The Development of a Supply Chain Measurement Framework for the Milk Products Industry

by

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Abstract

The purpose of the research program, documented herein, was to develop a generic supply chain management framework for the food industry. Ultimately, it is envisaged that industries could use the developed framework to identify the opportunities for improvement and then advance appropriate mechanisms for accomplishing them. As this research program has been in progress for more than one year, this paper contains the methods of generating a specific framework for a specific industry – in this case, the milk industry is the test case. The selection of a fundamental framework and related food standard was the first phase of framework development. Components were mapped from the food standards to the fundamental framework elements and the ramifications of this mapping were assessed. Once the mapping was completed, there were also suitable, related standards included in each process element of the developed framework. A test case representative from the industry was then interviewed to obtain an overview of the business process and product thread diagram. Those business processes of the case study were then compared with the fundamental framework. The final outcome of the industry specific framework will be to provide both managerial and operational assessment of the supply chain performance.

1. Introduction

This paper presents the research that is being undertaken at the Industrial Research Institute Swinburne (IRIS), Swinburne University of Technology, Australia. The research commenced in March 2001 and is expected to be completed in early 2003. The purpose of the research was to develop a supply chain management framework for a specific industry – in this instance, the dairy (milk products) industry was chosen as a test case.

This paper presents an overview of the research methodology, which illustrates how this research developed the initial framework for supply chain performance measures for the milk products industry. Subsequently, the structure of the modified framework is illustrated. Finally, the method of framework validation, pursued in this research, is presented using the milk products industry as a test case.

A basic priority for the milk products industry is to ensure that products distributed to customers, are safe and suitable for consumption. Milk-borne illnesses and injuries can be extremely serious, leading to fatalities and major litigation. However, there are also other consequences. Outbreaks of milk-borne illnesses can damage trade and also lead to major loss of earnings. Milk spoilage is also wasteful, costly and can adversely affect trade and consumer confidence (U.S. Department of Health and Human Services,1999).

The most significant operational factor in the milk industry is the nature of the milk product. The prominent features of the milk product are its short shelf life; its propensity to be a source of milk-borne diseases, and its need to be carefully stored in a proper condition. Since the nature of milk product is different from many other processed foods, it needs an efficient supply chain management operation to maintain the quality of the product before delivery to customers. An efficient supply chain management operation could provide for sanitary measures throughout the supply chain by evaluating the chain against related food and milk standard requirements. The monitoring of the chain would need to include the source of the raw milk, through production, handling, pasteurization, and the distribution process of the milk.

Milk product industries also need to keep their companies world competitive. Effective supply chain management could improve customer satisfaction (Adebunjos, 2000) as well as increase business efficiency (Hunt, 2001). However, Folkert (1998) proposed that food businesses had to redesign and reposition their activities to generate an effective supply chain. Likewise, the Supply Chain Council (2000) suggested that in order to achieve a competitive strategy, five performance attributes of the supply chain had to be assessed and improved. These were:

- Supply chain delivery reliability
- Responsiveness
- Flexibility
- Cost
- Asset management efficiency.

2. Industrial Implications

This research potentially had implications for the milk product industry, which needed to assess its supply chain performance in terms of management and operation. From a managerial aspect, this research provided quantitative measurements in the stipulation of performance metrics in each process element. On the other hand, the operational measurement took into account qualitative measurements. These took the form of assessing the availability of data and the conformity of related food and milk standards, in both input and output components, for each process element.

Consequently, the specific research outcome will be a supply chain performance measurement framework, specifically for the milk product industry. Companies participating in the framework validation process will receive feedback in return for

their input, after assessment. Companies will be able to assess their performance in terms of quantitative measures. The appropriateness of information flow along the supply chain will also be determined. Moreover, the results of the validation could highlight the impact of conformance requirements (to food and milk standards) upon other supply chain performance attributes. This information could provide basic improvement concepts to enhance the supply chain system for the milk product industry.

3. Framework Development

3.1 The selection of a fundamental supply chain performance measures model

In regard to fundamental framework selection, the major criteria for framework selecting were examined by Gunasekaran (2000), Beamon (1999), Singh (2001) and Merz (2001). These criteria included the scope of measurement and the reliability of the model. The initial model should be able to assess the whole supply chain system as well as achieving satisfaction from model users.

