Chapter - 8

DISCUSSIONS, CONCLUSIONS AND FUTURE DIRECTIONS

The discussions of the various results obtained and conclusions drawn from the various objectives of the thesis is briefly outlined in this chapter. The summary findings from the research study have been briefly deliberated upon. The empirical study with the framework and the series of models developed addresses the various aspects of performance measurement system of supply chain. The discussions and conclusions are covered separately under each of the chapter headings. This chapter also deals with the future directions of this research work.

8.1 Framework of supply chain performance measurement for Medium-sized industries

The results of the survey carried out in order to measure the performance of supply chain are discussed in detail. The average values of all the metrics obtained from the survey are shown in Figure 3.5 It can be seen from the Figure, that among all the measures, quality is given prime importance by medium-sized industries. The other important metrics are cost and delivery speed. As literature has stated medium-sized industries in India give importance to quality, cost and time as is proved from the study.

With respect to the supply link metrics, it is seen from the results that purchasing as a strategic activity and information sharing emerged as the most important measure pertaining to the evaluation of supplier performance. As information plays a crucial role for the success of any business, manufacturing industries are in line with it and hence it is given importance in this category.

As the survey was conducted the medium-sized firms, an opinion is drawn that the medium-sized firms are not in a position to extend beyond first tier suppliers. Firms would do well to not just use supplier metrics for selection of suppliers, but rather they should work closely with suppliers to see that they have in place within their organizations, measurement systems that will foster significant improvement in all of these areas. Such improvement contributes to the overall success of a supply chain.
Fig. 8.1: Average values of the metrics

With respect to production link metrics, production quality (6.76%) emerged as important, but along with it cost reduction (6.54%), team work (6.41%), production standardization (6.25%), flexibility (6.15%) and increase of capacity utilization (6.06%) are considered as important.

The latter two are essentially measures of the efficiency with which resources are used in manufacturing (produce/assemble), and good performance in these two areas translates into lower cost-per-unit to manufacture products/provide services. Efficiency of operations is important for all supply chain partners, if the elusive goal of supply chain optimization is to be achieved. The measures rated moderately are employee training, new product introduction, product development cycle time, cycle time reduction, process benchmarking, reduction of inventory, development of core competencies and R&D.

As noted in the literature, a broader range of products tends to result in fewer new products being introduced and a more narrow range is associated with greater product innovation. For this reason, the measure does seem worthy of the attention of managers, especially in making decisions about the breadth and depth of product lines. Product development cycle time relate to meeting customer needs and doing so in timely manner. Cross-functional teams, rapid prototyping, and concurrent
engineering involving suppliers would seem appropriate in efforts to improve product
development cycle time. Cycle time can be tackled by using techniques like single
minute exchange of die and group technology, whereby, similar facilities for
production will be grouped to reduce manufacturing lead-time.

The least important measure in the production link measures are use of SCM
application software, BPO, e-commerce and strategic IT Planning. Even though there
is a lot of advancement in Information Technology sector, its impact on medium-sized
manufacturing firms is comparatively less which can be seen from the survey.

In short, quality and efficiency seem to be more important considerations in
evaluating production performance.

With respect to customer service, the factors as delivery speed, customer service,
delivery performance to customer request date and are related to the satisfaction of the
customer. These are the most important measure in this category as seen by the
highest percentage importance. The moderately important factors are supply chain
cycle time, customer query time, brand image and third party logistics. In the survey,
companies were asked to express their views on reducing the cost of a delivery
system. Their responses tended to emphasize techniques like JIT and the application
of automation alternatives to reduce costs. Trade-offs between centralization of the
distribution system and decentralization of the system were mentioned as was third
party logistics.

The truck turn-around time and number of carriers per mode are the least important
measures as most of organizations have a feeling that the supply chain performance
cannot be optimized for their volume of production. Advertisements are also the least
important factors considered by the medium-sized industries.

