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Measuring Performance in Agri-food Supply Chains - A case Study of a Portuguese Company

Abstract

Organizations seek to create value, increase competitiveness, reduce costs, share information and strengthen relationships between the various actors in the chain. In this sense, it is of the utmost importance that tools be developed which define objectives, monitor processes and document the performance of the supply chains. The Performance Measurement Systems (PMS) have come about to aid decision support, bringing together relevant Key Performance Indicators (KPIs) which are fundamental for decision makers when deciding the best strategies for increasing supply chain competitiveness. In this study a PMS was developed collating a range of KPIs that seek to help in the continuous improvement of the agri-food supply chain. A case study allowed a PMS model to be designed incorporating the experiences of professionals in the area and subsequent tests to be made of its applicability, its outputs and its usefulness for decision support in a Portuguese plant.

Keywords

Supply chain management, performance measurement system, key process indicators, agrifood.

1. Introduction

The supply chain can be defined as a value system, made up of organizations that are connected together from the first stage of production up to the point of consumption, with the overriding objective of creating value along the chain (Porter, 1996). It represents a complex network of industrial plant and organizations with distinct, and often conflicting, objectives (Simchi-Levi et al., 2003). While there is no universally accepted definition of supply chain management, four elements exist that are common to the diverse definitions that can be found in the literature: a) it encompasses the whole supply chain, up to the final consumer, integrating and coordinating the diverse intra- and inter-organizational stages; b) it involves a number of different independent organizations; c) it includes a bi-directional flow of products (materials and services) and information; and d) it is designed to provide value-added to the consumers by appropriately employing organizational resources, creating a competitive advantage for the chain as a whole.

Supply chain management is a strategic management tool that seeks to raise the competitiveness and the profits of companies by increasing customer satisfaction levels (Christopher, 1992; Beamon, 1999). The competitiveness of companies and the economy means that all its agents must reach exacting levels of performance which are in-line with the expectations of the markets and their clients, existing as they do in the

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global economy. In this context, metrics and measures of performance become essential for managers in their decision making when it comes to logistics operations and continuous improvement of the service supplied to the customer along the length of the supply chain (Beamon, 1999;).

The creation of a Performance Management System (PMS) is primarily aimed at measuring the right things at the right time, in such a way that actions can be taken in a useful time frame. The metrics developed by the system should supply information to the various areas, always taking care to avoid duplication of information and to include the most relevant metrics. However, the performance metrics and measures should not just summarize mere performance measurement of the organizational processes. Producing good performance metrics and measures enables more open and transparent communication between workers, opening the way for continuous improvement in the global performance of the organization (Gunaskeran et al., 2007). To date there have been few works that have covered the agri-food supply chain. Notwithstanding the significant weight of the sector in the world economy, the analysis of a wide range of KPIs and of performance measurement models led to the design of a PMS tailored to the particular challenges faced by agri-industrial sector. With Aramyan's (2007) model serving as a basis, its application, using a case study of an industrial plant, showed both its usefulness and importance to the management's decision support process. This work has the potential to serve as a basis for other organizations that would like to test their performance, add value along the supply chain and increase their competitiveness in the face of competition.

Regarding the structure of this article, the literature review comes in the next chapter. Chapter 3 is a description of the methodology adopted. Then comes the case study of a Portuguese agri-food plant and finally, in Chapter 5, there are some conclusions and opportunities for future research.

2. Literature review

2.1. The agri-industrial supply chain

The agri-industrial supply chain is a chain producing, transforming and supplying agricultural and/or vegetable products at the same time as maintaining a flow of information between the various constituent members. This type of supply chain is notably different due to: a) the nature of the production, being based on biological processes, as such being more susceptible to variations and to risk; b) the nature of the products, with specific characteristics, for example being perishable; c) consumers' behaviours and attitudes in relation to food safety, environmental protection and animal welfare.

Generally speaking we can distinguish between two types of agri-industrial supply chain: a) supply chains for fresh produce, such as fresh vegetables, flowers and fruit; b) supply chain for processed products, such as tinned vegetables or deep frozen vegetables. The agri-food supply chain has many identifying features that distinguish it from other types of supply chain. Among those the following can be highlighted:

1. Seasonality of production;
2. Special conditions necessary for storage and transport;
3. The quantities processed and final product quality are dependent on biological variations, seasonality, weather conditions, pests and other biological maladies;
4. Governmental laws that cover environmental protection and food safety;
5. Product characteristics, such as flavour, odour, colour, size and appearance;
6. Value added to the products, as is the case for example with ready-to-eat food;
7. Product security: a growing concern by consumers with the means of production and processing of agricultural products;
8. The quality as perceived by the consumer: targeted marketing campaigns are able to emphasise the quality of the products.

