

A FRAMEWORK FOR PERFORMANCE MANAGEMENT IN COLLABORATIVE MANUFACTURING NETWORKS

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ABSTRACT

The framework for performance management developed in the Net-Challenge project aims at providing a practical approach to performance management for organisations getting involved in Collaborative Networks. The framework scope comprises objectives and strategy setting, strategy deployment, performance measurement and evaluation, monitoring and improvement. The framework aims at the alignment and achievement of strategic and operational business objectives in the Virtual Organisation and in its supporting Business Community environments. The approach relies on the identification of key stakeholders and on their key success factors which provide the external perspective driving the performance evaluation and improvement. An important component of the framework is the net of performance factors, the drivers of performance, which is identified collaboratively, oriented by the external perspective so that the value for stakeholders is kept in sight. The reference processes for both environments are proposed, connecting all the other framework components.

KEYWORDS

Performance management, Collaborative networks

1. INTRODUCTION

Through collaborative networks (CN), member organisations aim at delivering high performance to their stakeholders and at sustaining competitive advantage, by sharing knowledge and resources. Performance management, essential to the success of collaborative networks, requires approaches suitable to this type of networks and to their objectives. The evolution of organisational models, from companies with sharp boundaries, formal relationships with other companies and a focus on internal efficiency and effectiveness, to networks has a profound impact upon performance management practices (Folan and Browne, 2005). Though the single organisation performance management concepts and recommendations have been applied to networks and are to great extent valid, the new challenges require dealing with a larger domain, including new processes, new stakeholders and a less clear concept of internal and external to virtual and real organisations. Other

specific issues of networks to deal with are the duration of their life and their virtual nature.

The concepts of virtual organization (VO) and virtual organization breeding environment (VBE) (Camarinha and Afsarmanesh, 2003) were used by the Net-Challenge project (Carneiro et al, 2010). A Business Community (BC), according to the Net-Challenge project, is similar to a VBE, mainly composed of SME in the same industry, usually in a geographic proximity, that may be open or restricted, depending on the membership policy.

Performance management is even more important in CN to assure the delivery of value to the stakeholders since organisations are more loosely connected. Moreover, since trust is a fundamental enabler of collaboration, performance management should contribute to trust in CN, by delivering objective information on performance of networked organisations and of their members. In this context, several contributions can be found for performance measurement considering it a way to demonstrate the benefits of participating in CN and to promote

the acceptance of these organisational forms (Camarinha and Abreu, 2007) and aiming at achieving equity among partners (Alfaro et al, 2005).

In CN, performance management calls for suitable approaches and processes to identify critical factors and indicators, to formulate actions to take advantage of opportunities or overcome weaknesses and improve the system's performance as it is defined by the stakeholders (Cunha et al, 2008). In general terms, performance management is concerned with setting and sharing the goals to be achieved and developing and managing resources and initiatives, in order to achieve the goals set.

Performance cannot be objectively defined and it can only have a clear definition within each specific context (Lebas, 1995). In fact, the definition of performance lacks knowing to whom is performance delivered (Otley, 1999), the reason why stakeholders are central in a properly formulated approach.

Performance management covers objectives, strategies, performance measurement and evaluation, monitoring, learning and improvement (Otley, 1999). The following activities are part of a performance management process:

1. Definition of objectives and strategy formulation (what the organisation wants to be good at and what strategy is chosen to get there);
2. Definition of what to measure and targets setting;
3. Setup of a measurement system;
4. Measurement and analysis of performance;
5. Decision and carrying out of actions to assure targets are achieved.

The activities 2 to 4 of the previous list, which are part of the performance measurement process, receive inputs from the first one and deliver outputs to the last one. Performance measurement is about collecting data about the past so that a projection into the future can be done and improvement actions can be decided.

Performance management is tightly integrated with process design. Processes must be designed and continuously tuned for specific objectives that contribute to the organisation's strategy. The alignment of processes and of collaborating organisations and the development of suitable performance indicators that provide objective and explicit representation of performance and benefits within a collaborative network are tough challenges. Approaches like the Supply Chain Operations Reference (SCOR) model that proposes performance indicators for supply chains are not oriented for collaborative processes throughout the

supply network (Camarinha and Afsarmanesh, 2008), cannot cope with the dynamics of CN and cannot measure performance on soft factors related to the collaboration (Lebas, 1995, La Forme et al, 2007).

Collaboration has the potential to affect positively several performance factors such as flexibility, agility, resources utilization, specialization, dependence on third party, competencies development, innovation, which have consequences in market position, regulation, etc. (Abreu and Camarinha, 2008, La Forme et al, 2007). Collaborative networks may even be a survival mechanism in face of turbulent markets due to their implicit agility (Camarinha and Afsarmaneh, 2004). As an example, collaborative forecasting may enable better customer service levels or a reduction in inventory (Holweg et al., 2005).

Flexibility or changeability in general can be achieved mainly in the Business Community domain since it is a long term acquisition resulting from planning. Once a VO is set in form and purpose, its changeability can be limited to the accommodation of small changes or disturbances such as changing requirements from the customer or the reaction to unexpected events.