From principal component analysis it was found that there are only 12 factors which
explain the characteristics of performance measures among Indian Manufacturing
firms. All the 38 metrics were grouped into 12 categories on the basis of factor
loadings and they were categorized as internal supply chain management, logistics,
customer relationship management, outsourcing, flexibility, competition, outsourcing,
information management, supplier management, supplier integration, supply chain
design and procurement.
Conclusion: This thesis has presented an empirical methodology to identify the underlying supply chain performance components and their respective measures with a special focus on medium-sized manufacturing enterprises of India. The literature was extensively reviewed, and interviews with experts, academics, practitioners and consultants were conducted. After filtering by experts, a list of 38 measures that represents the important items in relation to Supply Chain performance of medium-sized enterprises was identified. Data were collected from a sample of 255 practitioners working at medium-sized enterprises in India's manufacturing industry. As a result and in line with the literature, it is found that Indian manufacturing industries give prime importance to quality, cost and time as compared to other factors. Analysis was done using the principal component analysis method and twelve underlying components were identified including quality, cost, flexibility, and delivery and reliability. Based on the eigen values generated from factor analysis, the 38 measures were grouped under the twelve underlying performance components. Studying only medium-sized manufacturing enterprises in India can be a limitation of this study. Hence, generalization of the results to other industries or even other countries may be a challenge, and needs to be further investigated. However, the identified performance components and related measures can be considered as a reference for future research. They can be considered by academics and practitioners as an input for a supply chain performance measurement system.

8.2 Supply chain performance measurement using AHP methodology

AHP methodology is used to align the performance measurement metrics with the strategy. The priority of the supply chain under different scenarios is as shown in Figure 8.2. As the relative importance of the attributes change, the weights in turn change and the priority of the supply chain change as observed from the Figure. For instance, if the time related metrics are given more weightage compared to cost metrics, the model depicts the situation to be responsive. If the quality and cost metrics are given more weightage as compared to remaining other six metrics, the alternative is efficient supply chain. This model gives an idea for the decision maker to choose the metric in align with the strategy which is essential for any competitive strategy.
Fig. 8.2: Priority of the supply chain under different scenarios

**Conclusion:** To remain competitive, any company tries to build a strategy allowing remaining in the best conditions in front of present competitive strengths within its sector. Analytical Hierarchy Process methodology was used with the aim of to identify the importance factors for different supply chain strategies. This will ensure companies that their supply chain performance measurement is aligned with their supply chain strategies. A framework consisting of eight criteria and the performance metrics that contribute to these eight criteria which are vital for the success of any organisation is developed after thorough literature review. The model linked the determinants of the supply chain performance measurement system and the supply chain strategies available to the decision maker. Thus, an AHP approach proposed in this thesis can provide to the decision maker a more realistic and accurate representation of the problem for selection of supply chain strategy. The utility of the AHP methodology in integrating both quantitative as well as the qualitative characteristics, which need the attention of the decision maker in arriving at the best possible solution, assumes tremendous value.

The methodological approach of organizing all criteria and sub criteria into a chain of hierarchy in the proposed AHP model has an advantage as it provides a framework in which it is critical to seek input about the criteria and sub-criteria within the hierarchy from different levels of managers in the organization. The flexibility to industrial uniqueness and the high acceptability to business managers have been addressed as
other managerial implications from the proposed AHP model. The flexibility to industrial uniqueness comes from the fundamental nature of hierarchical structure. Different industries often evaluate their long-term overall performance from different perspectives. Each industry may need a unique priority consideration in their long-term overall performance evaluation process. The application of the AHP model will allow industrial managers to structure their "uniqueness" into the priority weights computation to reflect their desired unique priority considerations.

8.3 Simulation modelling of supply chain performance

The results indicated that the process optimization has taken place and the system performance is improved substantially. This is as a result of elimination of non value added activities which were present in each of the processes plan, make, source and delivery. As a result, manpower utilization is also higher along with the other resource utilization. Inventory levels also decreased as more efficient kanban is in place, and there is adequate information flow between the manufacturer and the supplier.

**Conclusion:** Simulation study was conducted with an objective of optimizing the existing systems and procedures in each stage of the supply chain by eliminating the non value adding and redundant activities, procedures and documents, thereby reducing the lead-time. The material and information flows of a quick response consumer electronics supply chain are modelled by taking the sequential flow of data and the times taken along the various stages of the supply chain using ARENA simulation software. The performance of the models as a whole and along each stage has been studied. The results depict that the time taken to process the orders in the actual scenario have been found to be almost similar to that of the results obtained in the simulation. The feasibility of the new system was tested. By method study and conducting brain storming, existing systems and procedures were altered. Re-testing the altered new system was done and results proved substantially.

