

# Advances in Manufacturing Technology XXVII

*Cranfield*  
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## Proceedings of the 11th International Conference on Manufacturing Research

Incorporating the 28th National Conference on  
Manufacturing Research

**Essam Shehab. Peter Ball. Benny Tjahjono**  
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## APPLYING PERFORMANCE MEASURES TO SUPPORT INFORMED DECISION MAKING AT AN OPERATIONAL LEVEL

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### ABSTRACT

Performance Measurement Systems (PMS) have commonly been applied to evaluate and reward performances at managerial levels, especially in the context of supply chain management. However, evidence suggests that the effective use of PMS can also positively influence the behaviour and improve performance at an operational level. The purpose of the study described in this paper is to develop a conceptual framework that adopts performance measures for *ex-ante* decision-making at an operational level within the supply chain. A case study at Coca-Cola Enterprises has been carried out and as a result, a conceptual framework of the PMS has been developed.

**Keywords:** Performance measures, Performance Measurement System, supply chain, decision-making, flexibility.

### 1 INTRODUCTION

Research in the field of Performance Measurement Systems (PMS) has drawn on a multitude of disciplines, from production and operations management to accounting and management control. Even though the use of PMS is common amongst managers for decision-making during the review periods and when defining and evaluating the success of strategic goals (Gomes et al., 2011), the equivalent cannot be said for the use of the same systems as *ex-ante*<sup>1</sup> support tools to drive performance (Grafton et al., 2010). Furthermore, although research suggests that PMS can positively influence individuals at an operational level, there is little evidence that it has been put in practice. As a consequence, individuals require the right information, at the right time, in the right format and at the right cost, and meeting these requirements remains a challenge (Schuff et al., 2010).

Performance measurement innovation benefits organisations through the delivery of strategically aligned metrics that facilitate decision-making. Providing decision support frameworks and tools that integrate multiple measures in the evaluation process may reinforce the importance of these measures and thus enhance their efficacy in relation to strategic goals (Franco-Santos, 2012). Recent research also suggests organisations have to be flexible so as to adapt to frequent changes in customer demand especially in fast moving industries (Poon et al., 2011). To do so, adjustments to production have to be considered within short time periods and as a consequence operational level employees are being empowered to make more decisions and take subsequent actions.

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<sup>1</sup> Ex-ante means that a decision results in an outcome, as opposed to making a decision based on the outcome of an action.

From the literature and observation it has been found that decision-making processes tend to either be based on expert knowledge and little accurate data, or alternatively made by IT systems (e.g. decision support systems), using complex algorithms that provide employees with the answers (Chapman and Kihn, 2009). The main limitation in the former is that individuals are not making informed decisions and in the latter, psychological empowerment is being confined, consequentially tending towards reduced motivation and capacity to solve problems.

Taking these factors into consideration, the purpose of the study in this paper is to increase supply chain flexibility by enabling individuals at an operational level to respond to variations in customer demand, whilst considering the overall impact on the supply chain. A framework has been co-developed with Coca-Cola Enterprises (CCE) enables the informed ex-ante decision-making, by utilising performance measurement as drivers in the decision-making process at an operational level within the supply chains. The framework was then validated at the CCE Sidcup manufacturing facility focusing on the Production Planning Department.

## **2 DATA COLLECTION AND ANALYSIS**

The wide variety and high capacity within CCE Sidcup made it an ideal location to carry out this study. Demand is customer driven, originating at the direct consumer or supermarket chains, which is communicated on a weekly basis to the manufacturing sites, by the head office. An evermore-fluctuating demand in products has resulted in a need to develop flexibility mechanisms (including lean tools), in order to rapidly respond and maintain a competitive edge. The data to develop the framework were therefore collected using a combination of interview, questionnaire and probing.

Interviews were conducted with five individuals with a combined experience of 107 years. These were middle and top level managers with expertise in various food industries, aerospace and information technologies. The semi-structured interviews and the use of mind-maps helped to identify the strengths of PMS and extract concrete examples of the issues faced in a supply chain to achieve greater flexibility and decision-making efficacy.

