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Framework for performance measurement and management in a collaborative business environment

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Abstract

Purpose – The purpose of this paper is to provide practical justification for performance measurement and management within a collaborative business network. The basic performance measurement indicators are elaborated within the scope of this research.

Design/methodology/approach – Performance measurement techniques are highlighted through the application of an ICT-based solution approach, with special focus on business collaboration among small and medium sized enterprises (SMEs).

Findings – From the basic need to measure the performance of individual partners within a business network, this research proposes a generic framework and process flow with the objective of evaluating the individual partners in terms of various performance indicators such as key success factors (KSF), key performance factors (KPF) and key performance indicators (KPI). The outcomes from this framework or process flow will help partners in the network to build valuable trust, cooperation and coordination.

Originality/value – The focus of this paper is to demonstrate the methodological approach of measuring the performance through identifying and prioritizing the performance indicators (KSF, KPF, KPI) among collaborative partners and to highlight their importance for successful business operations.

Keywords Performance measures, Critical success factors, Small to medium-sized enterprises, Key performance indicators, Performance management framework, Business collaboration, Virtual organization, Key success factors, Key performance factors

Paper type Research paper

1. Introduction

In today's dynamic business environment and with increasing heterogeneity in the marketplace, more and more manufacturing companies, especially small and medium size enterprises (SMEs), are challenged to adapt to rapid market changes. This rapid



change of market exerts extra pressure on the manufacturing firms to concentrate on their core competencies as well as search for competitive advantages and innovations. To sustain such a competitive environment, firms have to cooperate with each other with the objective of meeting customers' needs effectively and efficiently (Chituc and Azevedo, 2005). This cooperation or collaboration provides the flexibility and mobility for enterprises to be successful in largely saturated markets (Camarinha-Matos *et al.*, 2005).

The driving force of business networking is to create a win-win situation between business partners through creating valuable trust, strong commitment and improved performance. In order to be successful in any business network it is crucial to continuously monitor and evaluate the individual partners' performances within the network. It is quite challenging to know how business networks should assess their performance. Performance management through financial measures has long been used to assess the performance of individual partners in the network. However, there are growing concerns that due to increasing level of complexity at the organization level, financial measures cannot be used as the sole criteria for assessing an organization's performance (Johnson, 1983; Kaplan, 1984). Also highlighted in the literature is the failure of financial performance measures to reflect the changes of strategies of modern organizations (Johnson and Kaplan, 1987; Bourne *et al.*, 2002).

The set of measures used to identify the performance by an organization are focussed on providing a balanced picture of the current business. These measurement criteria should reflect global outcomes of the business in terms of both financial and non-financial measures, internal and external measures, and efficiency and effectiveness measures (Keegan *et al.*, 1989; Kaplan and Norton, 1992). In the case of a collaborative business, the performances are usually measured and evaluated through the collection of data in terms of key performance indicator (KPI), key success factor (KSF) and key performance factor (KPF) across the partner organization's borders. All these performance factors should provide a succinct overview of the collaboration's performance.

The rest of the paper is organized as follows: Section 2 presents a review of the existing literature on performance measurement and management (PMM) within business organizations, while Section 3 highlights the formation of business networks within collaborative environments. It also explains the theme of performance measurement within the business network. In Section 4, a framework for PMM in the business network is proposed. In this section, major performance indicators such as KSF, KPF and KPI are also presented. A case example is illustrated in Section 5, where an ICT-based tool for performance management is demonstrated. The overall managerial implications of this research are illustrated in Section 6. This paper concludes with future research directions in Section 7.

2. Literature review

A collaborative business aspires to reach competitiveness, world excellence and business agility within the market segments. This networking paradigm implements common strategies and goals, upholds mutual trust, interoperable processes and infrastructures for business practices (Zacharia *et al.*, 2009). The performance measures for such networked businesses must be treated with more intensity. A performance management process encourages organizations to update or improve their performance (Trkman, 2010; Le Dain *et al.*, 2011; Lima *et al.*, 2011). In a

collaborative business, the performance management depends on the performance of the individual partners' knowledge and capabilities (Evans *et al.*, 2004; Chiesa *et al.*, 2009; Yin *et al.*, 2011).

The nature of performance management has been most extensively and effectively investigated as the process of quantifying the efficiency and effectiveness of action. Neely *et al.* (1995) defined performance measurement as consisting of three interrelated elements:

- individual measures that quantify the efficiency and effectiveness of actions;
- a set of measures that combine to assess the performance of an organization as a whole; and
- a supporting infrastructure that enables data to be acquired, collated, sorted, analyzed, interpreted and disseminated.

It is obvious from such a definition that performance requires a number of measures to assess and needs an infrastructure to measure and manage (Elbashir *et al.*, 2008; Glykas, 2011). An implicit concern in the literature on performance measurement is that it includes the development of strategies and taking the necessary steps to improve performance based on insights provided by the performance measures (Gates, 1999; Otley, 1999; Ittner *et al.*, 2003; Li *et al.*, 2009).

