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# Maintenance Business Model: a concept for driving performance improvement

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**Abstract:** Maintenance function within manufacturing companies should be seen as a source of added-value. Indeed, improvements of maintenance performance have an effect also on the whole company's performance: this integrated view may be supported by the concept of Maintenance Business Model (MBM). This paper proposes a framework including MBM as an intermediate link between the formulation and the execution of maintenance strategy. The MBM can be used as a means for analyzing and improving maintenance management activities in order to provide the highest value to the stakeholders of maintenance function.

**Keywords:** maintenance business model, maintenance value, maintenance stakeholders, maintenance management framework, maintenance strategy, maintenance process, performance improvement.

## 1 Introduction

Perception of maintenance in industry has changed in the last years, from considering it as a "necessary evil" to "an important support function for production and manufacturing" (Parida and Kumar, 2006). Moreover, it has gone even further and some authors refer to maintenance as a means for creating added value to companies (Liyanage and Kumar, 2003; Marais and Saleh, 2009) and for ensuring company's sustainability and continuity (Komonen et al., 2012). In this vision, maintenance performance creates value for the company by contributing to the whole company's performance. Indeed, an integrated view of maintenance, together with other company's functions, can be achieved only by a complete maintenance performance measurement system that considers not only metrics within the maintenance function, but also metrics for its contribution to the whole company's performance. Thus, the maintenance performance measurement system should be rooted in a maintenance management system that shares that integrated view. There are some recent attempts for attaining a holistic view of companies' performance including maintenance (Narayan, 2012), although only few contributions address a value-driven perspective towards maintenance management and decision making. For example, the value-driven maintenance planning (Rosqvist et al., 2009) or the value driven engineering of e-maintenance platforms (Macchi et al., 2014).

In the last years, there is also a raising concept in business literature frequently associated to the concept of value creation and mentioned together with business strategy: the business model (BM) concept. As considered by Richardson (2008), the BM drives the execution of the strategy. A simple definition of BM considers it as the way a company does business. By analogy, the BM concept could be also applied to single business functions within companies. Therefore, regarding the analogy with maintenance function, this paper proposes the concept

of Maintenance Business Model (MBM) as the logic that permits the right execution of maintenance strategy. Indeed, to get maintenance strategy aligned with business strategy, the MBM should be coherent with the business goals.

The execution of the strategy, although guided by the BM, is then realized by business processes; by analogy, maintenance processes are seen as the realization of maintenance strategy and they are driven by the choices taken in the MBM. Indeed, the concept of maintenance business model is not new; it was first mentioned by Garetti et al. (2007) as “*the way in which maintenance management is organized*”. They stated that the MBM is strongly influenced by company’s features and context and it aims “*to put in evidence the relationship between technical inputs and the management outputs that can be achieved*”. Later, Fumagalli et al. (2008) defined the MBM as a set of interrelated elements present in the maintenance organization and in the technological systems used to support maintenance operations, giving a technology-oriented perspective to the concept with a specific focus on the exploitation of new ICT systems for condition based maintenance. Finally, Gomez Fernandez et al. (2008) included the viewpoint of value into the MBM concept, specifically the value created by Maintenance Service Provider companies to their clients. Further on, their focus on the MBM concept was closely related to the changes that technological advances bring to maintenance organizations, without deepening on the MBM concept itself.

In the present paper, the concept is revisited and enhanced with a stronger background on business literature. The MBM describes the rationale of how maintenance function creates and delivers value to its stakeholders and how the value is captured by maintenance function itself. Indeed, the objective of the paper is to propose a framework that strongly grounds on the formulation of the MBM concept, while enabling a structured path for performance improvement.

This paper firstly introduces novelties grounding on business theory (section 2). Then, a brief review of maintenance concepts is presented (section 3). Section 4 focuses on the core part of the research, presenting MBM concept, highlighting its relations to maintenance strategy and processes: the purpose is to create a maintenance management framework that follows the analogy with business literature. The proposed framework advances in the direction suggested by Parida and Kumar (2006) who identified a gap between maintenance planning and execution, and stated the need of mapping maintenance processes. MBM concept is discussed in its components (section 5), thus providing a categorization of key maintenance decisional areas, which are presented as a conceptual map to express the business logic that should guide maintenance processes. Indeed, the MBM is fostered to be the relevant layer to execute the maintenance strategy by driving improvement of maintenance processes and of maintenance performance, compared to business goals.

