

PERFORMANCE EVALUATION WITHIN COOPERATE NETWORKED PRODUCTION ENTERPRISES

P.F.Cunha¹, P.S.Ferreira², P. Macedo¹

¹*Instituto Politécnico de Setúbal/ ESTSetúbal*
pcunha@est.ips.pt; pmacedo@est.ips.pt

²*Bright Partners*
psf@brightpartners.com

The concept of value has a great relevance in the definition and implementation of a performance management system in the context of cooperate networked production organisations. These new forms of organizations are, in many cases, still lacking suitable performance measures. Based on this idea, this paper we will discuss the problem of performance evaluation. Mainly we will discuss: How appropriate measure can be found to accurately measure the production network performance; What are the appropriate ways to implement those measures; and finally, How the information system can support the performance management.

1. INTRODUCTION

The ability to react to continuous and unexpected changes is essential for market success (Wiendahl, 2002) and it is dependent on: i) the evaluation performed, concerning values, criteria and preferences; ii) the existing planning capacity and iii) the ability to implement defined actions. In this context, the investment in information technology supported in adequate knowledge capital plays an important role for the industrial enterprises to maintain their competitiveness. However the large amount of data and its processing is, in the advanced manufacturing or service environment, a time critical factor for the design, planning and managing the operations (Cunha, 2005). Also, there is a trend for new forms of business organisation, stimulating higher levels of cooperation between organisations in the manufacturing sector, of which the production networks are only an example, referred as cross-company cooperation with mutual use of resources and the joint planning of value added processes.

The performance monitorization and control in new forms of organisation calls for suitable performance measures and metrics which contribute for a more precise performance management. The performance measurement and evaluation plays an important function and can be considered a critical factor for the success of any organisation because it creates understanding, models the behaviour and contributes

for competitiveness improvement. The existing information system and availability of data about the production network performance helps to create knowledge and consolidate the trust required, not only in the establishment of strategic alliances between partners but also during the network managing and operation.

The aim of this paper is to present a methodology for defining a well structured set of performance measures in a collaborative environment. This methodology is proposed based on production networks characteristics and taking into account their influence on performance measurement in collaborative networks.

2. COOPERATION AMONG PRODUCTION ENTERPRISES

Cooperation is nothing new to industry, but in more recent years and in reaction to the market volatility companies need to look beyond their internal processes to integrate functions and to improve their manufacturing or service performance, keeping their economical sustainability. Thus, we share the opinion presented by Wiendahl (2002), i.e. the picture of a stand-alone company that is linked to its customers and suppliers only by delivery and procurement of products is no longer valid.

The integration of functions intra-companies or inter-organisational is a key issue in new forms of manufacturing systems organisation and planning tasks are prime candidates for the integration effort (Gunasekaran, 2004). Planning decisions are distinguished not only by the context in which each decision is taken, but also by the planning horizon and hierarchical level of the decisions and the area or areas in which they are applied. It is also recognised that there are inter-relations among planning tasks as well as between planning and control activities. In this context, information exchange plays a key role in the manufacturing strategies and in the cooperation to be promoted in planning and decision-making. Therefore, a competitive advantage can be acquired through the improvement obtained from changing the traditional and non-integrated use of planning systems to collaborative tasks and from the synergies resulting from information share among distinct systems.

Production networks are a type of cross-company cooperation with a high degree of versatility and with an intended duration of cooperation, i.e. significantly longer than in a virtual enterprise. Network organisations are evolving from traditional organisations and as we see it, in a network members have their own strategies and their collaboration lays on common or compatible objectives and strategies that are perceived as network objectives and strategies. Traditional and networked organisations differ in several relevant aspects. Gunasekaran *et al.* (Gunasekaran, 2004) have summarized those differences and grouped them by the following areas: strategy formulation, tactical decision, operational controls, purchasing and logistics, knowledge management and information technology. Also, can be underlined the following common issues in all areas of networked organisations:

Distribution

- Narrow market *vs.* Global market on strategy area.
- Aggregate production planning *vs.* Enterprise resource planning in tactical decisions.