Many performance management models or frameworks can be found in the literature and applied to business practitioners, e.g. balanced scorecard system (Kaplan and Norton, 1992), PMS-EVE (Saiz *et al.*, 2005), GPM-SME (Alba *et al.*, 2005), performance prism model (Neely *et al.*, 2002), SCOR (Cabral *et al.*, 2005), etc. All the models are generally based on specific market opportunities and network types. In fact, to measure and manage the performance in a business network, it is necessary to implement some kind of methodology or framework that can contribute to supporting successful collaboration (Busi and Bititci, 2006). Each of the performance management models is based on a specific concept to build a framework that can focus on specific purposes and support the decision makers.

The challenge of collaborative business is to identify the factors that affect the evolution of the measurement system used by different partner organizations. With more demanding customers and highly competitive markets, the need for greater responsiveness among partners is crucial. Organizations in the network are required to implement new measures to reflect new priorities according to the current market need (Kennerley and Neely, 2003; Popova and Sharpanskykh, 2010; Ferreira *et al.*, 2011). In a collaborative enterprise, customers and suppliers get access to performance information beyond their own firm and offer access to performance information to the other partner firms within the collaborative network (Holmberg, 2000; Ireland and Bruce, 2000; Busi and Bititci, 2006).

3. Business networks

3.1 Collaborative business – the formation of networks

The collaborative business network forms with the interaction among corresponding enterprises which are willing to coordinate and cooperate with each other for achieving specific business objectives. This network formation can be longer or shorter term according to the market opportunities, commitment and building of trust with each network partner. Typically, a network's duration is temporary or shorter when the

market opportunities arise for a limited period of time, while a longer network life is expected when the market opportunities are presumed to last for a longer period of time and in such case partners invest in common infrastructures and with the highest level of trust building (Camarinha-Matos *et al.*, 2005).

The business network type not only depends on duration but can also be based on power sharing among the partner organizations. For instance, a typical network can be of two different types – hierarchical and non-hierarchical according to the type of power sharing. In a hierarchical type of network, there is one dominating partner organization that controls the basic power and control of the complete network. In this network type, other partners usually follow the decisions and guidelines from the dominant partner which has the biggest capacity and capability within the business network. On the other hand, in a non-hierarchical network type, the entire partner organizations enjoy equal power and control in the decision-making process within the network. In such a network, all the partners usually have almost equal capacity and capability and are SMEs.

The formation of a business network usually follows two main steps – business community (BC) and virtual organization (VO). In BC, the probable partners in similar business sectors communicate with each other to form a community. After forming such a community, several VOs can be evolved from this BC according to the market potential or opportunities. In this stage, the partners within the BC follow some predefined criteria to fit specific target markets. This stage is known as VO formation that proceeds to the VO operation stage, where the VO partners’ operational processes are activated to develop the target products or services. After the operation stage the developed VO is dissolved after fulfilling the target market opportunities and sharing the necessary benefits among the VO partners (Figure 1).

3.2 Performance measurement in business networks

In order to develop and manage a successful business network, continuous PMM for the individual partners in the network is very important to organize the collaboration successfully. However, it requires adequate technologies and supporting infrastructures, proper management tools and performance measurement solutions to guarantee the strategic and business performance of the partners in a collaborative

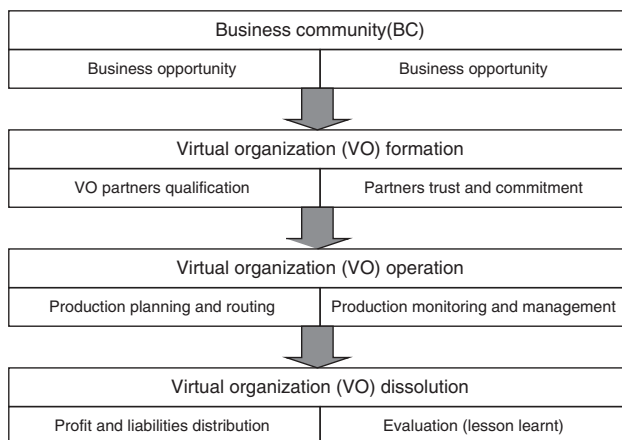


Figure 1. Life cycle of collaborative business network

networked business environment. It is therefore extremely important to design a structured performance framework that can be used to reach proper management and performance measurement solutions.

Answering specific questions often helps to identify and to measure the performance criteria in the business network. For instance, Busi and Bititci (2006) presented some guideline questionnaires that can be implemented to identify and to consider the performance measurement features, such as: which issues should be considered to be measured in the collaborative business? How can individual issues in the business network be measured collaboratively to offer an overall outline of the networked performance? How can a manufacturing firm that belongs to several business networks have a single performance measurement system? How can conflicting performance criteria be handled in a collaborative business network?

An integrated performance management system in the networked business enables decision makers to proactively and strategically manage the collaborative business itself. It contributes to change from the measurement view to the management view within the network and is applicable to support configuration, reconfiguration or dissolution of the network according to performance level. The performance criteria can be both static and dynamic (real-time) types based on the time line of the measurement. In static measurement, only the regular operational (internal) performances are measured, while in dynamic measurement the performance of actions (external) that solve problems and change with time are measured.