## **2 Review on business model concept and frameworks**

BM concept is widely used, although no agreement has been reached yet regarding its definition or its role within companies. On one hand, a lot of the fuzziness about business models stems from the fact that when different authors write about business models they do not necessarily mean the same thing (Linder and Cantrell, 2000). Indeed, several authors have made recently a review of publications on the BM concept (as examples: Al-Debei and Avison, 2010; Bask et al., 2010; Zott et al., 2011; George and Bock, 2011). In particular, Zott et al. (2011) suggested for the BM concept the following perspectives:

- (i) a new unit of analysis,
- (ii) a holistic perspective on how firms do business,
- (iii) an emphasis on activities,
- (iv) an acknowledgement of the importance of value creation.

Some definitions found in literature have been selected to be hereafter presented (see collections of BM definitions in Al-Debei and Avison (2010) and Zott et al. (2011)). These definitions have been preferred due to their approach/focus that make them interesting as basis on which building the application to industrial maintenance of this concept (see Table 1).

**Table 1** Selected definitions of business model

<b>Author/s, Year</b>	<b>Definition</b>
Chesbrough and Rosenbloom, 2002	The BM is the heuristic logic that connects technical potential with the realization of economic value.
Hedman and Kalling, 2003	BM is a term often used to describe the key components of a given business.
Richardson, 2008	The BM is a conceptual framework that helps to link the firm's strategy, or theory of how to compete, to its activities, or execution of the strategy.
Casadesus-Masanell and Ricart, 2010	A BM is... a reflection of the firm's realized strategy.
Osterwalder and Pigneur, 2010	A BM describes the rationale of how an organization creates, delivers and captures value.

There is an open debate regarding BM's place and role in the firm (Osterwalder et al., 2005), especially concerning its boundaries and interconnections with other business aspects, such as business strategy and business processes (Bask et al., 2010; Al-Debei and Avison, 2010). In fact, strategy, BMs, and processes are closely linked, focusing on the same challenges within the firm (Bask et al., 2010). Nevertheless, different level of such interconnections can be considered. For instance, BM may serve as a link or interface between the company's strategy and its activities or business processes (Amit and Zott, 2001; Osterwalder et al., 2005; Richardson, 2008) and, by consequence, it is seen as a conceptual tool of alignment, in particular by considering business strategy, BM and business processes as a harmonized package (Al-Debei and Avison, 2011).

Nevertheless, the BM is seen as a multi-purpose concept (Al-Debei and Avison, 2010), thus having diverse utilities within a company. Osterwalder et al. (2005) outline the managerial roles of the BM concept, identifying five categories of functions where it may have contribution: (i) understanding and sharing, as well as (ii) analyzing and (iii) managing the business logic; (iv) fostering prospects and innovation; (v) patenting of BMs or processes. Other authors delineate the BM contribution to company's development by considering the BM as a source of innovation (Zott and Amit, 2007; Teece, 2010), as the representation of the execution of the strategy to gain competitive advantage (Richardson, 2008) and a powerful tool for improving execution when it is used as a basis for employee communication and

motivation (Magretta, 2002). Moreover, “*business models are made of concrete choices and the consequences of these choices [...] different designs have different specific logics of operation and create different value for their stakeholders*” (Casadesus-Masanell and Ricart, 2010). This definition underlines the relevant links between the BM concept, stakeholders and value creation.