The interviews covered the details of the supply chain, perceived triggers, influencing factors, root causes, standard operating procedures (if applicable), the PM in place (if applicable), the importance and impact of decision making across the supply chain, and the relevance of developing a structured approach at an operational level. The findings obtained from these examples were then used in developing various models and the process framework, with direct applicability to the operational level of a fast moving consumer goods supply chain.

To further understand the degree of PM misalignment a questionnaire was developed and attempted by 30 individuals at all levels of the sponsoring company. The questionnaire was devised with the support of high-level managers to identify the key PM applicable to the CCE supply chain. A six point Likert scale was applied, whereby one is the most important and six the least. The questionnaire was completed by 30 employees at CCE Sidcup site, ranging from shop floor technicians and office workers, to middle and top managers. The reasoning behind the answers provided was captured and then manually recorded.

The results obtained from the data collected indicated that depending on the hierarchic level and role within the organisation, employees had different views as to the PM priorities and the general organisational alignment. Each of the six top and middle level indicated that the PM were all of high importance as they were all present in their pre-established yearly targets. Results also indicated that they perceived PM to be aligned throughout the site, which was further supported by their reasoning. In contrast, at a non-management level, from the 24 individuals in five different departments, the priorities of the PM varied depending on the department.

Following the interview and questionnaire, a detailed investigation was carried out at the Planning Department. Roles and responsibilities, information systems, activities and respective processes, and other resources available were all considered. This was achieved by following employees' actions, analysing existing company documentation, in addition to interviews and workshops. Once a general understanding of the Planning Department was reached, the decision-making process of a production change request was documented. Subsequently gaps in the process were identified, and a brainstorming session was then carried out to understand how to fill the gaps.

As there was no clear PM for the Planning Department, a set of inherent measures was recorded and, with the support of the current and previous managers responsible for the department, a selection of the most significant was obtained. This information, alongside the decision-making evidence, was used to add and extract details from the concept. It also formed the basis for the development of the tools which allow for prioritising and displaying data. The main gaps were found to be the lack of use of data and clear targets when making decisions. In addition, an established procedure for decision-making did not exist and this opened up an opportunity for the development of the concept.

### 3 FRAMEWORK DEVELOPMENT

The concept has been developed in several iterations with inputs from both theory and practice. It aims to close the existing gaps, through the use of PM, which should ultimately increase flexibility across the supply chain. In contrast with the existing performance measure systems, this concept takes the first step towards using PM as drivers. In addition, the concept integrates an illustration of how PM can be aligned throughout the supply chain, whilst incorporating the use of existing strategic level PMS. The business scorecard is given as an example.

The conceptual model has been developed with reference to a guiding equation below, in addition to strategic and tactical factors at CCE.



Figure 1: Graphic representation of the model equation

The model is strengthened with a process framework and set of tools that aim to provide a graphical representation of how flexibility at an operational level can be achieved in practice. Decision-making at an operational level is triggered by two main sources: manufacturing performance or customer driven. In both cases, the optimum decision is the one that creates the smallest impact, and highest throughput, to the supply chain. However, decisions are commonly made in an ad hoc manner, based on personal experience. The risk here is that individuals use emotion rather than information (Gunasekaran and Kobu, 2007). The use of PM in decision-making is therefore twofold. It drives the supply chain towards common accepted goals, and provides the data required to make informed decisions. As can be seen in the pyramid-like models (Figures 2 and 3), the concept proposes an organisational structure of a supply chain model and suggests how to align the PM in order to achieve common goals. The actual process of decision-making is illustrated in the form of a process framework (Figure 4).