The benefits of collaboration may come also indirectly through knowledge creation and sharing among the organisations in a network to affect many different performance factors. Collaboration is in the base of the reference collaboration processes developed in Net-Challenge, e.g. collaborative planning, capacity management, to improve performance in KSF such as delivery time, sales, capacity, etc.

Besides benefits, collaboration also has costs, related to trust building, time to achieve a common language, systems integration, trial and failure, etc. Hence, there are some requirements for collaboration to take into consideration in partner selection such as competence uniqueness, coherence with the network' strategy, flexibility and adaptability, reliability (Wiendahl and Lutz, 2002).

In the following sections of this paper the Net-Challenge framework for performance management is presented. First, an initial overview of the framework and of its elements is given. The central concepts (key stakeholder, key success factor, key performance factor and key performance indicator) and how they relate with each other are detailed in sub-sections 2.1 to 2.4. The reference processes for performance management included in the framework are presented in the sub-sections 2.5. The validation of the framework is addressed in section 3 and the conclusions are summarised in section 4.

2. THE FRAMEWORK FOR PERFORMANCE MANAGEMENT

The proposed approach to performance management aims at guaranteeing the alignment and achievement of strategic and operational business objectives in the Virtual Organisation and in its supporting Business Community environments. It relies on establishing a strategy based on key success factors (KSF) and on identifying and cascading them internally in alignment with the strategy. Figure 1 represents the Net-Challenge framework for performance management in its context.

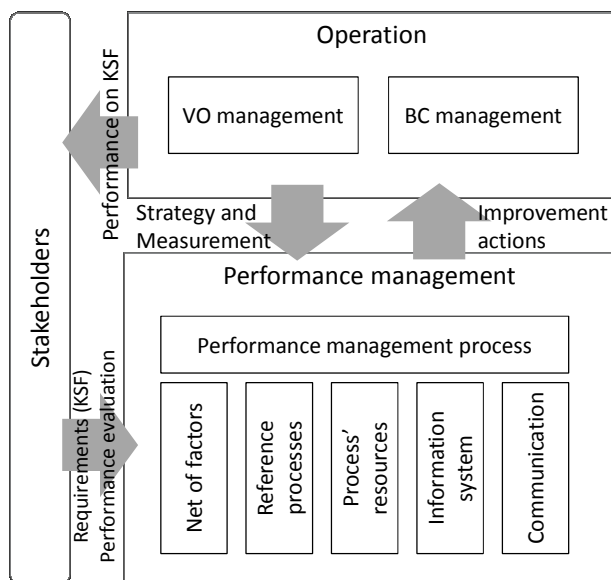


Figure 1 – Components of the framework for performance management

The main components of the Net-Challenge framework for performance management are:

- a stakeholder's perspective of value which defines what performance is (external environment);
- the interlinked factors in the CN which can be acted upon in order to change performance (internal environment);
- the reference performance management processes aiming at making the strategy succeed;
- the information system;
- the process' resources;
- the communication processes (internal and with stakeholders).

Performance can be changed by taking actions in the two environments, which means in two time horizons. In the VO, depending on its lifetime and in the BC, where members develop their capabilities, sharing knowledge whenever possible and try to know each other.

In the BC, a management process can improve the instruments related to membership and those made available to VO to support their formation and operation, such as the standard processes, templates and specific ICT tools. Also a BC management process for strategy revision ponders the actual performance and the environment changes and adjusts strategy if necessary, whilst a capability improvement process and an event handling preparedness process address the improvement of member's capabilities.

Two reference processes for performance management in the BC and in the VO are part of the Net-Challenge framework, which interface with the reference collaboration processes as briefly explained. In order to expedite the processes, particularly in VO, some resources are provided – scenario templates which characterise typical business scenarios and propose sets of factors to be monitored which are relevant in that business context, lists of factors, the corresponding performance indicators and definitions.

The information system collects data from VO partners and BC members as required to calculate performance indicators, conveys evaluation of performance and feeds a central repository of information (BC member and VO profiles). Aggregated and disaggregated data allows analysing performance of VO, VO partners and of the whole BC. This system supports search of partners based on claimed capabilities, qualified processes and actual performance. The type of information transactions is depicted in Figure 2.