4. PMM

4.1 Framework and process flow

The performance management framework generally describes the interrelationships of various performance indicators with their corresponding stakeholders. The stakeholders can be BC, VO, broker, partner, customer, etc. In any kind of performance measurement framework for business collaboration, the first and most essential feature is to identify the strategy and vision of the network, which is then followed by the execution and monitoring and output analysis. The proposed framework for the business network's PMM is presented in Figure 2. Figure 2 shows that the performance starts after developing a strategy and vision, which consists of strategic alignment and implementation to the organization level. It is also included essential business models, organizational performance and accountability of the business network.

The second level of the performance management framework is execution and monitoring, where the collaborative performance measures are determined for monitoring purposes. At this level, various measures are optimized in terms of business process execution and monitoring and business network management vision. During performance optimization, the required reporting is done in respect to corresponding business needs and functionalities. The progress of the performance measures is reviewed from time to time to enable the value-added feedback process. In the execution process, corporate and partnership priorities within the business network are monitored for the purpose of comparing the actual and target values of the performance indices.

The final level of the framework is to analyze the performance levels or outcomes from the coordinated business network. In this stage, business key value drivers and metrics are evaluated in order to assess the operational excellence in the network. Various performance indicators are checked out to compare the target values and the

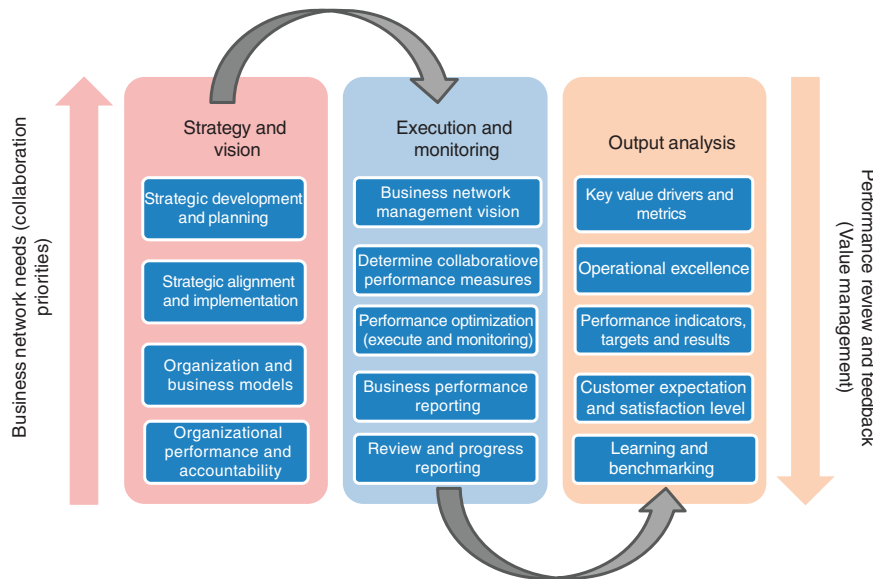


Figure 2. Performance management framework in business network

output results. This is done for the purpose of measuring the balance between the customer expectation and satisfaction level. At this level of the framework, the value-added activities or measurements are stored to facilitate the necessary learning process and benchmarking for the purpose of producing operational excellence within the business network. The complete framework life cycle should cover the business network needs and review the performance indices according to the collected feedback. The generic process flow for performance management framework can be presented as in Figure 3.

Figure 3 shows that in a business network where the individual partners form the BC develops a strategy for performance management in the BC creation phase. In the operation phase of the BC life cycle, the performances are measured through deploying the strategy, setting up the performance measurement process, improving the performance factors of the BC and revising the strategy depending on the acceptance of the performance factors among the BC members (partners). In the metamorphosis stage of the BC life cycle, the performances are revised according to the changed objectives and visions. The revised performances are evaluated and implemented throughout the BC life cycle before the collaborative network is dissolved.

4.2 Major performance indicators – KSF, KPF and KPI

In order to measure the actual performance level of the business network in comparison to the target level, individual partners within the network need to identify the essential performance indicators. These indicators can have been the mirror of the partner organizations' current situation and can be used as indicators for future development. Various types of performance factors are commonly available in the business environment, such as KSF, KPF and KPI. All these performance indicators also vary according to the characteristics of the stakeholders, such as customer, broker, VO partner, BC members, societal segment, etc.

