Benchmarking Agri-food Supply Chain Networks: A Conceptual Framework

Muhammad Moazzam, PhD Candidate, Institute of Food Nutrition and Human Health, Logistics and Supply Chain Management, Tennant Drive, Massey University, Palmerston North, 4474, New Zealand. Email: M.Moazzam@massey.ac.nz

Elena Garnevska, Lecturer, Institute of Food Nutrition and Human Health, Agribusiness, Tennant Drive, Massey University, Palmerston North, 4474, New Zealand. Email: E.V.Garnevska@massey.ac.nz

Norman E. Marr, Professor, Institute of Food Nutrition and Human Health, Logistics and Supply Chain Management, Tennant Drive, Massey University, Palmerston North, 4474, New Zealand. Email: N.E.Marr@massey.ac.nz

Abstract

Benchmarking has emerged as an effective tool for measuring and improving performance. Benchmarking of agri-food supply chain networks (SCNs) is complex due to their unique features including perishability and shelf life, seasonality of production, variability of quality and quantity, long production throughput time, and need of specialized transportation. This paper proposes to benchmark performance and best practices of milk SCNs in Pakistan and New Zealand. A conceptual framework based on Supply Chain Operations Reference (SCOR) model conforming to the specific needs of agri-food SCNs is proposed to measure performance and identify best practices. The framework integrates relevant food quality measures with the SCOR metrics. Moreover, the framework involves performing Gap Analysis to identify performance gaps between milk SCNs in Pakistan and New Zealand. The best practices leading to superior performance in milk SCN in New Zealand will be recommended for milk SCN in Pakistan with appropriate tailoring to the local situation.

Keywords: Benchmarking, agri-food supply chain network, performance measurement, best practices, SCOR model, and Gap Analysis.

Corresponding Authors’ Biography

Muhammad Moazzam is Pakistani born, and has lived and worked in Pakistan before coming to New Zealand in 2009. Muhammad completed his Master in Business Administration (MBA) with marketing and agribusiness specialization in 2006 from University of Agriculture, Faisalabad-Pakistan and joined the same university as lecturer in marketing and agribusiness in 2006. As a lecturer, Muhammad was involved in teaching, research, and as a member of the university’s administration team. In 2009, he qualified for Pakistan’s most privileged scholarship from Higher Education Commission (HEC) of Pakistan for MS leading to PhD at Massey University, New Zealand. Currently, Muhammad is a second year PhD student exploring best practices in agri-food supply chains to be helpful for the improvement of milk supply chain network in Pakistan. Muhammad’s research interests include supply chain management, agribusiness management, and benchmarking. He has published few papers/articles on agribusiness and supply chain management. He has also delivered a seminar at Massey University, New Zealand.
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1) Background

In globalised market place businesses are increasingly operating as part of collaborative networks, known as supply chains. Partners of a supply chain share information and skills to offer superior value to their customers. Now supply chains compete instead of individual businesses. In order to achieve comparative advantage and some time to surpass their competitors, organizations have always been exploring best practices leading to superior performance. Benchmarking is one of them and has emerged as the most effective tool for organizational improvement.

In recent years, international food markets have faced unusual price fluctuations (see Figure 1). These price fluctuations have seriously affected the world food security situation. In developing countries, like Pakistan, the number of people with inadequate food consumption (less than 2,100 kcal/capita/day) increased from 72 million (45% of the total population) in 2005-06 to 84 million (51%) in 2008 (FAO, 2008). Inherent issues of poor performing agriculture sector are the additional factors ever posing serious threat to the national food security situation.

![Figure 1: Evolution of FAO Food Price Indices](image)

2) What to benchmark?

Agriculture is an important sector in Pakistan economy, employing 45% of the total labour force and contributing 21% to the national GDP (Government of Pakistan, 2012). The agriculture sector is divided into major crops, minor crops, and livestock subsectors. The livestock subsector is the major contributor to the overall agriculture value added (55.1%) and counts 11.6 percent to national GDP (Government of Pakistan, 2012). The total milk production for the year 2011-12 was 47.95 million tons out of which only 38.69 million tons was available for human consumption and the remaining 9.26 million tons (19.3%) was lost either during transportation or calving (Government of Pakistan, 2012).
Pakistan is the fifth largest milk producing country of the world (FAO, 2012a), with dairy as one of the fastest growing industry. In spite of all this, Pakistan still imports infant milk powder of value 134.3 US$ million annually (Government of Pakistan, 2012). Various authors (Afzal, 2008; Tariq et al., 2008; Zia, 2009) highlight a number of issues in milk SCN in Pakistan responsible for the overall inefficiencies and poor performance. These are: traditional production and marketing channels, poor milk production practices, unorganized farming community, seasonal demand and supply patterns, lack of access to financial services, monopolistic and exploitative role of middlemen, poor infrastructure, price fixation and unsatisfactory role of government agencies. In order to identify the poor performing areas, to gauge the extent of poor performance, and to search out best practices helpful in improving the overall performance, a benchmarking study of milk supply chain network (SCN) in Pakistan dairy industry and milk SCN in New Zealand dairy industry is proposed.

