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A performance measurement system for managing mass production and mass customisation contexts

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1. Introduction

In supply chain/networks (SC/N) operating under a mass customisation (MC) strategy, i.e. producing customised products at a price close to that of mass production (Pine, 1993), real-time and cooperativeness receive special emphasis in order to improve customer responsiveness (Kumaz et al. (2005)). The main difference between MC and Mass Production (MP) lies in their logic of operating. For MP, lower prices lead to greater sales; greater sales in higher volumes, higher volumes in lower costs, and lower cost translate into lower prices. Nevertheless, in MC, customisation leads to more satisfied customers and innovation, which both lead to greater sales and higher profits and understanding of customer needs. Thus, MP is efficiency-driven and based in economies of scale while MC is customer-driven and based on offering higher variety of products at affordable prices.

This difference of logic is reflected in the processes involved in each approach. Even though both approaches, MC and MP, rely on the same processes i.e. collaborative order management, collaborative planning and scheduling processes in a SC/N context, the degree of interaction among all three processes depend on the strategy followed (MP or MC) as MC demands that all three processes react and adapt when an new customer order is received. Therefore, as both strategies differ considerably in the way they are implemented, the performance measurement systems (PMS) developed for MP need to be adapted to be used for MC. In fact, this situation is even more complex in the case where the same SC/N operates at both strategies, MP and PC, at the same time for different products. For example, in the current business environment, some enterprises usually operating under a MP approach are deciding to assign part of the available capacity of standard products (MP) to configurable products (MC). Then, PMS should evolve and integrate both approaches together in order to reflect the real situation of the SC/N. In order to deal with the management of both types of products under the same PMS, it is necessary to develop a structure that considers both situations and follows a process-based approximation to manage the processes involved.

The literature shows that there are some PMS developed under a process-based approach. However, these PMS do not present the necessary characteristics to manage processes in a consistent way for these contexts. In order to do it, several characteristics are to be accomplished by PMS. First, it is necessary to measure the performance of these business processes from a global perspective (inter-enterprise or SC/N level) and individual

perspective (intra-enterprise level). Second, PMS should measure the performance of the activities involved within each inter-organisational process (which implies that the PMS follows a process-decomposition approach) so that performance can be monitored following a top-down deployment path until reaching the activity/ies that excel or present any shortcoming. Third, PMS should integrate under the same structure the management of both approaches: MP and MC.

The purpose of this paper is to introduce a PMS for both contexts, called Mass Production/Mass Customisation-Performance Measurement System (MP/MC-PMS) that fills this research gap by including all three characteristics within its structure in order to provide a tool for managing the performance of MP and MP contexts more efficiently and effectively.

The structure of this paper is as follows. First, a literature review of PMS for inter-organisational contexts following a process-based approximation is presented. Then, the MP/MC-PMS framework is described as well as their application in a supply chain belonging to the tile industry. Finally, conclusions are exposed.

2. Background

The amount of PMSs for inter-organisational contexts following a process-based approach is not vast in the literature, although there has been an increasing interest during the last years. Brewer and Speh (2000) present an adaptation of the Balance Scorecard (BSC) (Kaplan and Norton, 1992), initially developed for individual enterprises, for measuring SC performance. The BSC considers four perspectives in order to measure performance: customer, financial, internal business process, and innovation and learning. The work exposes the need to link the individual enterprise BSC to the SC BSC. However, the BSC does not include process decomposition into activities that would give a deeper characterisation of the processes to be measured either they consider MP/MC structures to manage both approaches separately.

Gunasekaran *et al.* (2001) develop a framework of metrics for SC performance evaluation. The framework associates metrics to measure the basic SC processes (plan, source, make/assemble and deliver). However, it is not detailed the connection between intra and inter-organisational levels or the MP/MC structures.

Bhagwat and Sharma (2007) present a BSC for supply chains that categorises the SC metrics framework by Gunasekaran *et al.* (2001) within the four perspectives (financial, customer, internal business, and innovation and learning). Howver, their work presents the same limitations as Gunasekaran et al. (2001).

Bullinger *et al.* (2002) expose an integrated measurement methodology for supply network logistics process performance that integrates SCOR (Supply Chain Operations Reference) metrics (SCC, 2001) into the supply network (SN) BSC (Kaplan and Norton, 1992). The aim of the network scorecard is to monitor logistics business objectives by measuring management performance. The SCOR metrics aims at measuring material and product flow performance. The methodology considers that three levels: function unit, process and supply chain/network. However, the way to integrate both structures BCS-SCOR is not detailed or how they can manage MP/MC jointly.