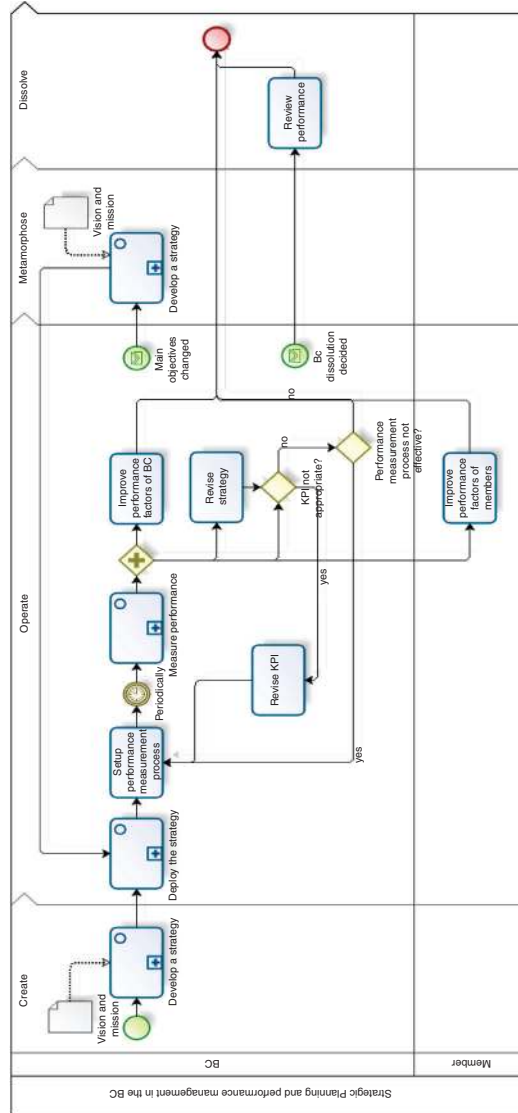


Figure 3.
Generic process flow for
performance management
framework in business
network

Before implementing the performance measurement indicators, it is essential to understand the definition of each of the factors. The KSF can be termed the factor that is identified as the driver of stakeholders' strategy and their success. The KSF is the most important success factor for the key stakeholders, the ones the organization will concentrate on (Kaydos, 1999; La Forme *et al.*, 2007). The term KSF is also named key strategic factor (Kenny, 2005). Another performance measurement factor is KPF, which can be defined as the factor that drives or affects the success factor, and thus the performance of an organization. It requires a systematic cause-effect analysis and is considered an enabler for an organization's successful business operation. As KPF has higher impact on other factors, it requires priority in improvement and monitoring (Otley, 2007).

The generic performance measurement factor commonly used by different stakeholders in the BC is KPI. This performance indicator is a variable that measures a performance factor quantitatively. Usually, KPI is considered as the selected factor that represents the overall performance of an organization or system (Ferreira *et al.*, 2011). Like other performance factors, KPI varies in meaning according to stakeholder type. The number of KPIs for assessing an organization's performance depends mostly on the available data structure or the complexity of the measurement process. Examples of different performance indicators (KSF, KPF and KPI) according to the stakeholders' types are displayed in Table I.

5. ICT tool for performance management: a case example

In this section, a case example is presented, where the generic performance measurement factors (KSF, KPF, KPI) commonly used by different stakeholders within a BC are elaborated through the application of an ICT-based tool. In this tool, various performance data were collected according to different stakeholders' types and loaded in the ICT-based software tool as presented in Figure 4. From Figure 4, different KSF and their key stakeholders' names can be seen. For instance, KSF "suppliers selection effort," "reputation" and "capacity" are collected from key stakeholders' "customer," BC member and "VO," respectively. It is seen from Figure 4 that each of the KSF has its own "as-is value (current value)" and "to-be value (target or future value)" which need to be enabled before populating the values within the tool. Other performance factors and their relationships with each other, such as "KPI for KSF," "KPF" and "KPI for KPF" are seen in Figure 4.

The target values of different KSF are determined according to the stakeholders' decision-making process. These values are varied from the current (as-is value) to the target (to-be value) ones. The name and brief description of each of the KSFs is also defined and saved according to stakeholder type. Figure 5 displays a KSF window with a detailed description of it.

When defining the KPI for KSF, it is essential to distinguish the KSF according to stakeholder type. Each of the KSFs according to the stakeholder has its own KPI for KSF. For instance, Figure 6, displays a customer's KSF named "suppliers' development" which has KPI as "safety financial ratios," "participation in higher value activities," "KSF failure" and "time-to-first proposal." Each of the KPI for KSF has its target value, source, measuring formula, unit, measurement period, etc., as seen in Figure 6.

The KPI for each of the selected KSF is populated within the window of the ICT tool as presented in Figure 7. All the required information for a specific KPI for KSF, such as name, description, target value, source name, required formula to measure the KPI,

Table I.
Display of various stakeholders and their corresponding performance indicators