- Central inventory control vs. Distributed inventory control in operational decisions.
- Investment in information technology has not just internal but also external focus.
- Pull/Push scheduling has evolved to scheduling of delivery with partners.

Agility and adaptability

- Purchasing and logistics is now based in agility and e-market.
- Agile manufacturing and/or agile services are characteristics of operations in networked organisations.
- A stable master production scheduling is not any more a characteristic of planning on a network organisation.

Since the creation of a network and throughout its life-time, the performance is an important aspect to be considered and some of the issued to address concern market evolution and strategy (price, quality and product innovation), competitors' performance, distribution efficiency and the strategic focus in terms of engineering changes, processes, planning and control.

3. PERFORMANCE MANAGEMENT OF MANUFACTURING SYSTEMS

The drive motive related with the performance management is to identify critical factors or activities, formulate actions to take advantage of opportunities or overcome weaknesses and improve the manufacturing system performance, mainly at the eyes of the *stakeholders*. Performance measurement is critical to the success of any form of organisation because by measuring or estimating the impact that any decision can have it is possible to create understanding, mould behaviour and improve competitiveness (Gunasekaran, 2004) and its main ability is to link strategies with targets and goals. Performance evaluation is considered, within an integrated planning environment, as a way to obtain a global view of all activities and the existing correlation between themes (Kaydos,1998), based on financial and non-financial information about activities.

Many studies have been published presenting different methodologies and frameworks for strategy definition and performance measurement of individual organisations. Some example of those approaches are the ones presented by Kaplan e Norton (1992), Bitici (1995), Neely (1996) or Kenny (2005). Folan et al. (2005) presented an interesting review on the frameworks and systems for performance measurement. Kenny (2005) proposed a methodology that encompasses the identification of the key stakeholders, the identification of the strategic factors for them, the objectives setting to all key stakeholders and the definition of performance measures derived from those objectives. Strategic factors also drive the concepts of value and of competitive advantage upon which a strategy is built. This methodology is especially interesting because it has an external perspective and because it individualises the key stakeholders and the transactions with them.



Figure 1 - Transactions according to Kenny (2005).

The measurement and evaluation process can occur at different levels of an organisation and many industrial enterprises already understand that the performance measure can be used also to improve the communication between different functional areas or manage their intra-companies relation. Nowadays this is done through the existing variety of technologies and management activities. Another return on the investment is the stimulus to create a continuous improvement environment.

The existence of a performance measure system is independent of company size and of its form of organisation and only dependent on the objectives and on the competitive environment in which the company is (figure 2). This understanding is particularly important because, increasingly, individual companies will no longer compete with each other but they will be members of competing supply chains or other new form of organisations, with new requirements in terms of cooperation, such as production networks (Wiendahl, 2002).

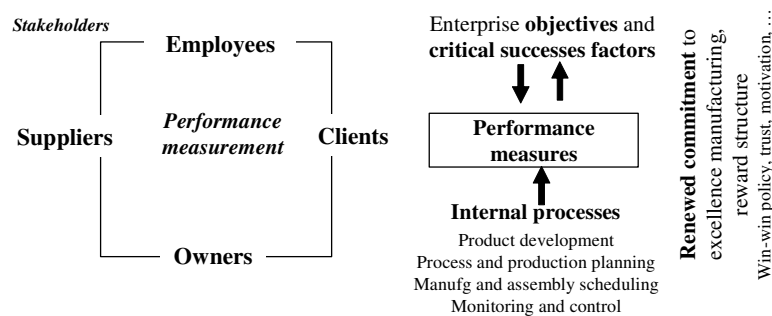


Figure 2 - A framework for performance measures alignment within an organisation.

