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Monitoring Extended Enterprise Operations Using KPIs and a Performance Dashboard

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ABSTRACT

The importance of performance management in relation to supply chain management is to play a vital role in translating strategy into achievable objective along and at the single nodes of the chain. The subject of performance management being a wide one, the author needs to narrow down the scope of this paper to the analysis of how performance indicators selection and representation should be carried out in order to support such strategy translation. This paper answers one main research question, i.e. how can key performance indicators (KPIs) for controlling supply chain operations be identified and selected. In addition it discusses how the existing information and communication technology could enable true extended enterprise performance management through the development of a performance dashboard. Answers to these questions are based on review of existing literature as well as on results from action research in which the author has been involved.

INTRODUCTION

This paper analyzes the concept of performance management as being part of supply chain management. The authors have been and are working on an innovative concept of supply chain performance management, defining: an extended enterprise performance management philosophy, proposing a list of extended enterprise key performance indicators (KPIs), and designing an electronic KPIs dashboard.

In performance management related literature some terms, e.g. measure metric and indicator, are used differently by different authors, often mixing research on performance measurement with results on how to use performance indicator (Winston, 1999). One reason for this may be the blurred borderline between some of the definitions. We therefore want to let the reader know what the terms used in this paper mean for us who wrote it, establishing hence a fix set of terms univocally defined.

DEFINITION OF A COMMON SET OF TERMS AND CONCEPTS RELATED TO EXTENDED ENTERPRISE PERFORMANCE MANAGEMENT.

1 Some of the ideas and concept hereby presented originated from a European research project, MOMENT (MOBILE extended Manufacturing ENTERprise). We hence would like to thanks all partners participating in the
We use the term extended enterprise instead of supply chain to stress that with the result of this research we aim to improve integration between chain partners. In developing a performance management philosophy from an extended enterprise perspective we analyze and model each value chain from a focal enterprise’s point of view. While considering the whole value chain, our research sets the limits to operations models that include the closest customers and suppliers of the focal enterprise. In more detail, we talk about extended enterprise processes referring to those related with the flow of information and material from the supplier’s outbound logistics, through the manufacturer’s manufacturing logistics process, down to the customer’s inbound logistics. Though, the focal enterprise could be any supplier in a value chain.2

According to Kathuria and Partovi (2000) there is a general agreement in the manufacturing strategy literature that the decisions regarding the structure and infrastructure of an organisation should be in line with its competitive priorities (Hayes and Wheelwright, 1984; Anderson, Cleveland and Schroeder, 1989; Ward, Leong and Snyder, 1990; Hill, 1994). In this context, competitive priorities have been referred to as the dimensions of manufacturing strategy or the content of manufacturing strategy. Hayes and Wheelwright (1979) identified competitive priorities with certain “dominant competitive mode” and “key management task”.

Enterprise competitive priorities depend on the customer’s order-winners and -qualifiers. In order analyze how “good” an enterprise is in understanding and fulfilling customer requirements we introduce the two terms of effectiveness and efficiency. Effectiveness refers to the extent to which customer requirements are met, while efficiency is a measure of how economically the firm’s resources are used when providing a given level of customer satisfaction (Neely et al., 1995). Thus we say that performance measurement is the process of quantifying the efficiency and effectiveness of an action (Neely et al., 1995).

A performance metric is a number or value that has been directly measured (e.g. no. of failures per day); metrics used to quantify the efficiency and/or effectiveness of an action are defined as performance measures and/or performance indicators.

A Key Performance Indicator (KPI) is a number or value which can be compared against an internal target (or an external target - “benchmarking”) to give an indication of performance. That value can relate to data collected or calculated from any process or activity (adapted from Ahmad and Dhafir, 2002). Performance indicators and KPIs are descriptive, i.e. they are derived from the performance metric measurement (e.g. % rejects) (Lupton and Dooley, 2003).

Last, a performance measurement framework assists in the process of performance measurement system building, by clarifying performance measurement boundaries, specifying performance measurement dimensions or views and may also provide initial intuitions into relationships among the performance measurement dimensions.

devlopment of such ideas. In particular we thank CIMRU (Ireland) for the programming development of the electronic dashboard.