Composition (i.e. which are the elements comprised in a BM) is another subject of debate regarding BM concept. Authors proposed diverse frameworks including a variety of components within the BM (see, as an example, the reviews made by Morris et al. (2005) and Richardson (2008) on BM components). Among other proposals, the business model canvas (Osterwalder and Pigneur, 2010) covers the dominant components discussed in literature, although presenting some limitations such as a focus on solely economic value and a restricted inclusion of stakeholders, comprising just customers and immediate partners (Holgado et al., 2013). The components enclosed within the canvas are: value proposition, customer segments, channels, customer relationships, key resources, key activities, key partnerships, revenue streams and cost structure. The value proposition is the most cited component in literature; therefore, it may be the central element around which the BM can be built (Richardson, 2008). Osterwalder and Pigneur (2010)’s canvas can be considered one of the most popular business model specification framework (Resta, 2012). It has been already used in several applications, such as to describe or map new service business for machine manufacturers (e.g. Barquet et al., 2012, Corti et al., 2013), to support the development of product service systems (PSS) (e.g. Wallin et al., 2013) and to be part of a lean approach for start-ups development (Blank, 2013). According to its diffusion within industry related works, it is considered as a main reference to keep a practical approach in the conceptualization of business models.

This brief review of the BM concept brings out the interesting ideas that are taken into account for the BM deployment for industrial maintenance, such as:

- the BM as an unit of analysis, endowed with a holistic perspective of business logic which provides alignment between strategy and processes;
- the emphasis on value as a driving concept for the BM: business logic is described from a viewpoint of how value is created, delivered and captured;
- the BM as a conceptual map illustrating the key components of a business, as a guide to influence the way operations (i.e. processes) are executed;
- the BM as a source of innovation, for analyzing the existent business logic and nurturing potential changes and innovations;
- the BM canvas for enabling concrete application of the BM concept (the canvas from Osterwalder and Pigneur (2010) is a relevant inspiration for the present work).

### **3 Review on maintenance concepts**

This section introduces a review of some key concepts, which represent the theoretical background of this research. Emerging or revisited concepts as maintenance value and maintenance stakeholders are important elements of the present proposal, while the review of concepts such as maintenance management and maintenance performance measurement provide the elements for focusing the work.

### *3.1 Maintenance value and maintenance stakeholders*

The traditional view of maintenance as just an expense for the company is changing due to the introduction of the concept of value in maintenance (Naughton and Tiernan, 2012). This has recently raised, so a clear definition of maintenance value has not been commonly agreed yet in literature. Some authors understand it as just economic value (Marais and Saleh, 2009) or connected to productivity and profitability (Alsyouf, 2007), while others advocate to give also environmental and social perspective to the concept (Liyana and Kumar, 2003; Rosqvist et al., 2009), including environmental friendliness, health and safety aspects and skilful personnel as potential benefits.

The concept of maintenance value has been applied to some recent methodologies regarding maintenance operations and decision-making. Some examples are presented herein. In their value-driven maintenance planning approach, Rosqvist et al. (2009) introduce the value tree as a reflection of the fundamental objectives of company and plant managers into maintenance objectives. The value of an e-maintenance platform is the central element of the methodology proposed by Macchi et al. (2014) for a value driven engineering of the services that the implementation of an e-maintenance platform could bring to maintenance operations and business objectives.

The application of a value-centric reasoning to maintenance services has also led to identification of their value elements / dimensions (Sinkkonen et al., 2013; Toosi et al., 2013). These studies are needed as, according to Ojanen et al. (2012), the value offered by maintenance services may be different from other industrial services.

However, the value of maintenance goes beyond the contribution to company and plant managers' objectives. Maintenance may have a say also in the fulfilment of external stakeholders' requirements, for example regulatory bodies (Söderholm et al., 2007). Nevertheless, the industrial practice and literature focus frequently just on the cost of maintenance but not on its value; this could occur due to the difficulty on quantifying the benefits of maintenance (Marais and Saleh, 2009).

Thus, it is possible to conclude that few concrete implementations of the concept of maintenance value have been proposed till now although they are remarkable contributions that foster the scientific community towards the integration of the value concept in maintenance function and activities.

### *3.2 Maintenance management and performance measurement*

A myriad of contributions, regarding how to manage the maintenance function in an industrial system, is presented in literature under different names such as frameworks, systems, or models. In this paper, those terms are used interchangeably.