Recent studies show that the agri-industrial supply chain is in constantly evolving (Van der Vorst, 2000; Fritz & Schiefer, 2008). One of the main changes is the adoption of new strategies by producers. Their viewpoint is no longer dominated by questions of production but has shifted to focus on the market, which has implied an increase in the information flows in the chain. Another change of note in the agri-food industry relates to innovation and the development of new products. All these changes are the result of consumer demand for quality and variety in the products. In contrast, there is a growing concern among consumers in relation to food safety and the conditions under which the products are processed. Many researchers have recognized the

relevance of supply chain management for agri-industrial businesses (Aramyan, 2007; Van der Vorst, 2000) noting the perishability of the products and the need for a rigorous quality control of the products as they are passed along the chain. This can become evident when products that were quality controlled at the start of the chain deteriorate due to the carelessness of a supply chain member down the line. This complexity pushed the agri-industry to create networks and new models of cooperation. Alliances were formed, vertical and horizontal cooperation proliferated, new members were added to the chain and innovation became one of the key factors driving competition. In this new world, organizations were obliged to develop and improve the quality of their products, logistics and information systems.

2.2. Performance measurement of the supply chain

For many years the performance evaluation of production systems was based on costs or on intrinsic quality characteristics related to the product, such as food safety or sensory properties (taste, colour, texture) (Van der Spiegal, 2004). However, quality is a multi-dimensional concept, made up of qualitative characteristics that are perceptible in an intrinsic and extrinsic form at the point of sale. This means that the decision to purchase a particular product is no longer uniquely defined by its intrinsic characteristics; extrinsic characteristics are also now recognized as playing an important role. The intrinsic characteristics are attributes related to the physical characteristics of the products (flavour, texture, appearance, nutritional value etc.). Quality is then derived from the transformation of physical properties into attributes of quality according to the perception of the consumer (Jongen, 2000). These characteristics define the state of the product, which is evaluated based on quality criteria imposed by either the producer or the customer (Sloof et al., 1996). When we refer to attributes of the production system we are referring to extrinsic quality characteristics, such as the quantity of pesticides used, the particular packing material or the application of biotechnology (Jongen, 2000). The extrinsic properties do not have a direct influence on the physical characteristics of the products but they influence the level of customer acceptance for the product. The two properties together determine the behaviour of the customers at the moment of purchase. In their study, Luning et al. (2002) divided the quality attributes into intrinsic (product) and extrinsic (process). Product quality took account of food safety, sensory properties and product shelf life, and the confidence and convenience of the product. Process quality covered the characteristics of the production system, environmental aspects and the marketing policies.

According to Rosneau et al. (1996), a Performance Measurement System (PMS) can be defined as a system that allows a company to monitor its most relevant performance indicators – related to its products, services and processes within a relevant time frame. The PMS should also be able to capture that which is essential to organizational performance and, at the same time, ensure that the metrics are being applied to the areas where their use is most appropriate. Another important factor is being able to guarantee that the organizational goals are aligned with the goals of the PMS, as such reflecting a balance between measures of a financial and non-financial nature, distributed in a clear way over the three levels of strategic, tactical and operational decision making (Thakkar et al., 2009). To be able to bolster the performance of the supply chain as a whole, it is necessary that the individual companies making up the chain look beyond their own frontiers and are able to analyse the supply chain in its totality. Only in this way is it possible to establish a cohesive PMS, capable of accounting for the most important aspects of the supply chain, and producing information which flows along the chain. This information system is a vital element for the performance of the PMS itself; it provides the basis for all the decisions taken with respect to the continuous improvement of the products and services supplied to the customer (Aramyan et al., 2007).

2.3. Performance measurement models

With the passage of time, PMS models have undergone changes. In the past their focus was placed on measuring costs in a short-term management perspective. Now, however, the PMS models envisage management policies for the medium- and long-term, centring on non-financial measures that make their contribution to value creation over the whole of the chain (De Toni & Tonchia, 2001; McCormack et al., 2008). In this way the companies became more aware of the fact that the value added is more than just cost reduction and profit enhancement. On the other hand, by moving the focus away from just financial indicators, companies also started to focus on the factors that drive them. In the processes they realised that these factors

are decisive for performance improvement. To develop new PMS models, adaptations were made of existing management tools such as the BSC – Balanced Scorecard (Baghwat & Sharma, 2007; Thakkar et al., 2009, Chia et al., 2009) or the SCOR model (McCormack et al., 2008; Thakkar et al., 2009). These new approaches brought new concepts and new metrics that enabled a new perspective on supply chain performance improvement, where the centre of management attention swung away from financial indicators with a short-term horizon. However, studies focusing on the agri-industrial supply chain are relatively scarce. An exception is the study of Aramyan et al. (2007), where the researchers designed a performance measurement system model focused on agri-industry [Figure 1]. The researchers divided the KPIs into four main dimensions (1) efficiency, (2) flexibility, (3) responsiveness, and (4) food quality..