8.4 Performance evaluation of order cycle software for a manufacturing industry

The software, which is user friendly, was tested with small scale industry for the functioning. It gave accurate results when verified with the manual method of calculation. It eradicates the difficulty and error liability associated with the manual
method of computation. The software allows for the drawing and visualization of product structure. With this software, local small scale manufacturing industries can achieve reduction in inventories, increase the number of variety of products they produce and also make and satisfy delivery commitments to their customers. Also, the suppliers of raw materials can be given order notices early enough for them to make up for the supply.

**Conclusion:** To be competitive and responsive organization should continuously improve their operations. An order fulfilment process functions is a critical determinant of how well you satisfy, and therefore retain, your customers. So the order fulfilment process plays a crucial role. With this view, software, which is user-friendly, and demonstrating the complete set of operation starting from the receipt of order to delivery of the product is developed. The software helps the small and medium-sized industry to improve their performance.

**8.5 Performance measurement of warehouse management system**

A Performance study is conducted to justify the reasons for implementing warehouse management systems. The warehouse is currently manually run and has a high cycle time of 773 minutes. With the company planning to add more stores and establish a centralized warehouse this process becomes inefficient. A framework with WMS, put-to-light and racking-stacking infrastructure was designed which showed a drastic reduction in the cycle time. The cycle time reduces to 236 minutes while the non value added time reduces from 537 minutes to 95 minutes. Also, there are many intangible benefits of implementing it which are showed in the Chapter 6. The cost benefit analysis for WMS implementation showed a savings of Rs. 19,60,000/-. The comparison between Manual and Automated WMS is shown in table 8.1
Table 8.1: Comparison of WMS v/s Non WMS

<table>
<thead>
<tr>
<th>PERFORMANCE METRICS</th>
<th>Warehouse Existing</th>
<th>Warehouse Proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Receiving</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appointment Scheduling</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Dock Scheduling</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Is it ASN enabled scheduling?</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>2. Put-away</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space Allocation</td>
<td>Random</td>
<td>Algorithm Based</td>
</tr>
<tr>
<td>If batch wise allocation, FEFO concept possible</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>3. Picking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pick Accuracy</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Picking Sequence</td>
<td>Random</td>
<td>Algorithm Based</td>
</tr>
<tr>
<td>Whether opportunity to cluster pick</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>4. Overall Time</td>
<td>773</td>
<td>236</td>
</tr>
<tr>
<td>5. Traceability</td>
<td>Poor</td>
<td>100 % Tracking</td>
</tr>
<tr>
<td>6. Capacity</td>
<td>6000/day</td>
<td>24000/ day</td>
</tr>
<tr>
<td>7. Manpower</td>
<td>97</td>
<td>57</td>
</tr>
</tbody>
</table>

**Conclusion:** With the boom in organised retailing in India, it becomes necessary for all the players to continuously improve their process. The retailers have to strive continuously to reduce their costs. Technology being an enabler, improved technology has to be incorporated into the current processes. Also the processes have to be designed in such a way that they provide for incorporating changes. The value stream mappings which had been constructed to show the current status of the warehouse systems showed many bottlenecks that prevail in the system. These bottlenecks restricted the capacity the warehouses could handle. Performance and productivity of the warehouse suffered as the operations were manually carried when it could be more easily and more effectively done using machines. The future state maps provided a framework for WMS implementation in warehouse. With WMS implementation the cycle time of the process decreases as in case study the cycle time reduced from 773 minutes to 236 minutes. The cost-benefit analysis for WMS implementation in the warehouse showed a savings of Rs. 19,60,000/- per month. The case study proved WMS to be an enabling factor for performance and productivity improvement. The productivity of a WMS warehouse is way higher than when the operations are manually performed.
8.6 Future Directions

While supply chain performance measures are studied in this thesis, more assessments seem to be necessary since this new topic is still under development.

- It will be useful to study performance measures in retail supply chains and draw a comparison.
- Furthermore, the methodology employed in this study can be expanded to identify the most critical performance measures in a SC by using system dynamics modelling and agent based modelling.
- Simulation models can be developed involving the financial measures which are not considered.
- Fuzzy set theory can be applied with combination of Analytical Hierarchy process to determine the performance of dynamic supply chains.
- Various scheduling approaches can be incorporated in the order cycle software to integrate all the production activities.