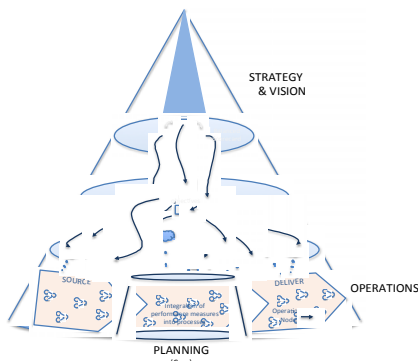


Figure 2: Adapted Model of the Supply chain

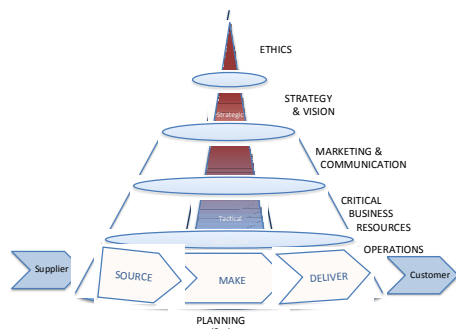


Figure 3: Illustration of organisational PM alignment

#### 4 TESTING AND VALIDATION

Testing the concept and its content demonstrated how the developed decision-making process and the supporting tools can be applied in a practical context. The examples all come from the Planning Department and the PM alignment is identical in all cases. The main scorecard objectives (strategic level) were linked to the related PM (operational level) as illustrated in Figure 3. Due to confidentiality, details have purposely been omitted. The PM were then integrated into the production change decision-making process and production change requests applied.

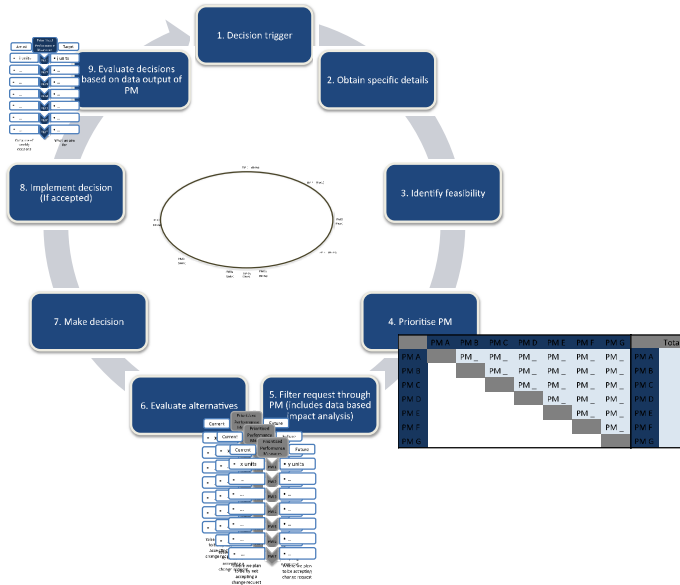


Figure 4: Decision making process and supporting tools

When analysing the three examples, the first brought to light is that the tool and the expert planners reached the same conclusion, however the tool provided an objective set of data to support the decision. In the second example, the decision-making process applied by the researcher allowed this analysis to be carried out, as opposed to ad-hoc reasoning. This enabled the identification of the simulated option with the least impact to the organisation. In the final example, the decision-making process framework was able to use the performance measure related quantitative data to conclude that the most beneficial decision for the organisation would have been to maintain the plan, rather than cut production. Therefore, by testing the tool, its power in providing data to make informed decisions has become evident.

The concept was validated in five iterations. Following each iteration, expert academics, after the first and fourth iteration, or industrialists, in the remaining iterations, validated it. The first validation was after the 'industry expert data collection', in the form of two semi-structured interviews. The second validation took place half way through the in-house case study, to verify the gaps identified in the ad-hoc decision-making process and corroborate the propositions that emerged from the thinking session. The following validation was after the specific PM for the Planning Department had been extracted and applied to the concept models and framework. A validation interview permitted the concept to be tested with examples from the Planning Department. The fourth validation semi-structured interview focused on approving the complete developed concept with academia, whilst the fifth validation was industrial based, taking the form of a questionnaire. The results were based on a 5-point Likert scale, ranging from 'strongly agree' to 'strongly disagree'.

## 5 DISCUSSION

It was a conscious choice to base the research project on a single case study. As the objective was to develop a solid concept, it was preferred to focus on one case only and to recommend that future research validate the concept in other areas of the fast moving consumer goods supply chain across different organisations. The in-depth, single case study allowed the complexities of decision-making and PMS in a highly-rated, market leading fast moving consumer goods supply chain to be understood. However, the limitation to this approach is that the concept needs to be further tested in similar environments.