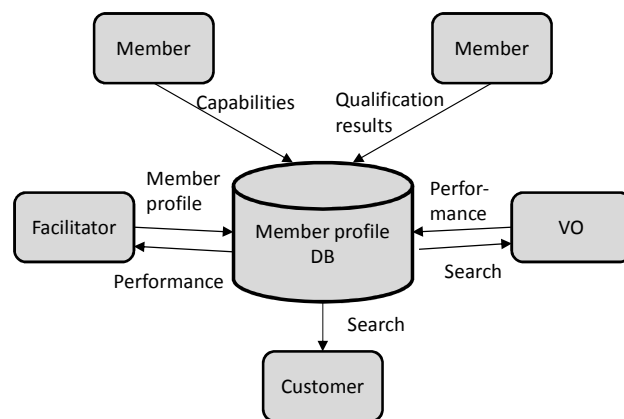


Figure 2 – Flow of information concerning the member's performance and profile

Internal and external communication of performance is essential to convey the BC strategy, to mobilise organisations for improvement and to reward the members in the sense that reputation may be a member's KSF. The framework does not include explicitly a reward system. If BC members and VO partners perform well they will be invited often. The

search for partners takes performance into consideration. Penalties may be foreseen in the partner's agreement (VO contract). Anyway, a penalty will be not to be invited for VO and, in extreme cases, to be excluded from the BC.

In order to speed up and guide organisations in the analysis process and in the identification of KSF and also to clarify the concepts of the performance management framework, the framework contains examples of KSF to BC's and VO's stakeholders. To find the KSF the key question is "what are most important requirements that the stakeholder wants from the organisation (and from other competing organisations) that will determine his evaluation or ultimately that will make him decide for one organisation?". Since it is important to establish a common understanding of the meaning of each KSF, a KSF glossary is a necessary process resource.

2.1. A STAKEHOLDERS' VALUE BASED APPROACH

The base principle in the present approach is that performance is determined by the stakeholders.

A key stakeholder is an entity with an interest in the organisation's activity or in its outcomes, which has the power to influence them considerably. Knowing who the key stakeholders are and what they are expecting from the organisation is the starting point to fulfil their expectations. The key stakeholders of the BC are BC member, VO, Customer and Society. The VO's key stakeholders are Broker, Partner, Customer, BC and Society. Figure 3 represents the stakeholders and their relations.

Even though the broker (the organisation holding the business opportunity) role is indispensable, the customer is considered a stakeholder in order to highlight the VO's orientation to value creation to the customer, and with the purpose to emphasise its specific requirements and to keep clear the specific role of the broker.

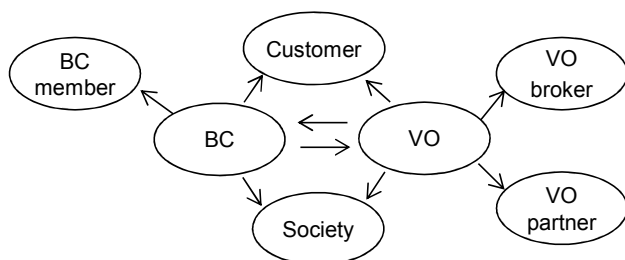


Figure 3 – BC's and VO's stakeholders

The Business Community is a VO's stakeholder since it only fulfils its potential and its mission through the VO. The VO is a BC's stakeholder by definition, since the BC must provide the conditions

for the formation and success of VO. The society is a key stakeholder of both BC and VO but with different perspectives related with their different time horizons and purposes.

Stakeholders are the ones who ultimately evaluate the performance of an organisation. So, it is fundamental to know what are the attributes they value most (in the product, service, job or whatever kind of deliverable) and that they expect the organisation and its competitors can provide them i.e., the success factors. The key success factors (KSF) are the most important success factors for the key stakeholders, the ones the organisation will concentrate on. The difficulty about determining the KSF lies in identifying the few things that will drive the organisation's strategy and its success. This performance management system is inherently multi-goal.

It is important to distinguish the success factors (stakeholder centred) from factors internal to the CN (organisation or process centred), which condition the success factors and that will be called performance factors. The key success factors have to be known by asking the stakeholders. The way an organisation satisfies the KSF will determine its competitive advantage and for that reason they are in the base of a strategy formulation.

There has been no consensus concerning this terminology. The concept of KSF is used with this name (La Form, 2007) and is also named key strategic factor (Kenny, 2005). A related concept in the SCOR model is the value proposition statement which identifies the KSF for types of customer in segmented markets (Bolstorff and Rosenbaum, 2003). Many authors do not distinguish the external and internal perspectives when using the names critical success factor (Kaplan and Norton, 1996, SCC) and key performance factor (Kaydos, 1999), among others.

The benefit concept is central in the approach to performance measurement of the ECOLEAD project (Camarinha-Matos and Abreu, 2007), since it is the driver of the collaborative network behaviour. According to those authors, the goal in a CN is the maximization of a benefit which is an attribute of its specific value system.

Since the KSF are related with competitiveness, it should be noted that competition and the possibility to choose alternatives exist both in BC and in VO and the choice will be determined by the performance on the KSF. As an example, an organisation may decide to participate or not in a BC and may be or not allowed to participate.

The identification of the most important factors that affect the key success factors – the key performance factors (KPF) – enables to act on the

processes and to measure them in alignment with the strategy.

2.2 THE KEY PERFORMANCE FACTORS

A performance factor is an enabler or a constraint that affects one or more success factors and, thus, the performance of the organisation. The organisation acts on the performance factor by changing processes, methods, tools and resources. The stakeholder has no direct interest on the performance factors and may not know about them. For example, production flexibility is of no interest to the customer but it may be a performance factor that affects delivery time and product mix, which are customer's KSF.