New Zealand (NZ) is an open mixed economy with annual GDP 185 NZ$ billion and annual exports around $11 billion (Statistics NZ, 2011). NZ dairy industry is the country’s biggest export earner. NZ market consumes around 5% of production whereas the remaining 95% goes to over 150 countries of the world with key markets in China, US, Japan and the EU (Fonterra, 2010). With only around 2% of world production, NZ is the world’s largest exporter (almost one third of global market) of dairying ingredients (Fonterra, 2010).

The proposed study aims to identify the poor performing areas and to suggest appropriate measures to improve its performance. The milk SCN in NZ dairy industry is selected as a best-in-class benchmark for the research study. The objectives of the study are:

1. To investigate the milk SCNs in Pakistan and NZ dairy industries.
2. To measure and benchmark the performance of milk SCNs in Pakistan and NZ.
3. To identify the performance gap between both the milk SCNs.
4. To suggest measures to improve the performance of milk SCN in Pakistan.

3) Literature Review

Organizations benchmark for a variety of reasons including: for improving quality, performance, and customer service; for successful implementation of business process re-engineering, total quality management, and best practices; for identification of performance gaps and best practices; and for continuous improvement (Yasin, 2002). There is no one universal way to conduct benchmarking (Camp, 1989). Andersen et al (1999) interpret benchmarking process in four simple steps: measuring ones’ own and the benchmarking partners’ performance level; comparing performance levels, processes, and practices; learning from the benchmarking partners’ best practices; and improving ones’ own organization.

A number of benchmarking frameworks are available in the literature. To suggest an appropriate methodology to measure and benchmark the performance of agri-food SCNs, benchmarking frameworks are organized into business excellence models and benchmarking frameworks developed by academicians, practitioners, and managers. Renowned business excellence awards are given in table 1.

Table 1: Business Excellence Models

<table>
<thead>
<tr>
<th>Business Excellence Models</th>
<th>Administered By</th>
</tr>
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<tbody>
<tr>
<td>Global Benchmarking Network</td>
<td>Informationszentrum Benchmarking (IZB) Germany</td>
</tr>
<tr>
<td>Process Classification Framework</td>
<td>American Productivity and Quality Center, USA</td>
</tr>
<tr>
<td>Baldrige Criteria for Performance Excellence</td>
<td>National Institute of Standards and Technology,</td>
</tr>
</tbody>
</table>
Business excellence models are fundamentally diagnostic in nature and focus on identifying, developing, and promoting best practices leading to superior performance. The key performance indicators used by business excellence awards target performance excellence for individual firms and not for the networks of businesses such as supply chains which leads to the local optimization. The conflict of local versus global optimization provides the basis for performance measurement in supply chain management.

Zairi and Ahmed (1999) report that the literature on benchmarking has reached its maturity and criticize that most, if not all, of the benchmarking methodologies preach the same basic rules. The commonly used frameworks developed by academicians, practitioners, and individual organizations are presented in Table 2. Balanced scorecard and SCOR model are commonly used for PM in supply chains (Li et al., 2011; Tuominen et al., 2009).