Crespo Marquez and Gupta (2006) propose three pillars which are: (1) Information Technology (concerning condition monitoring techniques, information systems, e-maintenance, etc.); (2) Maintenance Engineering (including procedures, techniques, RCM, TPM, maintenance policies, optimization models, etc.); (3) Organizational (related to knowledge management, internal and external relationships, operators involvement, incentives systems, etc.). They state that all three pillars are important but they cannot stand alone without the others. The connection among pillars would create some dependencies between the choices in each of them, which can be seen as a glue forming the maintenance strategy.

The strategic view of maintenance function, i.e. its connection to business strategy and its alignment with business goals, has recently obtained more relevance in manufacturing industry. This has occurred due to the major concern on equipment availability, environment and safety, the emerging operational strategies (e.g. lean manufacturing) and changes brought by new technologies to operations and maintenance practices (Murthy et al., 2002; Al-Turki, 2011). In this regard, Al-Turki (2011) proposes a framework for maintenance strategic planning which would enable the alignment of strategic goals between the company and maintenance, including a mindful approach to maintenance stakeholders' needs while setting maintenance objectives. The emphasis on the contribution of maintenance to the fulfillment of stakeholders' needs was first introduced in the maintenance management model proposed by Söderholm et al. (2007). The focus on stakeholders' needs is also guiding the framework developed by Lopez Campos and Crespo Marquez (2011) which is, moreover, aligned to the quality management standard ISO 9001:2008 and the normative PASS 55:2008.

To further analyze the spectrum of studies on maintenance management framework and models, the work of Lopez Campos and Crespo Marquez (2009) can be referenced. They made a review, classification and analysis of 20 maintenance management models published from 1990 to 2007. They disclose a tendency towards process orientation, as the majority of models show information flows, inputs and outputs definition or a closed loop sequence. Moreover, their analysis of contributions revealed, among others, that: (i) models often include the definition of maintenance objectives but they are rarely connected to business goals; (ii) a clear reference to principles of responsibility, authority, good communication is missed; (iii) resources management is often omitted, especially in recent publications; (iv) the focus on the concept of continuous improvement is an emerging trend. It is then remarkable that maintenance function is not only studied from a strategic view, but also related to the execution of maintenance operations, i.e. maintenance processes.

Closely connected to a process view of maintenance operations, the main sense of designing maintenance management models is to continuously improve maintenance performance (Lopez Campos and Crespo Marquez, 2009). In this regard, Macchi and Fumagalli (2013) review a series of maintenance management models, to better define process areas related to organizational, managerial and technological capabilities, and then drive a maturity assessment. Cholasuke et al. (2004) understand key measures in maintenance as related to the successful implementation of a maintenance framework: they study the connection between good practices and the benefits obtained on key measures in maintenance. Indeed, maintenance performance goals and measurement help companies and plant managers to drive continuous improvement in plant and maintenance performance with respect to business and maintenance objectives, as well as to realize a benchmarking of their performance within industry (Rosqvist et al., 2009). According to Simões et al. (2011), companies that tend to perceive maintenance as a strategic competitive resource would use consistently the maintenance performance measures in an integrated information system and broader benchmarking practices.

#### **4 Proposal of a maintenance management framework motivated by business literature**

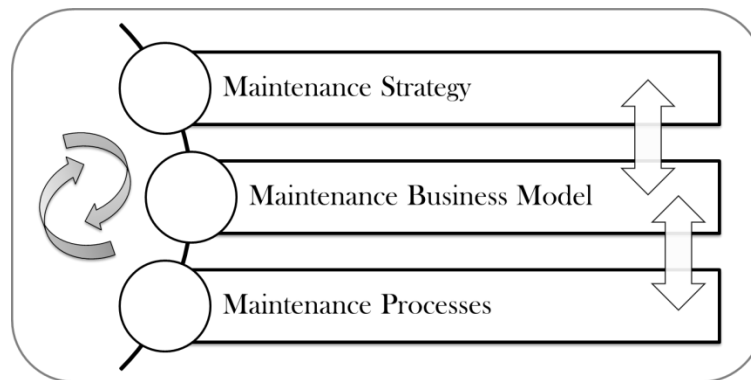
Some authors suggest that maintenance management involves two main aspects: the formulation and the execution of the strategy (Murthy et al., 2002; Crespo Márquez et al., 2009). However, a missing linkage between formulation and execution of the strategy can be claimed. Based on the evidences from business literature (section 2), a three-layer framework is proposed for maintenance management which adds a dimension as central point (see Figure 1). This proposal is based on the analogy with business literature: the MBM is an intermediate layer presented to link strategy and its execution and describing the key components and