2 From the MOMENT project deliverable, D1.4, The MOMENT conceptual framework
DEVELOPMENT OF THE EXTENDED ENTERPRISE PERFORMANCE MANAGEMENT CONCEPT.

The extended enterprise performance management concept hereby presented consists of the following three components:

1. An extended enterprise performance management philosophy: the related research is completed. The outcomes produced include:
   a. Theoretical guidelines for extended enterprise management through performance:
      • Description of the role of PM in translating extended enterprise strategy into operations goals (top-down approach)\(^3\).
      • Description of the role of actual performance of local nodes operations as inputs to extended enterprise strategy definition or refinement (bottom-up approach)\(^3\).
      • Definition of the rules for linking the performance measures and indicators to the extended enterprise operations and process model.
      • Development of the extended enterprise balanced scorecard concept and methodology for its use.
   b. Definition of the performance indicators selection framework:
      • For extended enterprise KPI selection.
      • For local node KPI selection.
   c. Definition of the role of ICT to support extended enterprise performance management:
      • Electronic performance management based on use of electronic KPIs dashboard: definition of tool’s features.

2. A list of KPIs: research related to this particular issue is still on-going. We though reached some milestones:
   a. Definition of most relevant performance indicators groups\(^3\).
   b. Definition of a list of ~20 extended enterprise KPIs linked to the extended enterprise process model\(^3\).
   c. Selection of an additional list of ~100 indicators for local node performance analysis\(^3\) and development of a selection support tool.

3. An electronic KPIs dashboard: research related to this tool is still on-going as for the programming. Up-to-date we have developed an electronic first version prototype.

In this paper we will focus on considerations related to the KPIs -their selection, use and display-.

SELECTION OF RELEVANT KPIS FOR EXTENDED ENTERPRISE AND LOCAL NODE PERFORMANCE MANAGEMENT

Even though it is correct to consider the extended enterprise as one single unit, managing its performance needs to consider both single nodes and extended enterprise processes. This in turn means that the set of KPIs used to manage extended enterprise performance, may be composed of two different types: indicators appraised at the single nodes, and indicators appraised and analyzed at the extended enterprise level. The two sets are correlated in different ways: extended enterprise can be aggregated value of single node indicators, or, as well, they can be based on measurements done at different points of the extended enterprise process. The major issue to solve is therefore how to cope with this bias between extended enterprise and local node KPIs. The next paragraph describes the concept of extended enterprise balance scorecard, which tackles this very issue.

The extended enterprise balance scorecard

The development of an extended enterprise balance scorecard, which contains all relevant indicators and give them an extended enterprise perspective may be developed using the model shown in Fig. 1.

Fig. 1 -Extended enterprise balance scorecard - development model

Considering an extended enterprise, as shown in Fig. 1, one will notice that four different perspectives must be considered when selecting indicators to include in the extended enterprise balanced scorecard:

- Internal-perspective (X KPIs) – inside the four walls of the company.
- Supplier-perspective (S1 - Sn KPIs) – located at the interface of the company and its respective suppliers.
- Customer-perspective (C1 - Cn KPIs) – located at the interface of the company and its respective customers,
- Extended Enterprise-perspective (EE KPIs) – the holistic system.

The model shown in Fig. 1, where only one supplier, one manufacturer and one customer are included, must be replicated per each company in the extended enterprise. Each node must examine both their intra- and inter-organisational performance. In addition, each node is required to maintain their internal set of KPI as one perspective, while also up-keeping KPIs at the two surrounding interfaces - supplier and customer; finally the holistic approach is completely covered by asking each node to account for certain extended enterprise measures in the extended enterprise-perspective.
At this point, the selected indicators grouped together will form the final extended enterprise balanced scorecard, which will be used to manage the extended enterprise based on local as well as global performance. In other words, considering that the different perspectives cover the whole range of actors’ needs in the extended enterprise, it follows that the extended enterprise balance scorecard can be used for both local as well as global management.

Now that the extended enterprise balance scorecard concept has been illustrated, we will discuss how to filter the KPIs into suggested “scorecards” or “dashboards” for the different actors in the extended enterprise.