A number of different models could have been adopted. However, the so-called "Supply Chain Operation Reference" or "SCOR" model was acknowledged as an adopted elementary framework because of its well-documented attributes. In addition, this process reference model was also integrated with the well-known concepts of:

- Business Process Reengineering
- Benchmarking
- Best Practice.

Hence, from a range of frameworks, the SCOR model was viewed as a powerful tool to evaluate the performance of supply chain (Supply Chain Council, 2000)

The SCOR model provided the process elements to the model user. In order to utilise this model, a user had to select an appropriate business process to apply with their supply chain system. Each process element of the SCOR model also contained the available metrics which could be used to assess the performance of the supply chain in five performance attributes. These were:

- Reliability
- Responsiveness
- Flexibility
- Cost
- Asset.

The characteristic of process element of the SCOR model are shown in Figure 1.

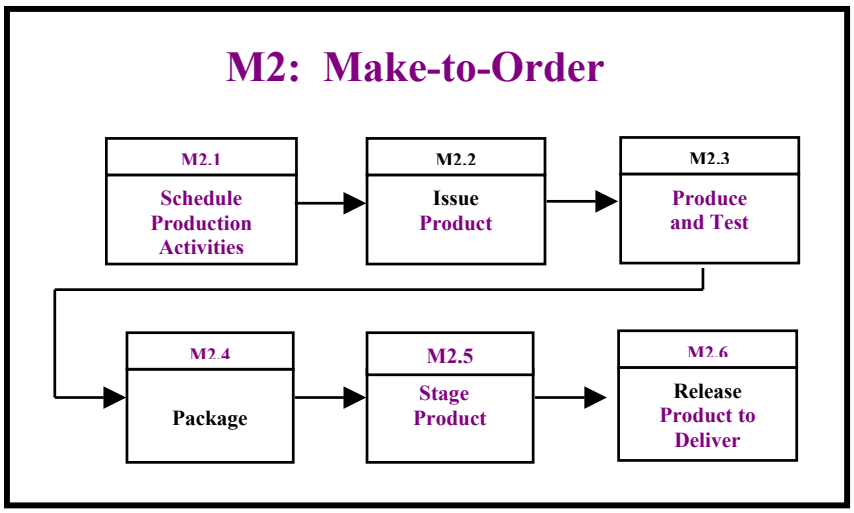

Figure 1- An Example of a Process Element of the SCOR model

3.2 The selection of typical food standards employed together with the fundamental model

At this stage of framework development, the wide range of specific standards for particular dairy products was examined. Consequently, the following standards were reviewed:

- The "CODEX Alimentarius Standard"
- The "grade "A" pasteurized milk ordinance"

The sanitary regulations for milk and milk products were selected according to the requirements of the sanitary and safety practices of the dairy industry.

The motivation in selecting the CODEX Alimentarius as a complementary standard to utilise in developing the initial framework was the ability to identify the essential principles of food hygiene applicable throughout the food chain. This standard follows the food chain from primary production to the final customer, setting out the necessary hygiene conditions for producing food, which is safe and suitable for human consumption. (Codex Alimentarius Commission, 1997)

Moreover, as the test case study of this research was, more specifically, the milk industry, it was necessary to select a suitable milk standard to support the applicable framework. The grade "A" pasteurized milk ordinance was utilised at this stage because of its complete fulfillment of dairy requirements. It provided the sanitary regulations for milk and milk products as well as the application of sanitation measures throughout the production, handling, pasteurization and distribution of milk. (U.S. Department of Health and Human Services,1999).

3.3 The combination of fundamental framework and standards - the ramification analysis

The definition of ramification analysis was identified in the research of Hunter (2001). This was defined as a method of determining both the likely outcomes from events occurring and the less likely – moreover, the very significant outcomes, from events occurring. Hunter(2000) applied this as a tool to provide the causal mapping method by analysing all possible pairing outcomes altogether with appropriate reasons for each mapping result.

The application of ramification analysis in a mapping method was more reliable than a general mapping because of its ability to illustrate all possible alternatives of mapping (Hunter, 2000). Moreover, all mapping results were divided in each category of relationship as major or minor concern. On the other hand, the end result of general mapping could provide only single decision of mapping, which had been done against selected criteria.

At this stage of framework development, ramification analysis was utilized to define the relationship between the Supply Chain Operational reference (SCOR) Model and "CODEX Alimentarius", together with "Grade "A" pasteurized milk ordinance". The result highlighted where the additional standard fitted with the fundamental model in its different aspects. Later, the combination of fundamental model and food safety and sanitary standard was presented.