choices taken with respect to those components. The inclusion of this layer supports also the emphasis on maintenance function as a source of value, due to the link between BMs and value creation stated in business literature.

The maintenance strategy layer concerns the strategic decisions for managing the maintenance function and aligning it with business goals and asset management strategy. Business context would determine the requirements for asset management strategy, e.g. capacity, flexibility, quality (Komonen and Despujols, 2013). Based on asset strategy requirements and overall business goals, the strategic goals and objectives for maintenance function will be defined, as the key aspects that concerns maintenance strategy.

The maintenance strategy then drives the choices to be made on the key components of maintenance function at the MBM layer. Those choices within the MBM would have operational consequences which, reflecting the maintenance strategy goals, lead maintenance processes to perform activities in a way that is coherent with both maintenance objectives and business goals, contributing to the whole company's performance.

**Figure 1** The proposed maintenance management framework



## 5 The concept of Maintenance Business Model

The MBM canvas is described herein, giving potential categorizations that could guide the choices for each company's context. The definition of MBM components are often derived from the analogue definition given by Osterwalder and Pigneur (2010) for business model components, reinterpreting the concepts according to maintenance function perspective.

The main components within the MBM are: maintenance value proposition, maintenance stakeholder groups, stakeholder relationships, communication channels, key resources, key activities, key partnerships, cost structure, value capture streams. These components are introduced in Figure 2, graphically reported within a MBM canvas similarly to the BM canvas proposed by Osterwalder and Pigneur (2010). The BM canvas is chosen as main reference for this study, since it has been recognized both as reference in the scientific community and as intuitive model for industrial application.



**Figure 2** The MBM canvas (elements reinterpreted from the BM canvas)

<b>KEY PARTNERSHIPS</b>	<b>KEY ACTIVITIES</b>	<b>MAINTENANCE VALUE PROPOSITION</b>	<b>STAKEHOLDER RELATIONSHIPS</b>	<b>MAINTENANCE STAKEHOLDERS</b>
Key partnerships are those formed with the main third parties which provide services and/or resources required to perform the value propositions for maintenance stakeholders.	The main activities/ processes performed in order to provide the value propositions to maintenance stakeholders.	A value proposition is the bundle of activities/services performed by maintenance function that creates value for a maintenance stakeholder.	Relationships created and maintained between maintenance function and its direct stakeholder groups.	Maintenance stakeholders are individuals, groups or business functions that has interest/ influence in maintenance decisions/ activities or that can be affected by the execution of maintenance activities.
	<b>KEY RESOURCES</b>		<b>COMMUNICATION CHANNELS</b>	
	The essential assets required to provide the value propositions to maintenance stakeholders.		Interfaces between maintenance and its stakeholders created in order to bring forth the value propositions.	
<b>COST STRUCTURE</b>		<b>VALUE CAPTURE STREAMS</b>		
The categorization of cost entries considered as expenses related to maintenance activities.		The value generated to maintenance function by realising the value propositions to its stakeholders.		

It is worth making some remarks: (i) the understanding of each category, within a component, could depend strongly on the type of company, industrial sector and other context variables, for example geographical dispersion (mono-site or multi-site); (ii) business / maintenance strategies can lead to different perception on the importance of different components and categories in the MBM.

Hereafter the main components, and examples of their possible categories, of the MBM are introduced; their definition represents a contribution to the conceptualization of the MBM concept.