The key performance factors are those performance factors that the organisation identifies as the most important, those with higher impact in other factors, requiring priority in monitoring and in improvement. The name is used also by other authors (Kaydos, 1999, La Forme et al., 2007), though Kaydos does not limit it to the internal factors.

The analysis of the KSF and determination of the corresponding KPF require a systematic cause-effect analysis, involving diverse points of view, from the partnering organisations. The concepts of causal model of Lebas (1995), the strategy deployment (Kaydos, 1999), the Hoshin Kanri method and other related approaches are of interest to this purpose.

Like the balanced scorecard (BSC), this method allows to link the strategy with the organisation's internal factors or processes and with the performance indicators. Furthermore, by determining the KPF, an organisation is answering the question "what must we do in order to satisfy the expectations of our stakeholders?", formulated by Otley (2007) to link the drivers of performance with the stakeholders and extend the BSC, which in the present framework are naturally linked. Moreover, the process of identification and definition of KSF and KPF contributes to create a common language within the Business Community.

As the map of cause-effect is built, one goes from success factors that the stakeholder asks the VO or broker, to enablers that are planned and achieved long before, within the Business Community. The consideration of a time dimension and of a time scale puts some performance factors outside the time scope of the VO and reveals some success factors the VO expects from the BC. The perspective of future inherent to the KPF should be emphasised. The KPF are causal factors of the KSF, thus, they locate further back in time. The indicators that measure the KPF are leading indicators of performance on the KSF.

In order to speed up the analysis, a list of some KPF found to be the most relevant in the context of the collaborative networks was also included in the framework to support the KSF proposed. It resulted from a cause-effect analysis, starting from each KSF and identifying its main KPF successively by repeating the key question "what are the factors that have a major impact in this KSF or KPF?".

This generic question or Otley's variant leaves unconstrained the scope of the analysis. However, the analysis may be limited to a specific area or macro-process.

The distinction between KSF and KPF and the open scope of this framework distinguish it from others such as Hon's (2005), which is specifically targeting manufacturing systems and includes both KPF and KSF in the five groups of metrics proposed.

The search for flexibility or changeability, as Wiendahl et al. (2007) name the general characteristic, is an important driver to form CN which are by nature agile, as pointed out above. Thus, changeability appears naturally as a KPF supporting one or more KSF. The toolbox developed by Georgoulas et al. (2007) is of interest to the present framework. It addresses three types of flexibility (corresponding to three possible KPF) and it enables to analyse flexibility in different production levels, through data aggregation. Krappe et al. (2007) integrated flexibility measurement into change management processes and claim that the integrated process allows choosing the most appropriate response to improve the manufacturing system's flexibility at any level. This response could be the best network configuration to achieve a desired flexibility.

The identification of the KPF requires the consideration of the nature of collaborative organisations and of the role of collaboration.

The VO performs well if its stakeholders get what they want and get higher value from it than they would from its alternatives. However, the evaluation of the global performance of the VO may be insufficient and the individual partners' contributions must be evaluated. The case of a VO that delivers to the customer as agreed, in spite of some members' bad performance and only due to the extraordinary effort of the other members, shows that a second dimension besides factorization (going from effect to cause) is needed, which is disaggregation (the contributions from the different members to a global performance). Both dimensions of the KPF development are depicted in Figure 4.

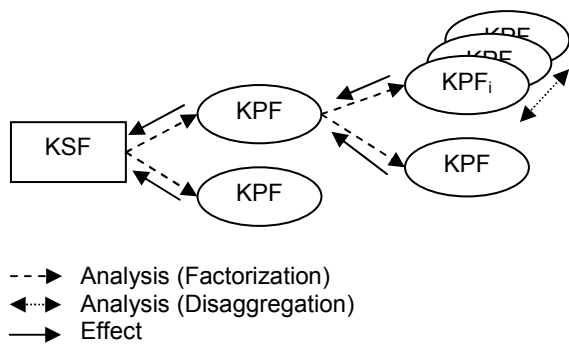


Figure 4 – Factorization and disaggregation of KPF

For disaggregation it may be useful to consider the different ways partners may work at a given moment, represented in Figure 5:

- i) the partners work together for a single output;
- ii) the partners work individually for a single output (sequentially or in parallel);
- iii) the partners work individually for multiple outputs (independently).

In the design and planning activities, i) may be prevalent. This would be the case of collaboration in strict sense (sharing resources, knowledge, etc.). During the execution of manufacturing processes, ii) may be more usual, a case that requires coordination. In the first case, the evaluation of the individual contributions may not be pertinent. This will have implications in disaggregation and in the calculation of KPI. The disaggregation of one KPF into KPF_i enables exposing the performance of individual partners through individual KPI.