3.4 The customization of the SCOR model

Although the SCOR model provided various performance metrics for supply chain evaluation, it did not indicate whether the metrics were suitable for all type of industry. In this research, SCOR model customisation was proposed in order to tailor the generic model to be practical for the milk products industry.

Initially, a thread diagram of a milk products business was investigated to evaluate the whole scope of the milk product supply chain. This was then compared against the existing SCOR model process elements. Corresponding process elements were chosen to regenerate milk industry process elements, which were based on SCOR model concept. Then, there was a selection of suitable performance metrics for each process element to adapt the existing metrics to suit with the character of milk product business.

Finally, the result of customisation was the establishment of process elements for the milk products industry. At the same time, each process element included suitable performance metrics to evaluate supply chain performance.

4. The Characteristics of the Modified Framework

The initial framework at this stage of research was divided into two main forms of assessment - management and operational. Management assessment was composed of quantitative measurements, which consisted of calculable metrics. This was also going to assess each process element in terms of reliability, responsiveness, flexibility, asset and cost.

The operational assessment was divided into two sets of evaluation. The first one assessed the availability of necessary inputs for each process element. The necessary input included the data and information related to operate each process element, as well as the sanitary requirements, which were achieved from the results of ramification analysis between process element and related food and milk standards. Meanwhile, the second set assessed the availability of output data and information from each process element. This output was significantly important in order to operate the subsequent process element. This operational assessment was considered as a qualitative measurement. The characteristic of the modified SCOR model are shown in Figure 2.

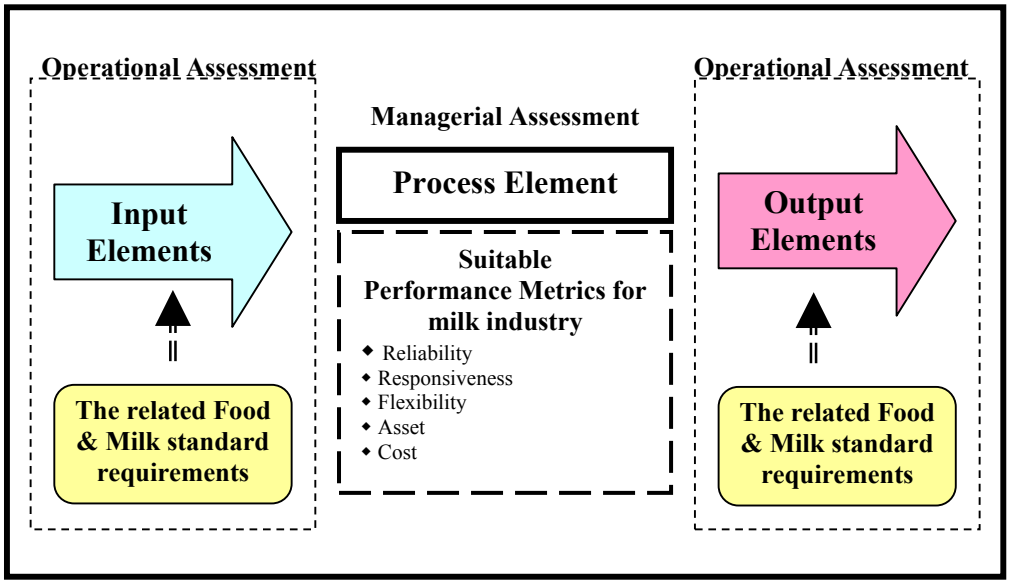

Figure 2 The characteristic of modified SCOR model

5. The Validation of the Modified Framework

Some experiments were conducted in order to evaluate the methodology. The experimental design for this research is outlined in the diagram shown in Figure 3.

The primary objective of the survey is to verify the applicability of proposed framework, which was derived from the model customisation procedure. The framework was developed from generic level to specific point of application.

The secondary objective is to assess the survey participants by using the proposed model. The measurement was established by three methods:

- Relevant performance metrics
- Necessary input
- Available output

in each process element. The results of measurement could possibly reflect the performance of participating industries in terms of the supply chain system. A conclusive recommendation is later given at the end of the assessment as a guide to how a company could improve its supply chain performance.