Stakeholders name	Performance indicators KSF	KPF	KPI
Customer	<ul style="list-style-type: none"> Delivery time and reliability Price and quality Product range Service level Flexibility of product Social responsibility Suppliers development Suppliers selection effort Capacity and expertise Innovation Flexibility of production capacity Level of interoperability Responsiveness Expertise Notoriety in the market Payment terms Payment terms Cost and risk sharing Information about members 	<ul style="list-style-type: none"> Satisfaction level Fulfillment of desired items Reliability of the end product Value for money Availability of service Suppliers efficiency 	<ul style="list-style-type: none"> Unit price Time to solve a problem Number of complaints Winning a proposal Safety financial ratio Participation in higher value activities
Broker	<ul style="list-style-type: none"> Business success Profit margin Customer satisfaction On time delivery Cost effective outcomes Capability level 	<ul style="list-style-type: none"> Business success Profit margin Customer satisfaction On time delivery Cost effective outcomes Capability level 	<ul style="list-style-type: none"> Response time Initial investment Time-to-first proposal Innovative solutions
VO partner	<ul style="list-style-type: none"> Trust Expertise in the VO Collaboration Commonality of processes Delivery time of partner Commitment of partner 	<ul style="list-style-type: none"> Trust Expertise in the VO Collaboration Commonality of processes Delivery time of partner Commitment of partner 	<ul style="list-style-type: none"> Sales volume Capacity utilization Exploitation of ideas Payment frequency Location of partners
BC members	<ul style="list-style-type: none"> VO sales Turnkey solutions Reputation in the market Business opportunity Economic of scales and scope Ethical behavior Environmental and tax compliance Social responsibility 	<ul style="list-style-type: none"> Management of dynamics Development of members BC attractiveness Trust BC marketing Societal benefits Level of environmental awareness Tax contribution 	<ul style="list-style-type: none"> Reported business community rules-related incidents Sales volume Exploitation of ideas
Society	<ul style="list-style-type: none"> Reported environmental non-compliance 	<ul style="list-style-type: none"> Sponsorship of projects Donation of assets Sustainability and governance reports Reported environment-related incidents Adherence to environmental standards Penalties resulting from environmental non-compliance 	<ul style="list-style-type: none"> Reported business community rules-related incidents Sales volume Exploitation of ideas Sponsorship of projects Donation of assets Sustainability and governance reports Reported environment-related incidents Adherence to environmental standards Penalties resulting from environmental non-compliance

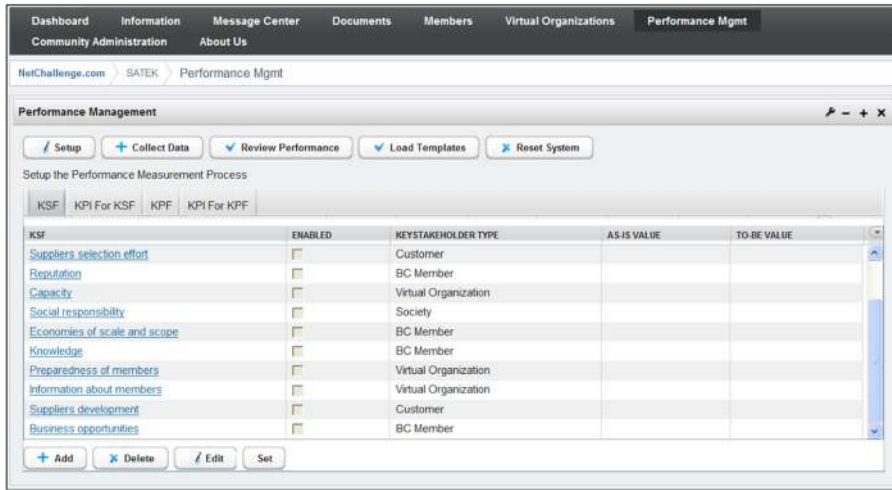


Figure 4. Display of ICT-based performance management tool

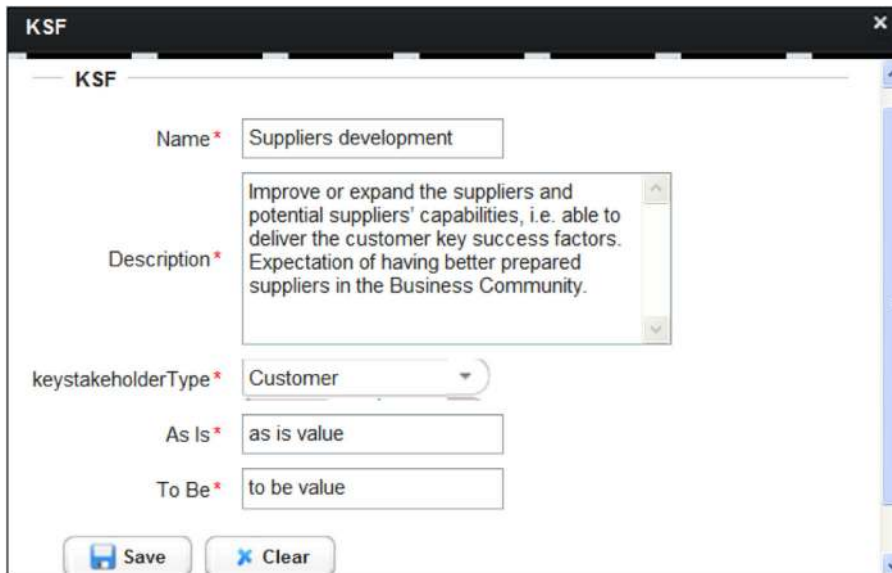


Figure 5. Display of required information for key success factor (KSF)

unit of measurement, measurement period value, measurement period unit, KPI start date, weight of the measurement, etc. are presented within the window of KPI for selected KSF and displayed in Figure 7.