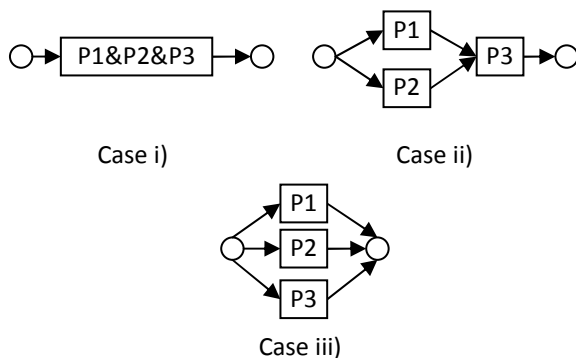


Figure 5 – The different ways partners work

2.3 COLLABORATION AS A KEY PERFORMANCE FACTOR

The collaboration ability of BC members, along with their technical and management capabilities, is a relevant issue raising the need for the assessment of the collaboration preparedness of a candidate to join a VBE or a VO (Afsarmanesh and Camarinha-Matos, 2005). In fact, some of the KPF found and included in the framework as examples are related to the processes of admission of members into the

BC and of search and selection of partners during the formation and reconfiguration of the VO.

In the Net-Challenge performance management framework, collaboration is present in the internal factors (performance factors). The identification of the role of collaboration, in the process of identification of the KPF, is important as it reveals “ex ante” the benefits that may result from collaboration.

However, assessing the performance of an organization on collaboration, directly, is difficult and many approaches to do so lack practicality. Indirect methods try to measure collaboration either by its consequences or by its factors or both ways.

One difficulty when reviewing the research work are the differences in the underlying, explicit or implicit, definition of collaboration. Camarinha-Matos and Abreu (2007) propose KPI to measure collaboration based on a benefit evaluation. Westphal et al. (2010) address the measurement of collaboration proposing the measurement of its effects and of its enablers. Borgatti and Jones (1996) presented a method to measure past collaboration which could be an indicator of preparedness for collaboration. Thomson et al. (2007) developed a conceptual multidimensional model of collaboration to measure collaboration. Simatupang and Sridharan (2005) developed a collaboration index to measure supply chain collaboration in three dimensions - information sharing, decision synchronisation and incentive alignment. Bititci et al (2004, 2008) presented four conditions for collaboration that were not met in some known cases of failure and collected and systematised in the form of recommendations, the result of a survey work. In summary, the recommendations that resulted from the companies’ experience of collaboration are that trust is the base of collaboration and communication is important to create trust; upon trust, relationships must be built aware of cultural differences; then methods and some formalisation must exist; afterwards, collaboration can be practiced by investing on it and when problems happen, collaboration and a constructive approach should be used to solve them.

The Net-Challenge approach is aligned with Bititci’s conditions and recommendations. The performance factors considered in the present framework to affect collaboration in the VO are:

- Motivation and customer orientation;
- Agreement and partner’s top management commitment;
- Trust;
- Communication in the VO;
- Leadership and problem solving instances;
- Methods and tools;

- Organisations' culture and individual social skills;
- Balance of internal process development among partners;
- Geographical distance.

The agreement factor is about rules, obligations, benefits and risks to be agreed upon explicitly. Some factors depend on the selection of partners, some depend on the agreements established to form the VO and others depend on the capabilities of people and organisations. Which of those are key depend on each network configuration and should be determined in face of its strengths and weaknesses.

The importance of communication and of establishing communication channels is known and it was highlighted for example in a Net-Challenge reference process to prepare the VO to respond to events which is part of the process of VO formation.

Though difficult, it is desirable that the performance factors affecting the collaboration are independent of each other so that evaluation is easier.

No research was conducted in order to establish the relative importance of those KPF so that weights could be set with a sound base. Nevertheless, organisations can determine those weights based on their experience.

2.4 MEASUREMENT OF PERFORMANCE

Key performance indicators (KPI) allow monitoring the performance of the organisations on the selected key factors (success and performance factors). A performance indicator, sometimes called metric, is a variable that measures quantitatively a performance factor. Key performance indicators are the (few) selected ones to represent the overall performance of a system or organisation. Some KPI are proposed within the framework for the KSF and KPF suggested, with the main objective to speed up the analysis during formation of BC and VO.

Although quantitative indicators were preferred, for some factors only qualitative indicators could be found. Some are measured periodically others are measured once, which is the case of qualitative measures obtained at the VO's dissolution phase in a review of VO's performance.

Many authors proposed KPI that can also be used or extended in the context of CN, some of them were cited in this article. The KPI are selected according to the factor to be measured, to the particularities of the business processes, to availability of data, etc. If the KPF is disaggregated the corresponding KPI should have that ability.

2.5. PERFORMANCE MANAGEMENT PROCESSES

Two reference processes describe how the performance management takes place in both BC and VO environments, across their lifecycle phases. The processes, whose diagrams using BPMN notation are shown in Figure 6 and in Figure 7, contain the steps from strategy formulation to performance evaluation and improvement, taken into consideration the differences between BC and VO and their lifetimes.

The purpose of the reference processes is to help CN in the design of their standard processes, which will be adjusted to the specific business characteristics.