### Table 2: Benchmarking Frameworks

<table>
<thead>
<tr>
<th>Benchmarking Frameworks</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xerox benchmarking methodology by Robert Camp</td>
<td>A ten-step process is organized into five phases: planning, analysis, integration, action, and maturity.</td>
</tr>
<tr>
<td>Balanced Scorecard by Kaplan and Norton</td>
<td>A PMS that complements financial indicators with PMs for customers, internal business processes, and innovation and improvement activities.</td>
</tr>
<tr>
<td>Spendolini’s five-step benchmarking process</td>
<td>These steps are: determine what to benchmark; form a benchmarking team; identify benchmark partner; collect and analyze benchmarking data; and take action.</td>
</tr>
<tr>
<td>Codling’s twelve-step benchmarking process</td>
<td>Twelve steps are categorized into four operational stages: planning, analysis, action, and review and recycle.</td>
</tr>
<tr>
<td>Business Performance Improvement Resource (BPIR)</td>
<td>The BPIR improvement cycle is a nine-step benchmarking process.</td>
</tr>
<tr>
<td>TRADE methodology by COER</td>
<td>Ten step TRADE methodology stands for: Terms of Reference, Research, Act, Deploy, and Evaluate.</td>
</tr>
<tr>
<td>Supply Chain Operations Reference (SCOR) model by Supply Chain Council (SCC)</td>
<td>A cross-industry reference model structured around five processes: Plan, Source, Make, Deliver, and Return and four levels of process details.</td>
</tr>
</tbody>
</table>

Sources: (Camp, 1989; Codling, 1992; COER, 2012; Kaplan & Norton, 1992; BPIR, 2012b; Spendolini, 1992; SCC, 2012)

The frameworks specifically designed to benchmark supply chains, in general, and agri-food supply chains, in particular, are very few. For example, Gilmour (1998) develops a framework to benchmark supply chain operations. The framework comprises of 11 capabilities (6 process, 2 information technology, and 3 organizational) to evaluate the characteristics of a supply chain. Prado (2001) benchmarks quality assurance system of Spanish companies from different sectors. Garcia et al. (2004) develop a three dimensional benchmarking framework to assess quality.
Performance gap in food standards of international supply chains. Tuominen et al. (2009) use supply chain balanced scorecard to benchmark Russian and Finnish food industry supply chains. Yakovleva et al. (2009) develop a framework for benchmarking sustainability of food supply chains in UK. A voluntary group in NZ dairy industry develops a benchmarking system for dairy farmers mainly focusing the KPI’s: cash (liquidity), profit, and wealth creation (Shadbolt, 2009).

Performance measurement is the key element in benchmarking process and the appropriateness of PMS used determines the overall effectiveness of benchmarking practice. To help selecting an appropriate PMS, the major issues in supply chain PM must be kept in mind. Those commonly discussed in the literature are:

- The use of too many matrices (Van Aken and Coleman, 2002).
- The use of only short term focused matrices (Van Aken and Coleman, 2002).
- Weak link between measures and strategy (Holmberg, 2000; Van Aken and Coleman, 2002).
- A heavy reliance on financial and cost metrics (Beamon, 1999; De Toni and Tonchia, 2001; Holmberg, 2000; Van Aken and Coleman, 2002).
- Lack of balanced approach (Beamon, 1999; Chan, 2003).
- A confusing multitude of isolated and incompatible measures (Holmberg, 2000; Van Aken and Coleman, 2002).
- Spanning single firm, not the entire supply chain (Beamon, 1999; Chan, 2003; Lambert and Pohlen, 2001).
- Insufficient focus on customers and competitors (Beamon, 1999).

The literature on supply chain performance measurement systems is too large and multi-dimensional to develop a clear understanding from all aspects. However, the categorization of performance measurement systems organized by Ramaa et al. (2009) is helpful. These categories are: function based measurement system (FBMS), dimension based measurement system (DBMS), supply chain operations reference model (SCOR), supply chain balanced scorecard (SCBS), hierarchical based measurement system (HBMS), interface based measurement system (IBMS), and perspective based measurement system (PBMS).

A. Function based measurement system (FBMS)

A FBMS is given by Christopher (1995) namely industry average cost model useful for measuring performance of the individual functions performed in an organization. According to Lapide (2000) the industry average cost model is diagnostic in nature and therefore is helpful in identifying problem areas. Furthermore in FBMS each function is evaluated in isolation from the supply chain which leads towards the local optimization at the cost of entire chains’ performance (Lapide, 2000). Ramaa et al (2009) add that the approach is easy to implement and is suitable when individual departments’ performance is needed to be optimized.