As with the KSF, the different values for KPF according to stakeholder type are also populated in the developed ICT tool and presented in Figure 8. The KPF for selected KSF is also displayed in Figure 8 along with the features of as-is value and to-be value. The essential measurement factors for KPF and KPF for KSF can be added, deleted and edited according to the business needs.

Figure 6.
Display of stakeholder's
KSF and KPI for selected
KSFs

NAME	SOURCE	FORMULA	UNIT	MEASUREMENT PERIOD	START DATE	WEIGHT	OWNER	ENABLING FACTORS	OBSTACLES
Sales Revenue ratio	Accounting	Three values are proposed to measure financial	None	1Month	14-10-2011	500.0	Hasi Challen		
KSF Salary	Management	$INVGRF + INVDF + INVWQDF + INVQ$	None	1Month	14-10-2011	500.0	INE/BC Purni		
Time to first approval	Management	$(SUM(DDFI - DRP)) / NP$	Days	1Month	14-10-2011	500.0	Hasi Challen		

The detailed information related to each of the KPF for selected KSF values are accommodated within the corresponding window as seen in Figure 9. Within this window the related information of the KPF, such as name, description, as-is value (e.g. few marketing activities), to-be value (e.g. more effective marketing campaigns) are saved and changed, depending on the needs.

Before proceeding with any performance measurement activities, the most essential part is to collect the required data. During the data collection period it is important to define the target value, measurement period, owner of the data, measurement formula, unit of the data and starting time of the collected data, as displayed in data collection window in Figure 10. The figure also displays the other values during the data collection such as measurement date, KPI value, user name and registration date. The name and corresponding value of other data can be added or edited according to the business requirements.

Reviewing the performance measures is essential from time to time in order to define the success of any organization. This review result displays the current situation of an organization and reflects its performance within a definite period of time. Periodic performance evaluation guides the organization or a business network to target future performance values. In each reviewing process, the performance values are collected within a pre-specified time, which has a start date and end date. The performances can be displayed both graphically and/or in tabular format, as seen in Figure 11. If any value has fallen behind the target performance value, the necessary corrective actions are usually taken by the corresponding organization or business network.

In a collaborative business, each partner's performances are evaluated separately and then compared with each other for decision-making progress. Usually, the performances are made transparent with each other within the network and they provide necessary suggestions or guidelines for future improvements if there are any activities or processes which are underperforming among the collaborative partners. The implementation of the proposed ICT tool can be a valuable aid for a networked business for measuring and managing the performance of the networked partners.

KPI for selected KSF

KPI

Name * Time-to-first-proposal

Description * Time elapsed from the moment a proposal is requested to the moment it is delivered in its first version.

Target * 5

Source * Management

Formula * Sum(DDFP i - DRP i) / NP

Unit * Days

Measurement Period Value * 1

Measurement Period Unit * Month

KPI Start Date * 14-10-2011

Weight * 100.0

Owner Name * INESC Porto

Enabling Factors factors that contribute positively to KPI evolution

Obstacles factors that contribute negatively to KPI evolution

Notes notes about the KPI

Save Clear

Figure 7. Display of required information of KPI for selected KSF

6. Managerial implications

The importance of setting performance measurement activities is considered a crucial part in any business activity. In order to be competitive effectively and efficiently in the market segments it is essential for organizational managers to continuously monitor and manage the performances of the corresponding organizations. Implementing various performance indicators and measures and setting targets reflects the strategic goals and objectives of an organization. It is considered a standard way to focus available resources and activities to achieve and maintain sustained improvement in an organization.

Before conducting the performance measures, organizational managers need to follow a specific performance management framework or methodology, where each