The performance measures are usually related with products, process operations, equipment or/and with the system in general. In spite of the accepted relevance of performance evaluation, there is no clear consensus in the industry, concerning the structure and the use of performance measures, as shown by Folan (2005). Also, there is a lack of reliable methods to evaluate the success or failure of the efforts expended by the company to improve its performance and to acquire the knowledge required in all phases of product's life (Kaydos 1999, Westkämper 2003). In fact, according to the study presented by Cunha (2005), there is a distinct set of difficulties related to the use of performance measures to monitor and control manufacturing or assembly system performance. Concerning the criteria used for performance measure, it is referred that the use of a single type criteria is limiting and promotes a short-sighted view because it ignores non-financial factors that also

contribute to success. Together with non-quantitative measures, qualitatively assessed measures have to be considered to describe the overall performance of an organisation (e.g. leadership, culture, organisation and personnel) (Hon, 2005). The increasing number of variables that can be used for the control and monitoring of a more complex manufacturing system or of a new form of organisation that can be a clear drawback to present useful data for planning and global management of the processes.

In new forms of organisation, such as integrated supply chains and production networks, information and knowledge sharing and communication play major roles in processes management as they do in single organisations but are more demanding and complex. Therefore it will be important to have an effective common information platform (figure 3) from which all members can draw knowledge when data about performance measurement is made available and it is analysed or understood.

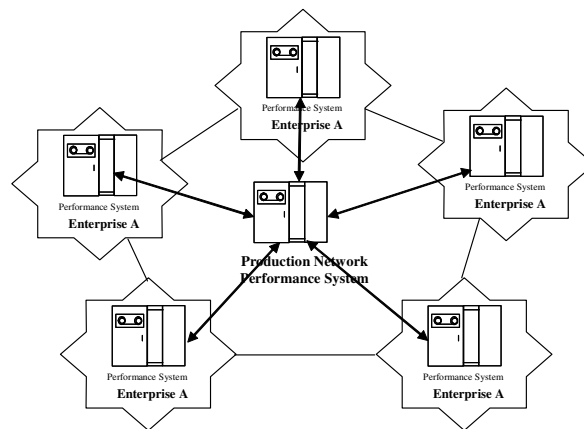


Figure 3 - Performance systems in network environment.

The performance of a network reflects itself in each member's performance, perceived from their own performance measurement system. However, being a network a complex organisation, the view from one member's perspective is partial. Compared to a supply chain, it has more connections active or idle at a given time. So, its performance evaluation requires the consideration of other dimensions besides the individual one. Concerning performance measurement systems in new forms of organisation, Lohman et al (2004) pointed out various barriers to its design and implementation. Those barriers are related with decentralised operational historical reporting, deficient insight in cohesion among metrics, uncertainty about what to measure, poor communication between reports and users and dispersed IT infrastructure. In fact, inter-organisational performance measurement is a much more complicated process because it attempts to merge the concepts of performance measurement and paradigms for cooperate networked enterprises. Considering the collaboration issues within networks, in order to develop performance management systems for production networks, a set of requirements should be satisfied.

- 1- The definition of indicators should be a collaborative activity to be performed during the network set-up, and redefined periodically during operation phase.

- 2- The indicators defined should contemplate the performance evaluation of the collaborative aspects in the network.
- 3- The vision of each member of the network should be contemplated and the individuals performance measurement systems should be embedded. So, a network level and a member level should be considered.
- 4- The technological design of the performance system should provide an architecture flexible enough to support the entrance and exiting of new members.
- 5- Thus, a methodology to define a well structured set of performance measures, would be considered an important contribute for the management activity.

4. PERFORMANCE EVALUATION METHODOLOGY FOR PRODUCTION NETWORKS

The methodology proposed defines two levels, - an *individual level* and a *cooperation level* to describe the performance behaviour of a network.

Individual level

At this level, the performance of the member organisations is evaluated. A methodology referred previously and proposed by Kenny (2005), has a key advantage of individualising the key stakeholders and developing consistently from that foundation each objective and the corresponding performance measures.