### 5.1 Maintenance value proposition

The value proposition concerns the bundle of activities and services performed by maintenance function that creates value for its stakeholders. The type of value created varies from one stakeholder type to another, according to their different needs and requirements. For example, the company itself would require maintenance function to contribute to its business goals and to gain advantages in terms of higher product quality or flexibility and availability of production equipment. Value can be categorized also according to its nature as tangible (e.g. quality, availability) or intangible (e.g. know-how, brand, status) or according to the triple bottom line viewpoint (Elkington, 1997) as economic (e.g. contribution to profit or productivity), environmental (e.g. energy efficiency) or social (e.g. health and safety). Some potential characteristics of the value provided by maintenance function could be, for instance, the following: technological update/upgrade, asset life cycle, product quality, process design, brand or status, cost reduction, risk reduction (related to decrease of risk of failure but also prevention or mitigation of its effects).

### 5.2 Maintenance stakeholder groups

Stakeholders can be seen as “any group or individual who can affect or is affected by the achievement of the organization’s objectives” (Freeman, 1984) or as “individual or group that

*has an interest in any decision or activity of an organization”* (ISO, 2010). The role of maintenance as a function inside a company has an effect on the definition of maintenance stakeholders, so it is important to consider its potential relations with other business functions. Thus, derived by the definitions from general literature, maintenance stakeholders may be seen as any individual, group or business function that has interest / influence in maintenance decisions / activities or that can be affected by the execution of maintenance processes. Understanding stakeholders’ requirements is an important issue in order to define adequate value propositions that provide them with their expected value. Therefore, the categorization of maintenance stakeholder groups would be useful for establishing the prioritization of actions to be taken. The categorization herein proposed consists of two drivers. A first driver considers their relations with respect to company’s boundaries, i.e. internal vs. external stakeholder groups. Maintenance function could be used also as a boundary, considering as internal stakeholders only those within the maintenance process, as suggested by Söderholm et al. (2007). A second driver relates to the way in which stakeholders and maintenance function interact with each other, i.e. direct vs. indirect. Depending on the company context, some stakeholders could be seen as indirect or direct from the maintenance function viewpoint, for example the final customer that in some cases would need to interact with maintenance department (Crespo Marquez and Gupta, 2006).

### *5.3 Stakeholder relationships*

This component concerns the relationships that maintenance function creates with its stakeholders and how these relationships are maintained. It would apply just to direct stakeholders to whom maintenance function establishes an immediate relationship, independently on being internal or external. Strong and dynamic relationships are the foundation of any successful business endeavour (Allee, 2008) and are important for value creation (Windahl and Lakemond, 2006). Thus, the relationships that maintenance function sets up with its direct stakeholders could be crucial to increase the value provided by maintenance’s value propositions. The relationships could be categorized by the role that the stakeholders play as a part involved in the release of the value proposition: they could offer assistance, consultancy, information, collaboration, coordination, ... The relationships could be supported by procedures and methods or not, e.g. so being provided in an informal way.

### *5.4 Communication channels*

Unlike the previous component, communication channels are established with direct and indirect stakeholders, although it may have different aims depending on the stakeholder type. Communication channels are the interfaces between maintenance and its stakeholders created in order to deliver the value propositions. These interfaces may be supported by available technologies in terms of information systems or platforms where information regarding maintenance performance or equipment health can be shared among several stakeholders. The interfaces may permit two-way communications, serving to send information from maintenance to its stakeholders and viceversa. Mobile technology could support this communication by providing contextualised information to different types of users through ubiquitous user interfaces (Emmanouilidis et al., 2009). Thus, communication channels could also be the means for receiving requests or work orders from maintenance stakeholders.

