances in small firms', *International Journal of Operations and Production Management*, Vol. 15, No. 7, pp.78–105.

Nonaka, I. and Takeuchi, H. (1995) *The Knowledge Creating Company*, New York: Oxford University Press.

Oge, C. and Dickinson, H. (1992) 'Product development in the 1990s – new assets for improved capability', *Economist Intelligence Unit*, Japan Motor Business, December, pp.132–144.

Pinheiro de Lima, E. and Gouvea da Costa, S.E. (2006) 'The conceptual foundations for the operations strategic management system design', *Proceedings of the 16th Production Engineering Conference of the Brazilian Association of Production Engineering – ENEGEP/ABEPRO*, Fortaleza (in Portuguese).

Platts, K.W. (1993) 'A process approach to researching manufacturing strategy', *International Journal of Operations and Production Management*, Vol. 13, No. 8, pp.4–17.

Platts, K.W. (1994) 'Characteristics of methodologies for manufacturing strategy formulation', *Computer Integrated Manufacturing Systems*, Vol. 7, No. 2, pp.93–99.

Platts, K.W. (1995) 'Integrated manufacturing: a strategic approach', *Integrated Manufacturing Systems*, Vol. 6, No. 3, pp.18–23.

Platts, K.W., Mills, J.F., Neely, A.D., Gregory, M.J. and Richards, H. (1996) 'Evaluating manufacturing strategy formulation process', *International Journal of Production Economics*, Vols. 46–47, No. 1, pp.233–240.

Sieger, J. (1992) 'Manage your numbers to match your strategy', *Management Review*, Vol. 81, No. 2, pp.46–48.

Santori, P.R. and Anderson, A.D. (1987) 'Manufacturing performance in the 1990s: measuring for excellence', *Journal of Accountancy*, Vol. 164, No. 5, pp.141–147.

Simons, R. (1991) 'Strategic orientation and top management attention to control systems', *Strategic Management Journal*, Vol. 12, pp.49–62.

Skinner, W. (1969) 'Manufacturing – missing link in corporate strategy', *Harvard Business Review*, Vol. 45, No. 3, pp.136–145.

Slack, N. (1987) 'The flexibility of manufacturing systems', *International Journal of Operations and Production Management*, Vol. 7, No. 4, pp.35–45.

Slack, N. (2000) 'Flexibility, trade-offs and learning in manufacturing system design', *International Journal of Manufacturing Technology and Management*, Vol. 1, Nos. 4/5, pp.331–348.

Slack, N., Lewis, M. and Bates, H. (2004) 'The two worlds of operations management research and practice: Can they meet, should they meet?', *International Journal of Operations and Production Management*, Vol. 24, No. 4, pp.372–387.

Teece, D., Pisano, G. and Shuen, A. (1997) 'Dynamic capabilities and strategic management', *Strategic Management Journal*, Vol. 18, No. 7, pp.509–533.

Tsang, A.H.C., Jardine, A.K.S. and Kolodny, H. (1999) 'Measuring maintenance performance: a holistic approach', *International Journal of Operations and Production Management*, Vol. 19, No. 7, pp.691–715.

Zilbovicius, M. (1997) 'Production models and producing models', PhD Thesis, Polytechnics School of Sao Paulo University (in Portuguese).