In the process of the BC, the sub-process "Develop a strategy" (detailed in Figure 8) deals with the identification of the KSF and consequent strategy formulation. Once decided a strategy, it is necessary to understand how every process of the Business Community, members and VO contribute to the execution of the strategy so that the total alignment can be achieved which takes place in the "Deploy the strategy" sub-process (detailed in Figure 8). KPF and KPI are identified here. The proposed KSF, KPF and their KPI are process resources of the framework to provide guidance and to speed-up the process. Only then performance measurement processes can be setup so that performance measurement will take place as detailed in Figure 8 c).

In the VO environment the starting point is a business opportunity and customer or market requirements. An agreement among partners is required to formalise the VO, also concerning the KSF, KPF and KPI relevant to the BC and to the specific business. Decisions at this moment, concerning performance management, are constrained by the BC's KPI and customer's requirements and targets.

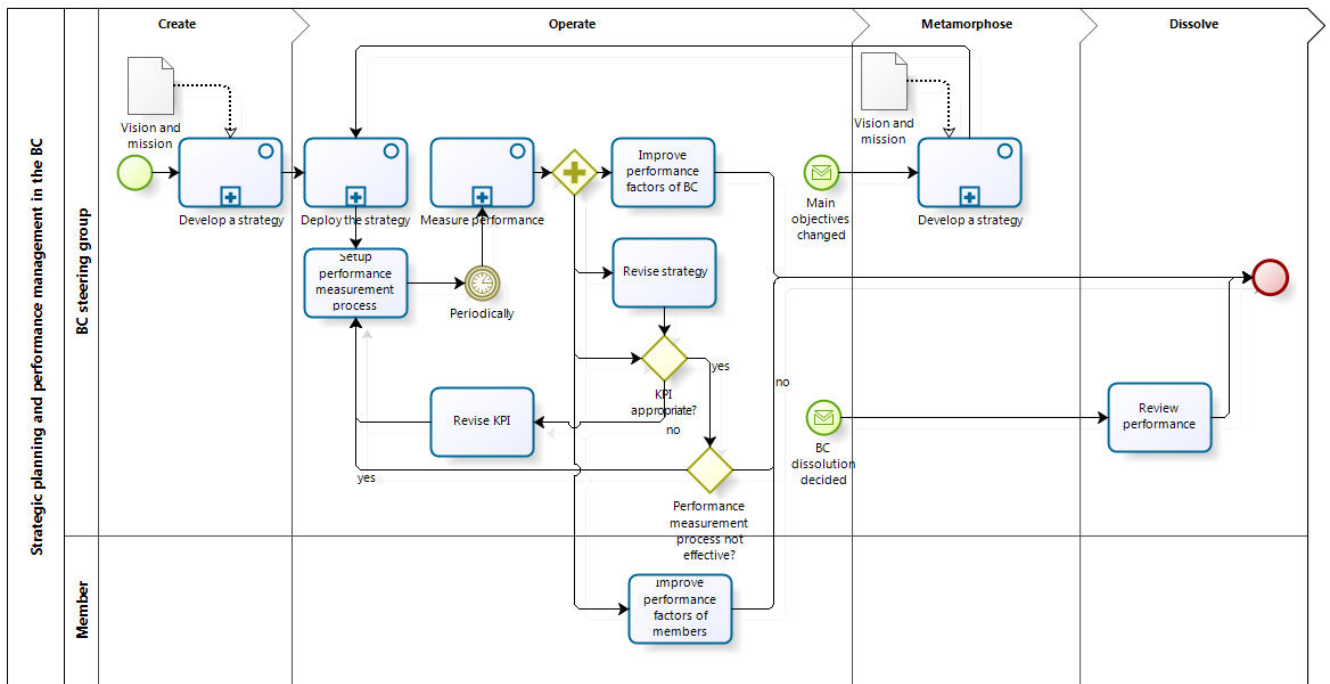


Figure 6 – Strategic planning and performance management in the BC

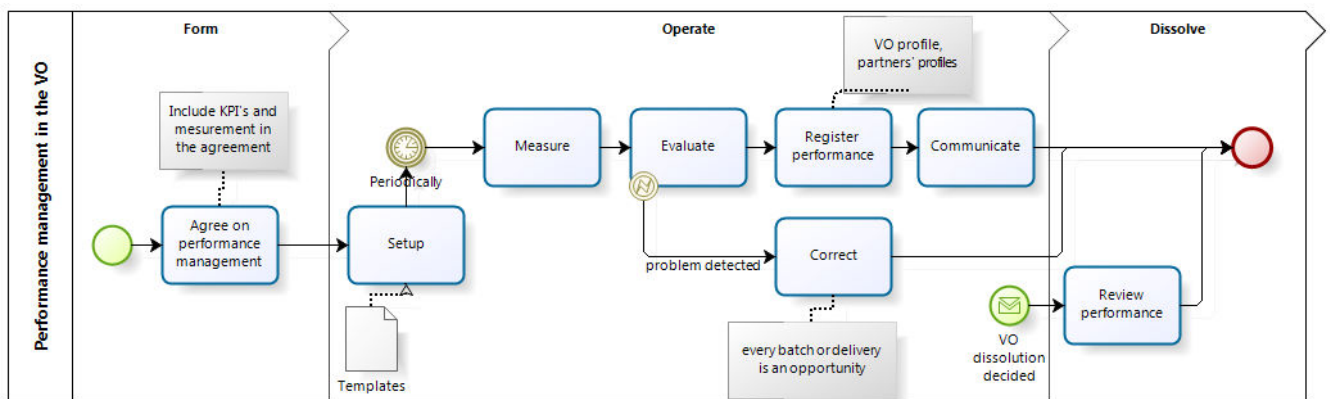


Figure 7 – Performance management in the VO

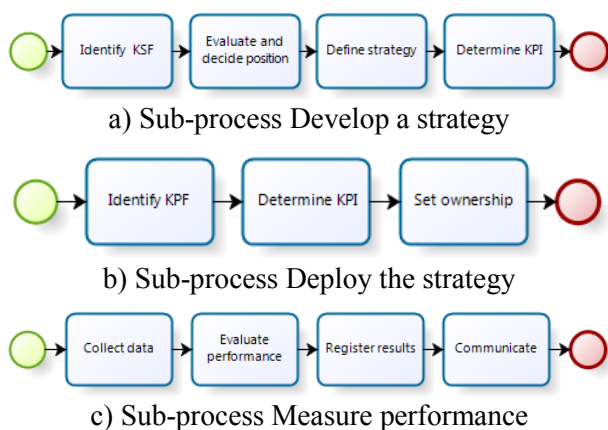


Figure 8 – Sub-processes of performance management in the BC

3. VALIDATION

The Net-Challenge framework for performance management is planned to be tested in a pilot

application led by industrial partners, in the textile and garment sector and in the footwear sector. In these sectors, supply chains are hierarchical; many companies are very small and have a very informal approach to performance management. The pilot applications will be mostly focused on the validation of the process resources (KSF, KPF, KPI and business scenarios) and of the sub-processes to negotiate them and setup the performance management processes.