B. Dimension based measurement system (DBMS)

A substantial number of researchers view performance measurement from different dimensions (Aramyan et al., 2006; Beamon, 1999; Chan, 2003; Gunasekaran et al., 2001; Neely et al., 1995) as summarized in Appendix. The Appendix shows a trend that during 1990s’ mainly quantitative measures of performance were employed by the researchers to value their businesses whereas the use of qualitative measures in combination with quantitative measures predominant in subsequent years.
C. Supply chain operations reference (SCOR) model

The Supply Chain Council (SCC) of USA introduces its first Supply Chain Operations Reference (SCOR) in 1997 (Stewart, 1997). The model is structured around five processes: Plan, Source, Make, Deliver, and Return and four levels of process details (Supply Chain Council, 2012). Stewart (1997) view SCOR model as the first cross-industry reference model and recommends for operational improvement in an organization. The SCOR model provides strategic visibility to the performance of entire supply chain (Lapide, 2000). Simatupang and Sridharan (2004) view SCOR model to be the most suitable for benchmarking for its comprehensiveness and standard process and metrics definitions which enable companies to evaluate and improve performance at individual as well as entire supply chain levels. Aramyan et al (2006) admire the holistic nature of SCOR model.

A few weaknesses have also been identified in SCOR model. For example, one of the SCOR processes “Return” does not apply on services business (Ellram et al., 2004). According to Aramyan et al (2006) criticise SCOR model for insufficient focus on food quality measures (a distinguishing characteristic of agri-food SCs), sales and marketing, R & D, product development, and after-sale customer service. They go on to say that it assumes but not sufficiently addresses: quality, information technology, training, and administration. Furthermore, Burgess and Singh (2006) add that SCOR model does not address to the complex social and political factors which are integral part of certain supply chains.

D. Supply chain balanced scorecard (SCBS)

Kaplan and Norton (1992) devise balanced scorecard (BSC) to help managers from which to choose measures. Balanced scorecard complements traditional financial indicators with performance measures for customers, internal business processes, and innovation and improvement activities. Lapide (2000) acknowledges the idea of alignment of executive level measures with strategic objectives. Moreover, BSC allows companies to identify niche markets through external customer involvement in strategy development (Bourne et al., 2003). There are some limitations of BSC are also found. According to Neely et al (1995) BSC provides inadequate assistance for the process of designing a performance measurement system and competitive benchmarking. More importantly it does not provide a holistic view spanning entire supply chain rather it captures the performance of individual organization (Lambert and Pohlen, 2001). Moreover, BSC focuses only executive enterprise level (tactical and strategic level) measures and not the management level (operational level) measures (Aramyan et al., 2006; Lapide, 2000).

E. Hierarchical based measurement system (HBMS)

The HBMS is given by Gunasekaran et al (2001). The framework classifies the performance measures into hierarchical levels of management: strategic, tactical, and operational and dimensions as financial and non-financial so that a suitable costing method based on activity analysis can be applied. Furthermore, these metrics are aligned into four processes: plan, source, make, and deliver that mainly constitute a supply chain. Bhagwat and Sharma (Bhagwat and Sharma, 2007) believe that HBMS is helpful in selecting the appropriate metrics and costing methods at different levels in an organization.

F. Interface based measurement system (IBMS)

Lambert and Pohlen (2001) devise a framework to align the performance of each link within the supply chain. The link-by-link approach looks at the supply chain as a series of different interfaces and aims to optimise the performance at individual links level as well as the supply chain as a whole. The IBMS is appreciated by the research for a variety of reasons. The interfaces can be
used to demonstrate the outcome of supply chain collaboration (Pohlen, 2003). It focuses on managing customer relationships and supplier relationships at each link in the supply chain (Gaiardelli et al., 2007). Moreover, IBMS is helpful in assessing the benefits of the collaborative efforts in supply chain management (Mentzer et al., 2007).

G. Perspective based measurement system (PBMS)

Otto and Kotzab (2003) develop a framework to measure supply chain performance from all the six possible perspectives: system dynamics, operations research, logistics, marketing, organization, and strategy. The PBMS can be employed to identify problems, their possible solutions, and to optimize the trade-off of measures among the perspectives (Hofmann, 2006). However, the existence of different perspectives makes it difficult to identify the significance level of different areas of performance measurement in a supply chain (Papakiriakopoulos and Pramatari, 2010).

This review offers a critic of existing performance measurement and benchmarking frameworks. Having known the advantages and disadvantages of the PMSs, it is learned that the selection of an appropriate PMS is case-specific. Moreover, the purpose of research also affects the selection of a set performance measures. The above review suggests that the SCOR model is comparatively more holistic and comprehensive in measuring performance of complex supply chains. However, appropriate modifications conforming to the specific needs of agri-food supply chain is needed.

4) Methodology

The choice of right PMS for a supply chain very much depends upon the nature of problem(s) that the research team is going to address. The SCOR model suggested by the literature review is the framework that links performance metrics, supply chain processes, best practices, and people into a unified structure. The model is constructed on five supply chain processes: Plan, Source, Make, Deliver, and Return (see Figure 2).