### *5.5 Key resources*

The key resources of the maintenance function are the essential assets required to create and deliver value to the maintenance stakeholders. They are necessary to perform the activities or services offered through the value propositions as well as to establish relationships and communicate with maintenance stakeholders. Resources pertain to different types and can be categorized in many ways. The classification herein proposed includes four categories of resources: financial, human, physical and support resources. Financial resources for maintenance function are mainly identified as maintenance budget. In some cases, it could also concern the life cycle budget of the equipment under maintenance, which is categorized according to two concepts: CAPEX (capital expenditures) and OPEX (operational expenditures). Human resources comprise the maintenance personnel, their skills and competences. The classification can be done according to different taxonomies. Maintenance personnel may be appointed with different responsibilities and duties, hence they could also be classified according to their organizational role, at an operational/technical, engineering/supervision or managerial level. Physical resources encompass a wide variety of technical and technological resources, spread from ICT components for maintenance management as a whole, to instruments, tools and MRO (Maintenance Repair Operations) materials for maintenance execution. Support resources concern the set of methodologies, procedures and techniques needed to support decision making and carry out maintenance activities at different management levels, i.e. strategic, tactical and operational levels.

### *5.6 Key activities*

The key activities of the maintenance function are the main activities or processes performed in order to create and deliver value to maintenance stakeholders. Maintenance is defined as the combination of all technical, administrative and managerial actions during the life cycle of an item intended to retain it in, or restore it to, a state in which it can perform the required function (EN 13306). In a broader sense, it comprises decisions at all levels of organization regarding acquiring and maintaining a high level of reliability, availability and value of assets (Al-Turki, 2011) and decisions along all life cycle of assets, i.e. not only during operations phase but also in design and end of life phases (Takata et al, 2004; Levrat et al, 2008). Thus, maintenance activities can be categorized in three levels: strategic, tactical and operational. Strategic activities are usually associated with long-term planning and could assume two different perspectives regarding the development of maintenance function (related to the alignment between business and maintenance objectives) and the life cycle management (concerning the contribution of maintenance to asset life cycle phases). The alignment with business goals would be done with respect to maintenance activities, processes, internal and external resources, as well as to maintenance organisation. Asset life cycle costing and operational availability analysis are activities where maintenance would contribute to support capital asset decisions. Tactical activities consider a mid-term horizon, comprising all the activities carried on to engineer and plan maintenance during the asset operations phase; such as maintenance budgeting, planning and control cycle, supervised (or not) through maintenance engineering. Herein, the activities deals with failure and criticality analysis, development of plans to avoid potential failures and performance losses, technical and economic performance control, continuous performance improvement as maintenance spending in the budget can be also dedicated to such activities. Besides, support activities are those related to the supplier and contractual management, regarding maintenance services and/or materials. Operational activities concern a short-term horizon and encompass a huge variety of activities performed by maintenance personnel for delivering field service, ranging from MRO replacements,

human sense inspections, to real time monitoring, diagnostics / prognostics based on availability of technical/technological tools. Short term planning and work order management are two relevant operational activities. Finally, it is worth observing that the different types of activities can be at different technology intensity, depending on the “tools” available at hand of maintenance personnel.

### *5.7 Key partnerships*

The key partnerships for maintenance function are those formed with the main third parties that provide services and/or resources required to create and deliver value to maintenance stakeholders. They entail a supplement to the key resources of maintenance function, which may be, in some cases, fundamental in order to perform the activities or services involved in maintenance’s value propositions. The key partners pertain to different types and can be categorized in many ways. The categorization herein proposed includes four categories: Maintenance Service Providers, Original Equipment Manufacturers, Consulting companies, MRO materials suppliers. Maintenance service providers (MSPs) are third parties providing specialized skills and competences to maintenance function. They may offer operational/technical, engineering/supervision or managerial capabilities, for example: maintenance planning and control, maintenance engineering, engineering support for plant revamping and retrofitting, spare parts engineering, diagnostics and prognostics, field maintenance service with different specialties (mechanical and electric maintenance, etc.). Original Equipment Manufacturers (OEMs) are manufacturers of durable goods providing additional services linked to their products (technical assistance supporting operation and maintenance of their equipment, for example: spare parts management, maintenance planning, field maintenance service, diagnostics and prognostics, tele-maintenance service,...). Consulting companies would provide support to rethink the maintenance activities in the company, in different matters such as: maintenance engineering, maintenance planning, business process re-engineering and re-organization, empowerment of maintenance personnel, etc. Last but not least, MRO materials suppliers would provide different classes of maintenance materials (i.e. strategic, generic and specific materials, and consumables) as well as related repair services.