Interviews with key people in the participating organisations will enable an initial validation and adjustment and to determine the needs and requirements for training and assistance. Information will be acquired through inquiries about the initial conditions and the effectiveness of process execution. It will also be examined the contribution of the performance management processes to the alignment of strategies and to

customer orientation. Both the validation and the specific requirements will enrich the framework.

4. CONCLUSIONS AND FUTURE WORK

The paper presents a comprehensive, coherent and practical framework to assist CN in managing performance which was missing even though several works have addressed specific aspects.

The framework makes use of some existing base concepts which were extended and articulated to support the development of new processes applicable in the domains of BC and VO and embedding collaboration in a straightforward way. A methodical identification of links from stakeholders to KSF and to KPF provides guidance on the quite often chaotic task of selecting KPI.

The concepts adjusted to the new environment, the reference processes developed, the lists of KSF, KPF and KPI and other supporting elements are combined in the framework to make it comprehensive and usable. CN can derive from this framework the standard processes tailored to their specific conditions.

Validation of the framework must still be done and it may determine the improvement of its components.

The benchmarking of collaborative practices in the BC, inspired in the proposal of Simatupang and Sridharan (2004) for supply chains may be an instrument to include in the framework to determine the success factors, to spread good practices of collaboration and to improve the performance of VO and BC.

5. ACKNOWLEDGMENTS

The authors would like to acknowledge the co-funding of the European Commission within NMP priority of the Seventh RTD Framework Programme (2007-13) for the Net Challenge project (Innovative Networks of SMEs for Complex Products Manufacturing), Ref. CP-FP 229287-2. The authors also acknowledge the valuable collaboration provided by the project team during the research work.