**Selection of KPIs for local node- and extended enterprise dashboard development.**

Considering both the definition of extended enterprise given at the beginning of this paper and the concept of the extended enterprise balance scorecard, it follows that at the local node level, only three perspectives of the extended enterprise balanced scorecard are of interest: the supplier-, internal-, and customer-perspective. The extended enterprise-perspective is dealt with at the higher extended enterprise level.

Before we discuss the selection framework, we need to introduce the concept of extended enterprise host. The extended enterprise host is the member of the extended enterprise with responsibilities for formulating, detailing and distributing information concerning the extended enterprise direction and requirements to the other nodes of the extended enterprise. Furthermore, the extended enterprise host controls the aggregated extended enterprise perspective, and issue audit requests to the other nodes. The recommended extended enterprise host is a first-tier supplier of the extended enterprise. The reasons for the nomination of a first-tier supplier over other parties (in particular the Original Equipment Manufacturer – the O.E.M.) are similar to those proposed by Gulledge (2002; 2003): O.E.Ms. have few incentives to broker transactions with their smaller supplier counterparts in the extended enterprise, and they have specific implementation conventions that they may pressure their suppliers to adapt to. In extended enterprise performance management this situation may lead to O.E.Ms. forcing particular KPIs upon their suppliers.

The requirements of the extended enterprise performance management concept hereby described are: the full participation from those parties that are interested, and a common electronic platform, as opposed to specific implementation conventions.

The separation of the supplier-, internal-, and customer-perspectives from the extended enterprise-perspective is essential. Allowing the local node to concentrate upon their inner processes and immediate linkages with their respective suppliers and customers, means that the extended enterprise-perspective becomes independent, and is thus treated equally with the other perspectives. The local node concentrates upon those perspectives that it sees as being of immediate importance to its development, while leaving to the specialist extended enterprise host the issue of determining the extended enterprise KPIs. Entrusting the extended enterprise-perspective to the local nodes risks downgrading its importance; the local node is unlikely to be in a good “position” (extended enterprise-wise) to develop such perspective sufficiently.
The previous considerations have led to the development of two frameworks for the selection of KPIs to display in the dashboard:

- Local node framework (concerned with the supplier-, internal-, and customer-perspective);
- EE node framework (as implemented by the EE host) (concerned with the EE-perspective).

**Local node framework**

The performance indicators selection framework for the local node level is a sequence of the following steps:

- Define the company’s mission and strategy: important to allow effective translation of the resulting strategy into effective KPIs.
- Determine the importance of the competitive priorities\(^4\) for each perspective: this must be assessed according to the company’s strategy derived in the previous stage. This step is crucial for determining the relevant KPIs.
- Derive critical success factors and customer requirements from the company’s strategy: using competitive priorities strategy, statements are translated and developed.
- Select measures: At the end of this stage a list of KPIs for the internal-, supplier- and customer-perspective should have been specified under the various competitive priorities.
- Implementation of KPIs: A performance measure record sheet is produced to standardise the process of actually recording used KPIs in the company.
- Periodic Review.

**EE node framework**

The extended enterprise performance measurement selection framework at the extended enterprise level is similar to the previous one:

- Develop the extended enterprise direction and requirements plan: the extended enterprise host should develop the plan through an examination of the four factors of Waggoner et al. (1999): the internal, external, process and transformational factors.
- Translate the plan into KPIs: performed in a similar fashion to the second step previously discussed.
- Select measures using extended enterprise KPI template list: at the end of this section a list of KPIs for the extended enterprise perspective is specified under the various macro measures of performance.
- Transmit the developed extended enterprise KPIs: the extended enterprise host must transmit the KPIs to those parties that require them.
- Periodic Review

At this phase of implementation of the extended enterprise performance management concept, each actor in the chain should have a balance scorecard available, and, at the same time, the overall extended enterprise balance scorecard should be available as well.

Measures alone are though not useful. They must be appraised and analyzed periodically in order to control extended enterprise operations and to support strategy refinements. An important role in this regards is played by information and communication technology, which

\(^4\) Cost, time, quality, flexibility, precision, innovation, and environment
makes it possible for globally distributed extended enterprise to maintain and visualise real time measurements of the KPIs at different stages and in different views. In the following paragraph we describe a first version of an ICT supported KPI dashboard we are developing for supporting extended enterprise operation control based on performance monitoring and analysis.