Academic researchers and industry experts alike have established that organisational flexibility is paramount for organisations to maintain competitive in today's market (Tang and Tomlin, 2007). Researchers have suggested that in order to achieve organisational flexibility, PM need to incorporate flexibility measures (Beamon, 1999). However, this research suggests that rather than solely incorporating the flexibility measures, the use of PM as drivers to guide decision-making is what may lead to a more effective organisational flexibility. The guiding model developed in collaboration with CCE (Figure 1) is simple enough to be accessible to those who may require it, although at this stage it has not yet demonstrated qualitative results.

Following academic recommendations to develop an integrated PMS that supports an integrated supply chain (Gunasekaran and Kobu, 2007), a concept of a PMS that drives informed decision-making at an operational level has been created. This research project has considered what is known as one of the most significant paradigm shifts of modern business management; that individual organisations in a fast moving environment must do business as supply chains, so as to maintain competitiveness (Lambert and Cooper, 2000). It has also considered that the success of strategy fulfilment is highly dependent on the degree of alignment of PM, and that highlighting supply chain objectives and goals allows for associating targets at all levels (Akyuz and Erkan, 2010). This has often failed to occur in previous PMS (Holmberg, 2000). Furthermore, at the operational level the different sections of the supply chain perform different activities. Some activities involve decision-making in the process. It is at this level that the aligned PM should be integrated.

The analyses of the findings have led to inferences that have been incorporated into the framework. They include; within a fast moving consumer goods supply chain, flexibility involves producing according to customer demand, which encompasses being agile to short-term requests. This ultimately increases supply chain resilience (Tang and Tomlin, 2007). To accommodate short-term requests the supply chain has to be able to make decisions not only at a strategic level, but also at a tactical and operational level. At an operational level, the department that makes decisions with a significant level of impact to the CCE Sidcup site is the Production Planning Department. Short-term decision-making at an operational level implies making daily choices. Some are in-house driven, due to material availability and unplanned downtime; CCE Head Office, driven by customer demand, originates other requests. By proving that the process enables employees to make informed decisions, the acceptance of the change request can no longer be an ad hoc decision.

It is acknowledged that complex decision-making environments involve a greater degree of uncertainty (McDaniels, et al., 1999). However, it is fundamental that individuals have adequate information and expert knowledge, as well as the required materials, to make choices (Kiker et al., 2005). For a fast moving consumer goods industry, adequate information implies the data is accurate and as up-to-date as possible (ideally real time). Studies have also shown that too many restrictions in decision-making activities tend to have negative effects (Berglund and Karlton, 2007). Provided flexible information technology tools are available and there are processes in place at an operational level, it is possible to optimise the decision-making process.

The decision-making process has been developed taking the previous factors into consideration. Financial and non-financial performance measures appropriate for production planning at CCE Sidcup site were contemplated in the testing phase. The framework has been developed to allow these measures to vary across the site and between organisations. This allows for the concept to be agile as it can suit different areas of a supply chain. There is, however, a risk that the individual making the analyses of the PM priorities may not have the required skills. Thus, it is important to provide the necessary training and institute clear roles and responsibilities.

## 6 CONCLUSION

The concept proposed in this research project draws on the existing literature as well as the case study. It presents the resulting framework for decision-making at an operational level, which is intended to increase supply chain flexibility with regards to customer demand. The formation is put forward as a concept for making informed decisions in a timely and accurate manner, applying PMS an innovative way. It is expected that the concept provides a ground to build tools that practitioners can employ to gain a competitive advantage, by satisfying fluctuating customer demand whilst quantitatively considering the impact on the supply chain. The concept responds to several key issues in the current research in PM. Firstly, by commissioning organisational routines as one of its constructs, it provides a solid organisational foundation that are lacking in the PM literature. Furthermore, by contemplating an alignment of PM with organisational strategy, the concept is balanced in every direction, be it strategic determinants, tactic performance criteria or on a metrics level. The testing and validation of the concept has considered it useful and valid as a concept.

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