### *5.8 Cost structure*

Cost structure is the categorization of cost entries to be included as costs of maintenance activities. The categorization can be done in several ways. A simple manner of classification is the following: fixed costs versus variable costs. In all cases, the cost structure is very related to the concrete context of maintenance function within the company and company’s organizational structure. Detailing cost structure within the MBM means to relate such structure to the strategic perspective of maintenance. In fact, it is possible to highlight peculiarities within the MBM by identifying specific cost categories. For example, the identification of cost category “Cost for walk-around inspections for condition based maintenance activity”, highlights an element within the MBM that then can be related to the created value (e.g., the reduction of failure risk), to key activities (e.g., condition based maintenance related actions such as on condition lubrication, on condition substitution of components), or to key partnership (e.g., service providers offering such inspection service). Detailing appropriately the costs thus allows to create a path that links properly all the elements of the MBM among them.

## 5.9 Value capture streams

This component concerns the value generated to maintenance function from the creation and delivery of value to its stakeholders. The value that maintenance function perceives from the activities and/or services shaping its value propositions may come from different sources, i.e. from different value capture streams. As main stream, maintenance stakeholders would provide maintenance with feedback from activities or services performed, which can be quantitative, such as incentives, but also qualitative, such as satisfaction or recognition. Another stream could be reflected within the maintenance function itself. According to Parida and Kumar (2006), maintenance performance measures are used for quantifying the value created by maintenance. These measures could not only serve as a means to communicate the achievement of maintenance goals to the stakeholders, but also as feedback to maintenance function regarding its performance, thus as a source for continuous improvement. This would be used to evaluate internally maintenance performance and guide actions to improve maintenance processes and to increase the value created for maintenance stakeholders. It is worth mentioning that this can be concretely important for one group of maintenance stakeholders, maintenance personnel, which could capture value in different ways such as incentives on the available budget, direct monetary benefits or public acknowledgement and visibility within the company. A proper design of value capture streams is crucial to avoid some risks, such as not achieving good maintenance practices due to the difficulty to motivate maintenance personnel.

## 6 Conclusions

The research herein presented supports to foster the vision of maintenance function as source of added value, grounding on the idea that improving maintenance performance have an effect also on the whole company's performance. Adopting this integrated vision, the concept of Maintenance Business Model (MBM) has been discussed with reference to the available literature. The MBM has been considered as a means to detail the link between the formulation and the execution of maintenance strategy and a proper MBM Canvas has been proposed as synthetic description of MBM and description of the single components of the MBM has been provided.

MBM concept fits to the present scientific literature and actual industrial practice. In this last regard, it is worth mentioning that, during the empirical research of the Observatory "Technologies and Services for Maintenance" of the School of Management of Politecnico di Milano ([www.tesem.net](http://www.tesem.net)), the potential use of MBM as reference tool for analysis has been already explored by the authors in different events, with more than 150 people from industry as attendants.

The envisaged potential uses of the MBM concept concern the mapping of main elements within maintenance function and the understanding of their connection among each other, with maintenance strategy and maintenance processes. A particular interesting use would be to analyse how implementation of new technologies as key resources (e.g. e-maintenance) or acquisition of a concrete service from key partners (e.g. from an OEM extending its product-service offer) can affect or influence the different elements within the MBM Canvas, with particular concern to the cost structure and value capture streams as leading factors of expected performance improvement.

Further future work can ground on the concepts herein introduced and further develop the robustness of the MBM concept in industry. Further research could also focus on the components of the MBM, i.e. on understanding of their categories and priorities depending on different application scenarios (industrial sector, company size, type of production facilities,

geographical distribution, etc.). Last but not least, the use of the MBM Canvas is going to be refined and analysed by empirical case studies, in order to achieve a consolidated procedure.

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