![Figure 2: SCOR-Model’s Processes](source: SCC, 2012)

To measure performance of five supply chain processes the SCOR model identifies five supply chain performance attributes: reliability, responsiveness, agility, costs, and assets management (see Figure 3). Reliability, responsiveness, and agility are customer focused whereas cost and asset management are a supply chain’s internal focused performance attributes. To modify SCOR model conforming to performance measurement in agri-food supply chains, the relevant food quality attributes are added as level-3 metrics to the SCOR metrics.
Food quality

Food quality implies product quality and process quality (Aramyan et al., 2006). A number of food quality metrics are found in the literature, however, the most relevant ones are given in the Table 3. The selected metrics (given in table 3) are incorporated in the relevant performance attribute and at appropriate level of SCOR metrics.

Table 3: Proposed Performance Attributes for Food Quality

<table>
<thead>
<tr>
<th>FQ.1.1 Product Quality</th>
<th>FQ.1.2 Process Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>FQ.2.1 Sensory properties and shelf-life</td>
<td>FQ.2.2 Production system</td>
</tr>
<tr>
<td>FQ.2.3 Food safety</td>
<td>FQ.2.4 Product handling and transportation</td>
</tr>
<tr>
<td>FQ.2.5 Food nutrition</td>
<td>FQ.2.6 Environmental aspects</td>
</tr>
<tr>
<td>FQ.2.7 Packaging</td>
<td></td>
</tr>
</tbody>
</table>

Source: Adopted from (Aramyan et al., 2006; Hooker and Caswell, 1996).

5) Future Research

This paper introduced a research problem of low performing milk systems in Pakistan and reviewed the existing frameworks to measure and benchmark the performance in supply chain management, in general, and agri-food supply chains, in particular. The literature review probed into the pros and cons of existing frameworks and assessed their conformity to the proposed research problem. A conceptual framework based on Supply Chain Operations Reference (SCOR) model and conforming to the specific needs of agri-food supply chains has been proposed and needs to be tested empirically. The proposed model will be pilot tested with the participants in milk SCNs of Pakistan and New Zealand, before final data collection. The methods of personal interviews and postal survey will be employed to measure performance and identify the best practices leading to superior performance. Gap analysis will be performed to identify performance gaps between both the milk SCNs. Best Practices from the Benchmark milk SCN (New Zealand) will be recommended with sufficient tailoring to the local situation in Pakistan.
References


BPIR. (2012b) What is the BPIR?


FAO. (2012b) World Food Situation.


COER. (2012) TRADE Best Practice Benchmarking.


Appendix

Dimension Based Performance Measurement Frameworks

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Performance Measurement Framework/System</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neely et al. (1995)</td>
<td>Quality, time, flexibility, and cost.</td>
<td>QN, Q, F, C, T</td>
</tr>
<tr>
<td>Li and O’Brien (1999)</td>
<td>Profit, lead time, delivery flexibility, and waste elimination.</td>
<td>QN, F, T</td>
</tr>
<tr>
<td>Gunasekaran et al. (2001)</td>
<td>Strategic, tactical, and operational focus.</td>
<td>QN, QL, FN, NF</td>
</tr>
<tr>
<td>Author(s) and Year</td>
<td>Measurement Dimensions</td>
<td>Abbreviations</td>
</tr>
<tr>
<td>--------------------</td>
<td>------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Najmi and Kehoe (2001)</td>
<td>Quality, time, and financial.</td>
<td>QN, QL, Q, FN, T</td>
</tr>
<tr>
<td>Suhnag Li et al. (2005)</td>
<td>Strategic supplier partnership, Customer relationship, information sharing, information quality, internal lean practices, and postponement.</td>
<td>QN, QL, Q, C</td>
</tr>
<tr>
<td>Aramyan et al. (2006)</td>
<td>Efficiency, flexibility, responsiveness, and quality.</td>
<td>QN, F, R, Q</td>
</tr>
<tr>
<td>Li et al. (2011)</td>
<td>SCOR model: reliability, responsiveness, agility, cost, and asset.</td>
<td>QN, QL, R, A, C</td>
</tr>
</tbody>
</table>

NB: The abbreviations used for the measurement dimensions are: agility (A), quantitative (QN), qualitative (QL), quality (Q), cost (C), flexibility (F), responsiveness (R), financial (FN), non-financial (NF), time (T), and innovativeness (I).