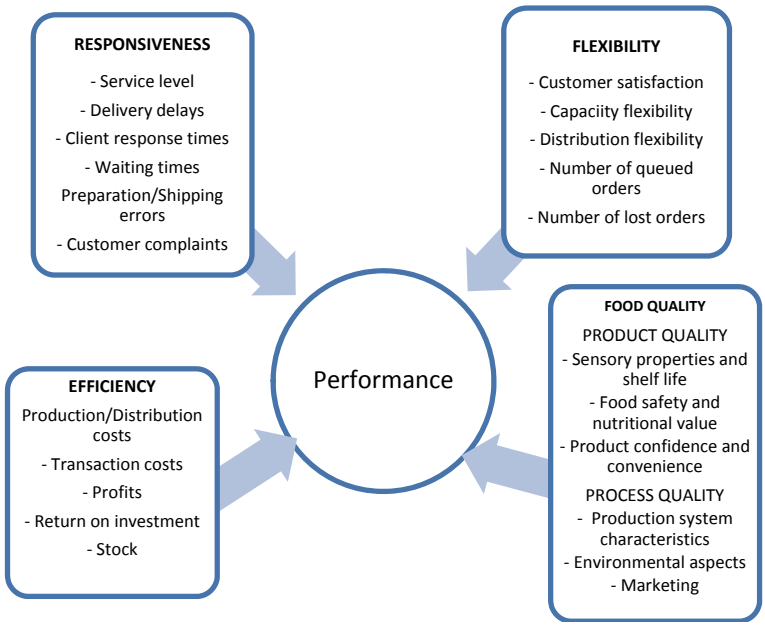

Figure 1: Aramyan's model (Source: Aramyan et al. ,2007)

3. Methodology

The current work is an exploratory study designed to understand and improve supply chain performance for the agri-food sector. A case study was used to make an in depth analysis of the different aspects of the supply chain in this sector, so as to be able to gain an empirically grounded understanding of the way it works. The case study helped illustrate and analyse the supply chain, feeding into the discussion and decision making process aimed at improving the company's results. This current work developed a lightweight PMS that brought together a number of KPIs considered to be fundamental for monitoring the agri-food supply chain. These KPIs were chosen to be able to easily adapt to constant changes in the supply chain, be able to cover the whole of the chain, from the suppliers to the customers, and provide reliable outputs for decision making. The first phase of this work consisted of an in-depth review of the literature, where the most important KPIs were identified providing a correct performance measurement for each of the stages of the agri-food supply chain. A second stage saw a working group brought together covering the whole of the supply chain and including those responsible for the agricultural, production, logistic, quality, financial and purchasing areas. The group held several sessions over three months, where each of the indicators was discussed and approved for consistency and real-world applicability to the agri-food industry. The results obtained used the model of Aramyan (2007) as a starting point, which was then adapted to the particular case study firm, augmented with the experience of a number of managers and finally approved by the company's top management. The third phase covered the practical application of the PMS proposed by the working group. Application of the model took place during the pea harvesting season, over a period of five weeks, where it was possible to test and showcase its applicability, its importance and its contribution to achieving improvements in the management, decision making and the

operational results of the company. The goal here was the construction of a self-contained and wide-ranging tool, able to respond to the major challenges faced by the sector.

4. Case study

The case study firm is in the business of processing and deep-freezing of vegetables, with an annual production volume of 25 thousand tonnes of finished product. It is a company with seasonal production, accompanying the agricultural production cycles and the resulting availability of raw materials coming from the land over the year. Agricultural technicians manage a total of 1500 hectares which are contracted out to 220 raw-material suppliers with processing occurring between the months of May and January.

Its production is mostly destined for export, given that only 15% of its output is consumed by the home market. For the home market the company supplies a range of 123 different product lines, to a total of 190 customers throughout the mainland and islands. Annually more than seven thousand orders are processed representing more than 10 thousand tonnes of frozen or canned products. Using the model of Aramyan (2007) as a basis, the group developed the following PMS:

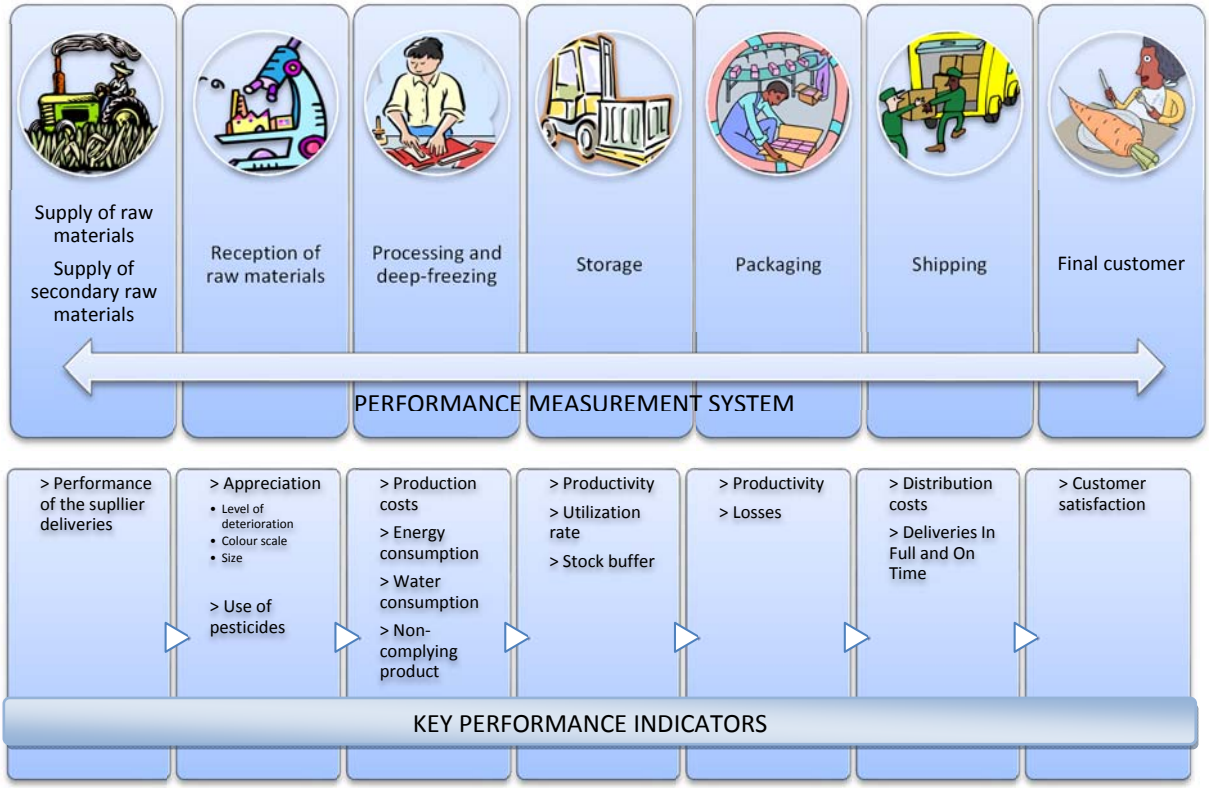

Figure 2. A Performance Measurement System for the agri-food industry

For each of the stages in the chain, a set of indicators were brought together that were considered essential for the correct performance measurement of the chain. All the KPIs were previously subject to a process of analysis and approval by each one of the areas of the company under study: agricultural, production, financial, purchasing, quality and logistics. In the third and last phase of this study, the application of the proposed model was tested in a business setting. The interest shown by all parts of the organization illustrated the degree of concern that organizations have for developing tools which allow them to measure and improve their processes, increase their efficiency, create value over the length of the chain and improve their competitive standing. This new tool makes its own contribution to the continuous improvement of the agri-food sector.

5. Conclusions and opportunities for future research

The main objective of this work was the design of a tool to measure the supply chain performance for the agri-food industry. Out of the various models which exist in the literature, the model of Aramyan et al. (2007) is the most appropriate for application to the sector as it brings together dimensions capable of characterizing any supply chain – efficiency, flexibility, responsiveness. A fourth dimension was added here, specific to the sector in question, that of food quality. In the PMS proposed, 24 indicators are brought together which are considered to be essential to the agri-food industry. Its practical application to a company within the sector allowed its importance to be confirmed and showed the contribution it can make to the performance of the agri-industrial supply chain. Measurement of the results over the whole supply chain of the company allowed various decisions to be made leading to the company attaining operational and financial gains. In comparison to the results obtained for the pea season the previous year, the main improvements can be found in a reduction in the consumption of electrical energy by 2.2%, natural gas by 1.3% and water by 4.4%. These savings were translated into a reduction in the total operating costs of 5.1% when compared to the season of the previous year. The positive results obtained reinforce the utility of this tool, which is under analysis for application in other industrial units of the group. In this way, the practical benefits of the proposed model have been attested. This work focused on the agri-industrial supply chain for processed vegetables, with a view to responding to the needs of the company under study. The application of the proposed PMS in only one company does prove to be a limitation of this study. The agri-food sector is a sector where the business structure is highly fragmented. It would be interesting to find out if this dispersion affects the day-to-day of the supply chains and the way in which it interferes in the construction of systems that monitor their performance. Comparisons can be made with other sectors of the economy where companies are more closely bound together.

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