**MONITORING SUPPLY CHAIN OPERATIONS USING A PERFORMANCE DASHBOARD.**

In the extended enterprise performance management concept, KPIs are used:

- To monitor performance
- To evaluate and analyze performance
- To monitor the status of the flows and processes in the logistics value chain
- As a decision support for controlling the flow of goods and information in the value chain (supply chain control)
- To identify problems and focus effort in improvement projects.

That is, indicators show past, present and expected future performance levels, being therefore used to monitor, evaluate and analyze the material- and information-flow performance (Busi et al., 2003).

Considering the value of time savings in today’s global competition, it is clear that real-time measurement of important indicators in the extended enterprise becomes utterly important. Hence, the extended enterprise performance management concept requires an automated measurement and analysis system: thanks to existing ICTs, an electronic performance dashboard would enable the users to easily access real-time measurement, ensuring efficient extended enterprise operation control.

Features of the ICT supported dashboard are:

1. Electronic and integrated measurement of KPIs along the whole extended enterprise: collecting information from the ERP-system, the data collection system, the communication system (EDI), etc., KPIs value is shown as measured on-demand and therefore real-time.

2. Display of the KPIs as “linked” to the extended enterprise process model: KPIs must be easy-to-find at different location on the process model, hence attaching the KPIs as relevant data to the flow of information and material in the extended enterprise

3. Display of the KPIs values and trends in a user-friendly fashion: information built-in the KPIs and useful for performance analysis must be shown using different display technique, both graphical and text-based. This has a two fold objective: first, it allows the performance analyst to get a quick but precise snapshot of the extended enterprise performance at the instant he needs it; second, it support learning and training of non-expert users in need of using extended enterprise performance related information for any particular reason.
4. Display of the shared local KPIs and the extended enterprise KPIs as “linked” to the extended enterprise operations model\(^5\): it gives the user to rapidly assess performance at any virtual location in the chain, pinpointing for example weak links in the extended enterprise.

At this stage of our work, we developed a very first draft of a KPIs dashboard together with a case company that is moving towards integration with its partners to become an integrated extended enterprise. In this case, the status of development of the tool, referring to the list of features discussed above is as follows:

1. Electronic and integrated measurement of KPIs along the whole extended enterprise: the dashboard gathers the needed measures (i.e. data) automatically from the different management system already in use. It therefore must be seen as a system above the typical for example ERP systems; like an integration platform common to all extended enterprise actors. The data gathering is based on accessing the different management system databases of information and extracts only the data of interest.

2. Display of the KPIs as “linked” to the extended enterprise process model: after having implemented the extended enterprise performance management concept, a list of about 20 KPIs plus an additional ~100 (for local node dashboard), have been defined. At this stage the graphical representation of the link between indicators and process model is still missing; though, formulas of indicators use existing measures located at specific and unique position in the process model.

3. Display of the KPIs values and trends in a user-friendly fashion: different possibilities have been analyzed so far and several proposals are under study. Fig. 2 shows one possible way of graphically displaying the KPIs values and trends in the dashboard. While Fig. 4 shows a text-based representation of the list of KPIs in the dashboard.

4. Display of the shared local KPIs and the extended enterprise KPIs as “linked” to the extended enterprise operations model: selecting an actor from the extended enterprise operation model is now possible to access the relevant KPIs he’s for the moment willing to share. The access page, which is an electronic version of the extended enterprise operation model is shown in Fig. 3.

g. 2 - The KPI dashboard should enable the performance analyzer to quickly see performance.

Fig. 3 - Electronic extended enterprise operations model. It can be used for performance monitoring.
CONCLUSION

In this paper we discussed the extended enterprise performance management concept. We focused mainly on the importance of selecting relevant indicators, and we proposed a model for extended enterprise balance scorecard development. In addition we discussed the features that a KPIs dashboard should have in order to support extended enterprise operations control and we finally presented an ICT supported performance dashboard that we are developing in a case company.

With this paper we aim to contribute to the scientific literature with the extended enterprise performance management concept we have discussed; and to the industrial world with the electronic performance dashboard we have presented.

REFERENCES