In the context of a network, the other partners of the network that the organisation has transactions with, being either clients or suppliers, have to be included among the key stakeholders and the objectives for them are negotiated and the monitoring and control to apply is setup and enabled. The organisation(s) marketing the final product(s) are the forefront of the network on the market as in a supply chain, competing with others. However, each member organisation has its own objectives and indicators that although being different characterise their performance in a similar and compatible way.

Cooperation level

A similar approach can be used to evaluate the network, which is a second level. All members are network' stakeholders and each states what it expects from the network, i.e. its strategic factors (figure 4). We bring up into this level the relevant individual level objectives, here strategic factors, common to all members. What are usually described as network attributes, such as responsiveness, innovation ability, versatility, reconfigurability, information sharing and communication can be classified as strategic factors too, common to all stakeholders and addressed at this level. All network members expect the network to fulfil most or all of its expectations to some extent.



Figure 4 – Single direction transaction within network.

At this level, performance measures are set on strategic factors, not on objectives. The network is performing “satisfactorily” if all members are “satisfied”, i.e. if are getting value. Note that this performance is internal to the network. How the network is performing in the market is measured at the individual level.

What if the network is not performing well, that is, if one is not getting what it expected? The unmet objectives and expectations translated through the performance measures should provide a straight forward reading of the causes as well as the ground for the choice of competencies needed and partners. It leads to changes in the network structure.

The following picture resumes the processes that support the methodology.

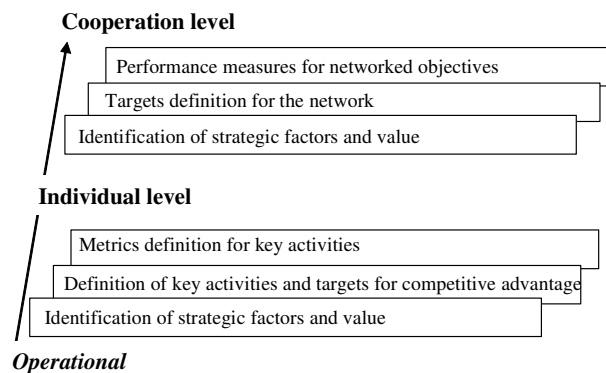


Figure 5 – Step toward performance measure definition.

Strategic factors and values for the network or at internal level are translated into performance measures through the involvement of partners or through an internal process. It requires discussion, commitment and a shared vision to support the validation and implementation plan for each measure, taken into account potential conflicts, barriers and difficulties.

The measures should be checked for redundancies or conflicts, as well as for its ability to answer questions about the network performance management, such as:

- How effectively the enterprises within the network are interacting?
- How flexible is entire network in responding to requests?
- To what extend are decisions within the network motivated by mutual trust rather than power?

Having the metrics accepted by all network members, the implementation phase should be planned having the following considered (factors that make implementation easier; factors that make the implementation difficult):

- A plan for a systematic introduction and induction of performance measurement through training actions at different levels within the companies and network;
- Clear designation of tasks for collection, analysis and report for performance measurement.
- Adequate allocation of resources for an efficient and continuous operation of the performance management system.
- An agenda for future revision of performance indicators and definition of mechanisms to do it. Simplicity, understanding and usefulness are aspects to taking into consideration,

- Mechanisms for performance evaluation system revision;
- An agreement about the adequacy of such performance measures to drive improvements throughout the network

The sources of data, its use and the action that should be promoted must be defined and the information system must support the network operation and management, having in mind the use of information at both individual and cooperation levels.

5. CONCLUSIONS

The way information is shared will have impact in the communication between partners and in the network performance evaluation. The existence of a single methodology for clean and understandable performance measures definition promotes trust and a better cooperation in network environment.

The methodology proposed extends an existing one and shows to be a good link between different perspectives within the network, i.e. *stakeholders vs individual organisations* and *cooperation organisation vs stakeholders*. It also drives the organisations to find accurate measures aligned with the objectives and suggests procedures for the implementation phase.

Through the validation and implementation of this methodology we hope to further its details, test and define its practical applicability and value.

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