REFERENCES

- Afsarmanesh, H., Camarinha-Matos, L.M., "A Framework for management of virtual organization breeding environments", *Collaborative Networks and their Breeding Environments, (PRO-VE'05)*, 2005, pp 35-48
- Alfaro, J., Rodriguez, R., and Ortiz, A., "A performance measurement system for virtual and extended enterprises", *Proceedings of the Sixth IFIP Working Conference on Virtual Enterprises*, Vol. 186, 2005, pp 285-292
- Bititci, U. S., Martinez, V., Albores, P. and Parung, J., "Creating and Managing Value in Collaborative Networks", *International Journal of Physical Distribution & Logistics Management*, Vol. 34, No. 3/4, 2004, pp 251
- Bititci, U., Butler, P., Cahill, W. and Kearney, D., "Collaboration: A key competence for competing in the 21st century", *SIOM Research Paper Series*, No. 003, 2008
- Bolstorff, P., Rosenbaum, R., "Supply chain excellence: a handbook for dramatic improvement using the SCOR model", American Management Association, 2003.
- Borgatti, S. and Jones, C., "A measure of past collaboration", *Connections*, Vol. 19, No. 1, 1996, pp 58-60
- Camarinha-Matos, and L. M., Abreu, A., "Performance indicators for collaborative networks based on collaboration benefits", *Production Planning & Control*, Vol.18, No. 7, 2007, pp 592-609
- Camarinha-Matos, L. M., Afsarmanesh, H., "Collaborative Networked Organizations - A research agenda for emerging business models", *Kluwer Academic Publishers*, 2004
- Camarinha-Matos, L. M., Afsarmanesh, H., "Elements of a base VE infrastructure" *Computers in Industry*, Vol. 51, No. 2, 2003, pp 139-163
- Camarinha-Matos, L. M., and Afsarmanesh, H., "Related work on reference modeling for collaborative networks", *Collaborative networks: reference modeling*, 2008, pp 15-28
- Carneiro, L., Almeida, R., Azevedo, A., Kankaanpaa, T., and Shamsuzzoha, A., "An Innovative Framework Supporting SME Networks for Complex Product Manufacturing", *IFIP Advances in Information and Communication Technology*, Boston, 2010, pp 204-211
- Cunha, P. F., Ferreira, P. S., and Macedo, P., "Performance evaluation within cooperate networked production enterprises", *International Journal of Computer Integrated Manufacturing*, Vol. 21, No. 2, 2008, pp 174-179
- Folan, P. and Browne, J., "A review of performance measurement: Towards performance management", *Computers in Industry*, Vol. 56, 2005, pp. 663-680
- Georgoulas, K., Papakostas, N., Makris, S. and Chryssolouris, G., "A Toolbox Approach for Flexibility Measurements in Diverse Environments", *CIRP Annals - Manufacturing Technology*, Vol. 56, No. 1, 2007, pp 423-426
- Gunasekaran, A., and Patel, C., McGaughey, R. E., "A framework for supply chain performance measurement", *Int. J. Production Economics*, Vol. 87, 2004, pp 333-347

- Holweg, M., Disney, S., Holmström, J. and Smaros, J., "Supply Chain Collaboration: Making Sense of the Strategy Continuum", Pergamon, *European Management Journal*, Vol. 23, No. 2, 2005, pp 170–181
- Hon, K.K.B., "Performance and Evaluation of Manufacturing Systems", *CIRP Annals - Manufacturing Technology*, Vol. 54, No. 2, 2005, pp. 139-154
- Kaplan, R. S., and Norton, D. P., "The Balanced Scorecard", Harvard Business School Press, Boston, 1996
- Kaydos, W. J., "Operational performance measurement: increasing total productivity", St. Lucile Press, Boca Raton, 1999
- Kenny, G., "Strategic Planning and Performance Management: Develop and Measure a Winning Strategy", Elsevier/Butterworth-Heinemann, London, 2005
- Krappe, H., Stanev, S., Ovtcharova, J., Georgoulis, K., Chryssolouris, G., Abul, H.A., "Development of Flexibility Methods and their Integration into Change Management Processes for Agile Manufacturing", *New Technologies for the Intelligent Design and Operation of Manufacturing Networks*, Fraunhofer IRB Verlag, 2007, pp. 37-52
- La Forme, F.-A. G., Genoulaz, V., and Campagne, J.-P., "A framework to analyse collaborative performance", *Computers in Industry*, Vol. 58, 2007, pp 687–697
- Lebas, M. J., "Performance measurement and performance management", *International Journal of Production Economics*, Vol. 58, 1995, pp 23-35
- Otley, D., "Performance management: a framework for management control systems research", *Management Accounting Research*, Vol.10, 1999, pp 363-382
- Otley, D., "Accounting performance measurement: a review of its purposes and practices", *Business Performance Measurement: Unifying Theory and Integrating Practice*, Cambridge, 2007, pp 11-35
- Simatupang, T.M., and Sridharan, R., "Benchmarking supply chain collaboration: An empirical study", *Benchmarking: An International Journal*, Vol. 11, No. 5, 2004, pp 484-503
- Simatupang, T.M., and Sridharan, R., "The collaboration index: a measure for supply chain collaboration", *International Journal of Physical Distribution & Logistics Management*, Vol. 35, No. 1, 2005, pp 44-62
- Thomson A. M., Perry, J. L. and Miller, T.K., "Conceptualizing and Measuring Collaboration", *J Public Adm Res Theory*, Vol.19, No.1, 2007, pp 23-56
- Westphal, I., K.-D., Thoben, M. Seifert, "Managing collaboration performance to govern virtual organizations", *J Intell Manuf*, Vol.21, 2010, pp 311-320
- Wiendahl, H.-P. and Lutz, S., "Production in Networks", *CIRP Annals - Manufacturing Technology*, 2002, pp 573-586
- Wiendahl, H.-P., Elmaraghy, H.A., Nyhuis, P., Zäh, M.F., Wiendahl, H.-H., Duffie, N. and Brieke M., "Changeable Manufacturing - Classification, Design and Operation", *CIRP Annals - Manufacturing Technology*, 2007, pp 783-809