Figure 8.
Display of stakeholder's
KPF and KPF for selected
KSF

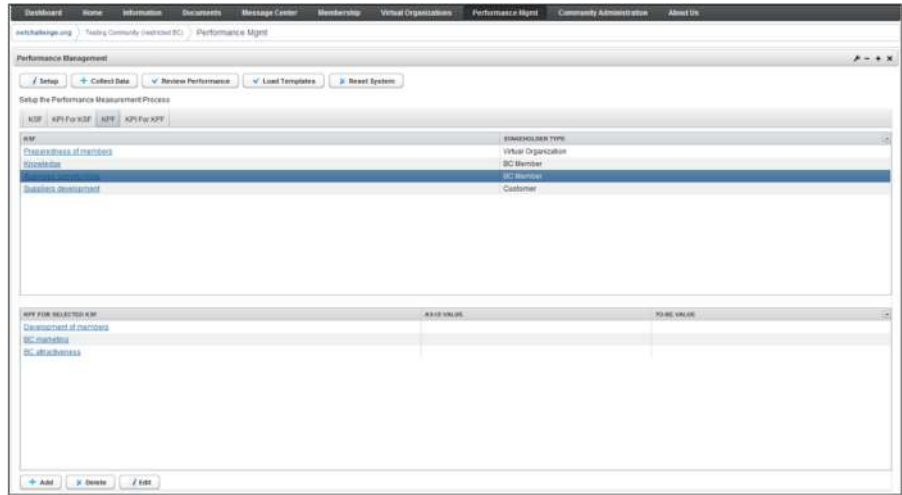
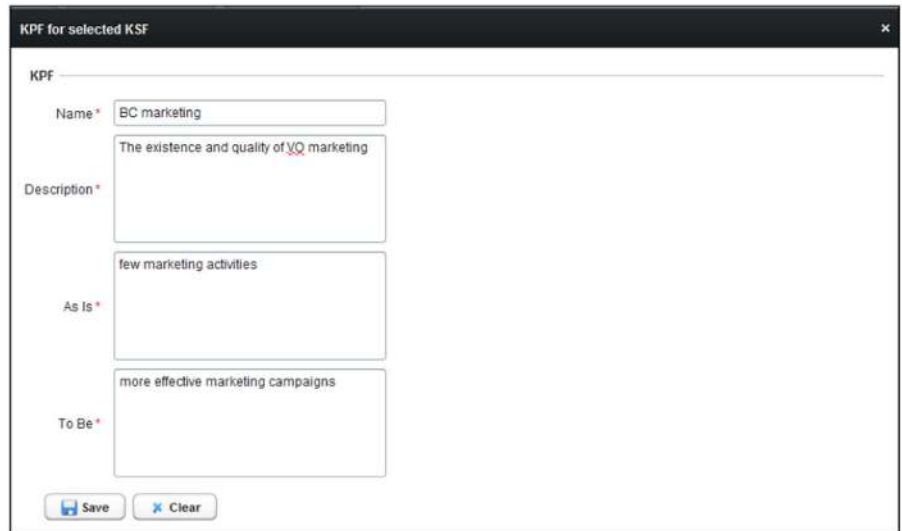


Figure 9.
Display of required
information of KPF for
selected KSF



step is consecutively performed one after the other. The generic performance management process can be explained as in Figure 12, where the sequential stages can ensure better outcomes on this perspective. As in the procedural stage as presented in Figure 12, it is observed that managers need to define the objective first, which is then followed by setting up the target indicators/values of the performance measurements.

The target indicators/values are measured to identify the acceptable level. If the values are not acceptable to the managerial team, they are revised or improved and followed by taking corrective actions. The accepted values are compared with the target values and checked out for differences if there are any. If differences exist

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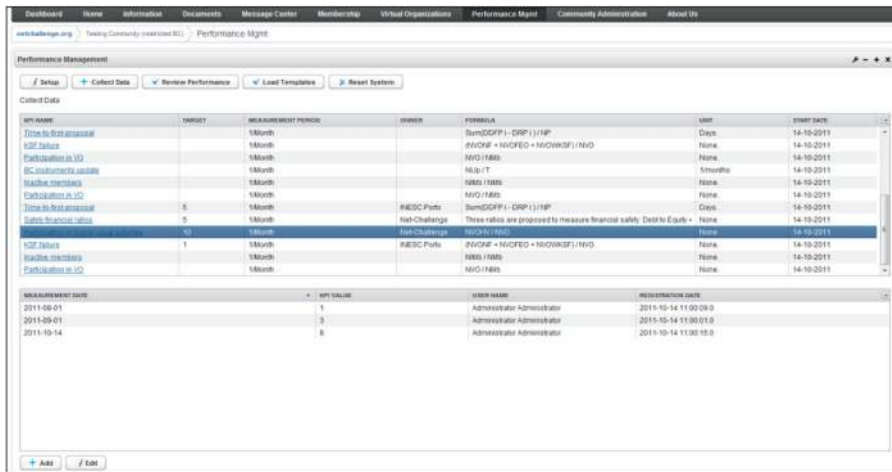


Figure 10. Display of data collection window for various KPIs

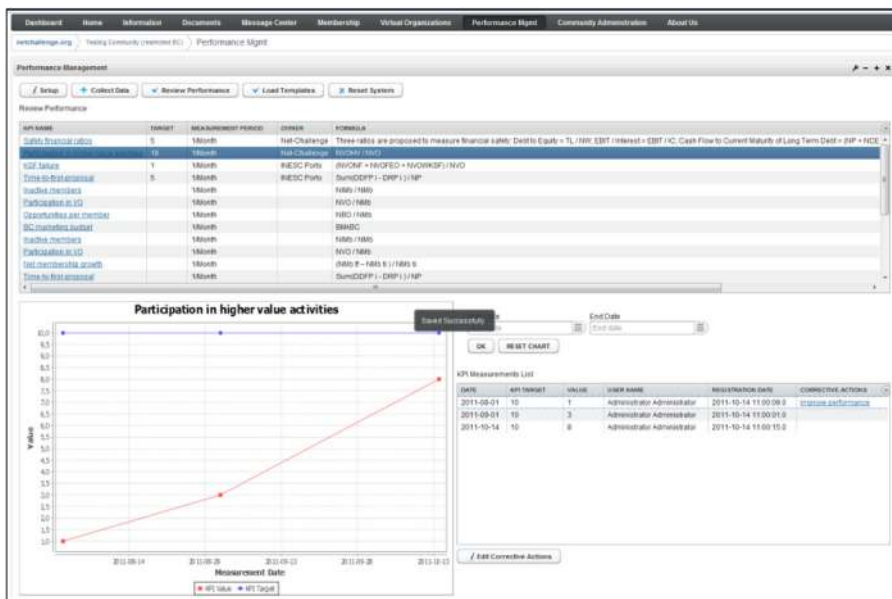


Figure 11. Display of performance review window for various KPIs

between the measured values and the target values, the indicators are revised and the cycle restarts. The measured values are stored for future record if there are no differences between the actual values and target values. In this generic step, managers can keep track of their operational processes in a more professional way.