Chan and Qi (2003) develop a process-based approach for measuring SC performance. The approach starts by considering the SC strategy in order to define the SC core processes. The SC core processes are decomposed into sub-processes and then, sub-processes are decomposed further into activities. Theeranuphattana and Tang (2008) present a SC PMS by combining the work by Chan and Qi (2003) and the SCOR process approach and metrics

(SCC, 2006). However, their PMS do not consider integrating two strategies such as MP and MC.

Bititci et al. (2005) expose a PMS that is composed of three functional levels: extended enterprise, business unit and business process level. At the business process level, the performance of the different extended processes is measured. For each extended process, there are two types of scorecards: sub-process and extended business process scorecards. The sub-process scorecard is the one used for measuring the operational performance of the part of the extended process (or sub-process) under the responsibility of every enterprise. However, the PMS do not detail how to integrate two approaches such as MP and MC.

Other PMS that follow a process-based approach include Chalmeta and Grangel (2005), Angerhofer and Angelides (2006), Gaiardelli et al. (2007) and Chae (2009). In the same vein as the previous PMS, they do not consider in their structures integrating two strategies such as MP and MC.

Jufer et al. (2010) present a PMS developed for specific MC contexts called the Performance Factory. The PMS considers a process-based approach and a detailed methodology to define KPIs from strategy. However, the PMS only covers the intra-organisational level and do not considers the possibility of managing a mixed MP-MC situation.

As a conclusion, it can be stated that although some of the PMSs reviewed include some of the requirements needed to manage MP-MC contexts in their structure, there is a clear lack of a PMS that allows managing both MP and MC strategies simultaneously in an inter-organisational context under a solid performance structure. The PMS proposed on this paper aims to fill this research gap.

3. MP/PC-PMS

3.1 Description of MP/MC-PMS

From the literature review, it can be observed that there is a need of methods, systems and procedures that establish the steps to be followed to manage performance within inter-organisational contexts considering the MP and MC strategies and following an integrated approach. The MP/MC-PMS framework introduces these characteristics based on the PMS developed by Alfaro et al. (2007) which is founded on three phases: 1) definition of the strategic framework, 2) definition of the process framework and 3) monitoring. The characteristics of a PMS for collaborative environments are related to the requirements that should be covered by the PMS in order to be considered solid and integrated. This implies that the PMS should provide all the necessary functionalities to approach the context for which it was developed. Additionally, this PMS should support the decision-making process of the enterprises and entities that collaborate. For that reason, it is necessary that the PMS considers two levels: inter-organisational (SC/N) level and individual enterprise level. Both levels should be aligned in order to keep traceability among the performance elements that are to be defined.

At the individual enterprise level, MP/MC-PMS derivates from the vision and strategy and reflects the most important aspects of the business. If this concept is extended within the inter-organisational context, it can be said that it is a process of strategic planning for all the partners and implies a common understanding of their aims what facilitates the evaluation and degree of success reached in their objectives and strategies. Thus, MP/MC-PMS starts with a strategic approach for its adequate interpretation and application. Therefore, the starting point

of MP/MC-PMS is the definition of the strategic framework (phase 1) that will be developed for both strategies MP and MC.

Fig. 1.1 shows the composition of the MP/MC-PMS generic framework which distinguishes between two types of frameworks: strategic and process framework. In detail, the definition of the strategic framework needs to incorporate all the performance elements (philosophical planning (mission and vision), stakeholder requirements, objectives, strategies, critical success factors and key performance indicators (KPIs). All these elements at defined for the four performance perspectives of Kaplan and Norton (1992): financial, customer, process and learning & growth. These perspectives aid to structure performance measurement following relationships of cause-effect.