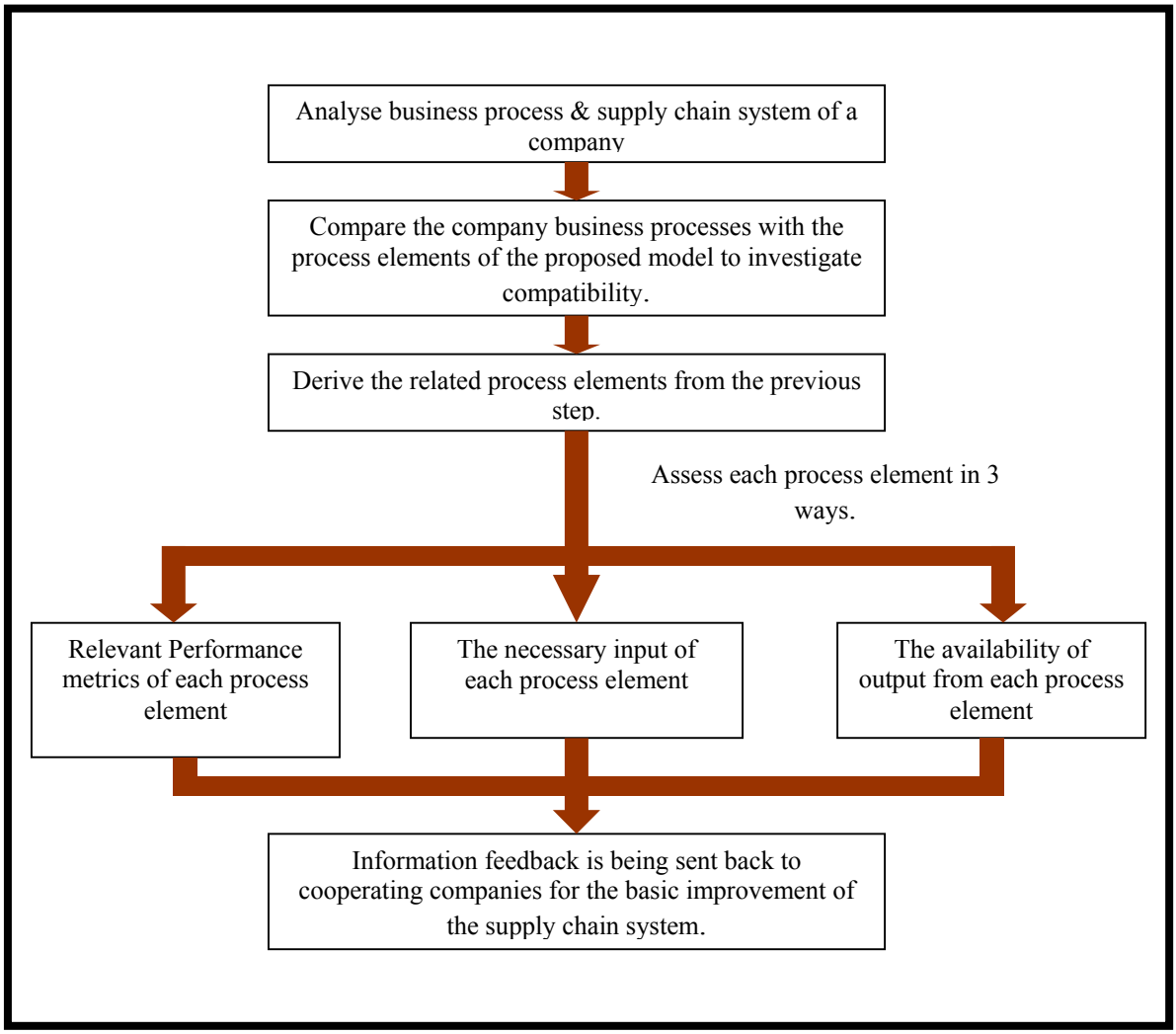

Figure 3 The flowchart of experiment, testing and verification of the model

6. Conclusions

At the time of writing this paper, the development of the initial framework had been completed. The next milestone was to validate this modified framework in order to investigate the feasibility of using this model to assess supply chain performance in managerial aspects as well as the safety and sanitary aspects of its operation. To complete this achievement, various milk industries were chosen as case studies, both in Australia and Thailand. The result of framework validation will then be compared and analyzed between two countries.

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