The target-setting performance indicators may be valuable to managers in producing the best performance within the organization. Managers in organizations can use challenging, specific goals for the purpose and must prepare to provide employees with timely, useful feedback on performance goals in order to ascertain the

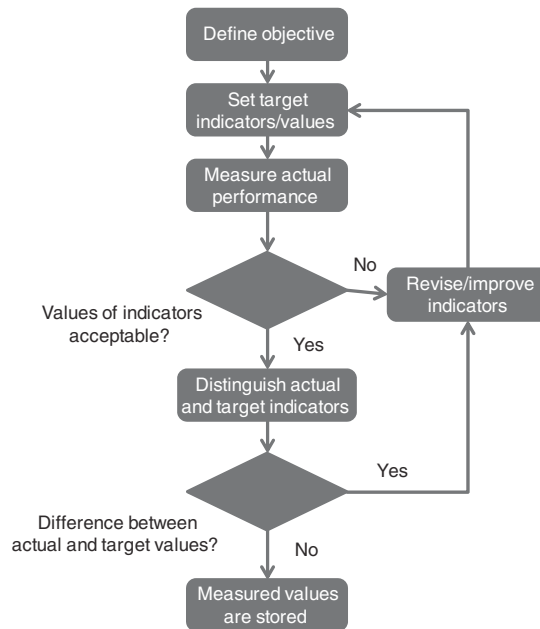


Figure 12.
Generic information flow
in the performance
management process

progress of the operational activities. Managers who rely on valid and reliable performance measures may use them in process development and take corrective actions in cases of poor performance. Each organization is usually set up with a specific mission and vision based on its performance indicators. It therefore becomes the primary responsibility of managers in implementing that mandate to ensure not only that the mission is made possible, but also that the goals are achieved.

7. Discussion and conclusions

The globalization of market and production processes is triggering continuous changes within manufacturing organizations in order to be competitive. Today's business environments are not confined to one factory or one geographical region, but decentralized around the globe in order to achieve positive business benefits. Such a change within the business perspective emphasizes that organizations need to move toward working together such that they consequently form a business network. This business network demands the exchange of information between collaborative partners with a view to managing operational processes within and beyond the single company's four walls and managing the collaborative enterprise performance, not only measuring it.

In order to manage the operational processes efficiently the real-time monitoring of performance is recommended. The performance measurement process usually consists of two parts, namely identifying performance indicators and establishing a measurement framework. The performance indicators describe the contents that are to be measured for assessing the performance of an organization or a business network (Camarinha-Matos *et al.*, 2008). On the other hand, the performance measurement framework describes how to set up and conduct the required measurement. In the literature, various forms of performance management framework are available. Some frameworks offer predefined sets of performance indicators, some provide just the

concepts of measurement process and others holistic methodologies with concrete performance indicators (Westphal *et al.*, 2008).

In collaborative business, there is a lack of explicit alignment of the PMM framework among the independent partners. This gap in the collaborative performance framework is described in this research work with the objective of filling the existing gaps concerning the dynamics, mechanisms and infrastructure needed for integrated performance management in collaborative enterprises. The basic questions related to performance measurement in the network are what is to be measured and how it will be measured. Collaborative performance measures enable the making of decisions that proactively and strategically manages the collaborative enterprise itself.

The implementation of an ICT-based tool supports efficiently the fulfilling of the objective of conducting the necessary performance measurement activities within a business network. The performance measuring and managing process needs the deployment of an integrated ICT tool across organizational boundaries to enhance crucial information exchange among the partners in the network. The ICT tool provides equity, flexibility, reliability, responsiveness and information sharing, which are the prime requirements for an effective and efficient performance measurement precondition. ICT-based infrastructure and support should also reduce the complexity of specifying, searching for and obtaining information related to the performance measures in the network.

The performance management framework, different performance management indicators and ICT-based supporting tool presented in this research would be a valuable aid to business organizations to measure the performance of their corresponding operational processes. The stated KSFs, KPFs and KPIs will provide a guideline to organizations in sorting out the essential measurement indicators before conducting measurement activities. In future research, the proposed ICT tool can be implemented in more real cases in order to generalize its accessibility and solution approach in PMM issues. Further improvement in the PMM framework can also be considered through adding the possibility of obtaining key performance data automatically from the company's connected ICT systems such as enterprise resource planning, customer relationship management and supply-chain management.

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