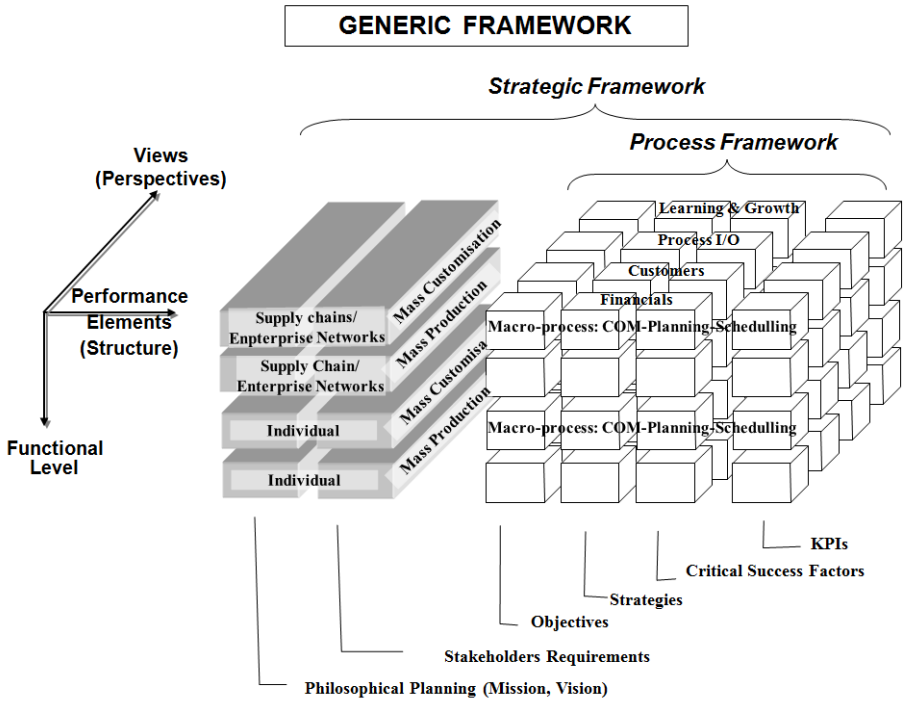

Fig. 1.1 MP/MC-PMS Framework

Once the strategic framework is obtained, performance elements of the process framework (objectives, strategies, critical success factors and KPIs) are defined for those key processes (phase 2). These key processes are processes directly linked to a common product/service produced by the partners or processes that support the success of the production of those products/services. When operating under both MP and MC approaches, it is necessary to stress the relationships among processes in both cases. On one side, MP activity will be managed through a set of performance elements associated to the strategic and process levels. The process level will specifically define performance measurement elements for each process (collaborative order management, planning and scheduling) independently as they interact but can be managed separately due to their lineal nature. On the other side, MC products follow a process more complex, called "macro-process", in which all three processes interact more dynamically. Thus, in this case, it is necessary to define performance measurement elements associated to the whole macro-process so that the whole collaborative order management-planning-scheduling macro-process can be monitored.

In the previous phases, all the performance elements have been defined. The last phase (phase 3) aims at monitoring of all those elements in order to know which the most important elements are in the long time.

3.2 Case study

A MP/MC-PMS has been developed for a supply chain belonging to the tile industry in Spain dedicated to the design, marketing, manufacturing and distribution of white clay-based and red clay-based ceramic flooring and coverings. This supply chain is composed of manufacturing enterprises, suppliers, logistic centers and end-customer selling points. Table 1.1 shows the process framework for the order management-planning-scheduling macro process at the supply chain level.

Table 1.1 Process framework for the order management-planning-scheduling macro process

Perspec.	Objectives	Strategies	KPI
Financial	FO1 Reduce stock costs	FS1 Reduce stock levels	KPI1 = variation of global costs
		FS2 Reduce set-up costs	KPI2 = variation of stock costs
	FO2 Reduce cost of production		KPI3 = variation of production costs
			KPI4= variation of stock levels
Customer	CO1 Improve customer satisfaction (%)	CS1 Improve re-planning process through efficient event management	KPI5 = satisfaction index
			KPI6 = customer claim
			KPI7 = satisfaction index variation
Process	PO1 Improve efficiency in production and inventory capacity	PS1 Implement a tool to monitor real capacity availability	KPI8 = production capacity efficiency
		PS2 Improve information flows among planning, order management, forecasting and scheduling	KPI9 = variation of production capacity efficiency
	PO2 Improve reactivity of planning-order management and scheduling		KPI10 = stockout number
			KPI11 = variation communications before launching production orders
Learning & Growth	LGO1 Introduce staff experience for system improvement	LGS1 Establish a feedback system to improve planning-order management-scheduling	KPI12 = employee suggestions number
			KPI13 = implemented suggestions
			KPI14 = feedback system (yes/no)
	LGO2 Improve knowledge on techniques for planning-order management-scheduling management	LGS2 Staff training	KPI15 = training hours per year
		LGS3 Establish collaboration with technological centers	KPI16 = collaboration agreements signed
			KPI17 = variation of mistakes performed in the process

4. Conclusions

This paper has reviewed the literature regarding inter-organisational process based PMSs in order to analyse if they can manage MP and MC approaches through a solid and integrated PMS structure. Based on the gaps coming from the literature reviewed, we have introduced a new PMS, called MP/MC-PMS, which includes performance elements within its structure for managing MP and MC more efficiently and effectively under a common PMS.

This framework considers two functional levels (inter-organisational and individual enterprise levels) but structured into two blocks in order to manage both MP and MC performance. In fact, there is a need to consider a specific block for each approach as the strategy of MP and MC differs as well as the interaction among the inter-organisational processes involved. In the MC case, it is developed a performance management macro-process that allows managing its performance integrating all three processes order management-planning and scheduling. In addition, we have described the elements that integrate the MP/MC-PMS framework so that enterprises that desire to implement both MP and MC approaches have a tool for aiding to define and collect performance management information. Further research involves validating the PMS developed through its application in other SC/N as well as the development of a web-based tool for implementing the PMS.

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