Chapter -1

INTRODUCTION

This chapter gives a brief outline of areas related to research, with a view to discuss state of the art of research topic. The motivation for conducting the research, problem definition and the objectives of the research has been dealt. Further the scope for the research work has been delineated. Finally the chapter concludes with the thesis organization.

1.1 Background of the study

Globalization has a tremendous impact on manufacturing, both at national and international level. Through broadening the marketplace and increasing competition, globalization has led customers to place greater demands on manufacturers to increase quality, serviceability and flexibility, while maintaining competitive costs [1]. So, firms are now aiming at securing cost, quality, technology and other competitive advantages as strategy to pursue in a global competitive environment.

Supply chain management is an important multi-disciplinary topic in modern business management and research. It enhances organizational productivity and profitability through a revolutionary philosophy of managing the business with sustained competitiveness [2]. Supply chain management has become increasingly important to businesses which supply goods and services to the end customers. The focus is on different stakeholder groups and their relationships, which is of great importance to all businesses, regardless of size or whether they supply products and services [3].

While it is not easy, the concept of supply chain performance measurement, as an approach to measure the performance of all activity in the chain, can help stimulate continuous improvements. This can be achieved by linking performance measures to specific improvement efforts. This helps to drive performance towards critical strategic objectives and improves the efficiency of all operations, from original suppliers through to the customers, with win-win strategies to create benefits and added value throughout the chain [4]. Performance measurement of supply chain management is a rapidly growing multi-criteria decision making problem owing to the large number of factors affecting decision making. Nevertheless, the right choice of
performance measurement factors is critical to the success and competitiveness of firms in the era of globalization [5].

1.2 Overview of Supply Chain Management

A typical supply chain commonly involves a network of tiered suppliers producing raw materials, parts, components, subassemblies, assemblies and final products together with business process and customers [6]. The supply chain includes all functions involved in receiving and filling a customer request. The supply chain encompass all activities associated with the flow and transformation of goods from the raw materials stage (extraction), through to end users, as well as the associated financial and information flows as shown in Figure 1.1

Fig. 1.1: Supply chain management

An effective supply chain may be defined as the art of bringing the right amount of the right product to the right place at the right time while minimizing related costs within and between all parties involved [7].

Manufacturing firms worldwide have embraced the concept of supply chain management as important and sometimes critical to their business [8]. Literatures
reveal that many multinational companies in India and worldwide have taken lead to develop and improve their supply chain architecture, resulting in marked improvements in their business performance. They have incorporated new innovative technology and new management practices to cope with ever increasing competition. The pressure is building up and the rest of the industries will need to catch up if they want to remain competitive.

1.2.1 Performance measurement of supply chain
Performance measurement can be used to determine the effectiveness of a supply chain. In recent years, organizational performance measurement framework and factors have received much attention from researchers and practitioners [2]. However, in supply chains with multiple suppliers, firms and customers, whether regionally or globally dispersed, performance measurement is challenging because it is difficult to attribute performance results to one particular entity within the chain. There are also difficulties in measuring performance within organizations and even more difficulties arise in inter-organizational performance measurement [9].

There have been relatively few attempts to systematically collate models for evaluating the performance measurement of supply chains [10]. Moreover, there is argument over the most appropriate way to categorize them. From the review of literature, the present supply chain performance measurement frameworks can be classified by the following three main models that are mentioned frequently by other scholars:

- Result-based (balanced scorecard) [11, 12, 13]
- Hierarchical (decision making levels) [2] and
- Process based (supply chain operations reference, SCOR model) frameworks (Supply Chain Council, 1996).

1.2.2 Modelling approaches
The analysis of various supply chain strategies and the implementation of the most effective strategy is dependent upon the model that represents the supply chain characteristics. The modelling approaches followed for representing the supply chain can be classified into five broad classes:
(i) Network design,
(ii) Mixed-Integer Programming optimization,
(iii) Stochastic programming,
(iv) Heuristic methods and
(v) Simulation based methods.

The objective for modelling and analyzing the supply chain may be to realize tangible goals such as, minimize total cost, boost output, lower per unit cost, reduce lead time, decrease the system dynamics, etc or intangible goals like synchronize the requirements of the customers with flow of materials from suppliers, increase customer service, build competitive advantage for the supply chain, etc. The research has developed Analytical hierarchy process model and simulation model.

1.2.2.1 Analytical Hierarchy Process

Analytical Hierarchy process (AHP) is one of the prominent multi-criteria decision-making techniques. AHP is a multi-attribute, decision-making approach based on the reasoning, knowledge, and experience of the experts in the field. AHP can act as a valuable aid for decision making involving both tangible as well as intangible attributes that are associated with the model under study. AHP relies on the process of eliciting managerial inputs, thus allowing for a structured communication among decision makers. Thus, it can act as a qualitative tool for strategic decision-making problems [17].

One of the main advantages of this method is the relative ease with which it handles multiple criteria. In addition to this, AHP is easier to understand and it can effectively handle both qualitative and quantitative data. The use of AHP does not involve cumbersome mathematics. AHP involves the principles of decomposition, pair wise comparisons, and priority vector generation and synthesis.

The following are the benefits of using AHP [18]:

- It formalizes and makes systematic what is largely a subjective decision process and there by facilitates "accurate" judgments;
- As a by-product of the method, management receives information about the evaluation of the cost drivers' and activities' implicit weights; and
• The use of computers makes it possible to conduct sensitivity analysis on the results.
• It results in better communication, leading to clearer understanding and consensus among decision makers groups, and hence a greater commitment to the chosen decision.

1.2.2.2 Simulation Modelling
Simulation provides a practical basis for representing complex interdependencies between organizations, and help realistically analyze the performance tradeoffs associated with different organizational decision-making assumptions. Supply chain simulation models can be used to improve supply chain decision-making. The relevant decisions can be classified into three categories: strategic, operating, and control [14]. Strategic decisions refer to decisions such as, selecting the location of a facility have long-term significance. Operating decisions refer to decisions about production to meet demand. These decisions are made on a weekly or monthly time frame. Control decisions are concerned with problems in execution. Simulation models can be used to evaluate policies (such as inventory management policies) or to predict the outcome of a specific alternative. Researchers have used simulation models to study different aspects of the supply chain such as, the instability of the chain, the performance effects of operational factors, re-engineering the supply chain, demand amplification effects etc [15, 16].

Simulation is the process of designing a model of a real system and conducting experiments with this model for the purpose of understanding the behavior of the system and /or evaluating various strategies for the operation of the system. Thus, it is critical that the model be designed in such a way that the model behavior mimics the response behaviour of the real system to events that take place over time. Simulation modelling is an experimental and applied methodology, which seeks to describe the behaviour of a system and use the model to predict future behavior, i.e. the effects that will be produced by changes in the system or in its method of operation.

1.2.3 Supply Chain Information Systems
The role of information systems in organizational performance is changed effectively, and nowadays information systems for organizations are creator of value. Information systems play the role of integration, coordination between different parts of the supply
chain and the performance of this system has a direct impact on the efficiency of supply chain performance. Literature states that the creation and deployment of information systems requires a variety of information technologies. Information technology can also support cooperation between companies and their internal operations in supply chain and effective use of technology, is a key factor in the success of the company. Major cause of uncertainty is, poor information flow, which can include inaccurate, being premature or incorrect information management. Information technology with ability of managing information flow affect on dimensions of supply chain, such as cost, quality, flexibility and timely delivery of goods and services and ultimately profit of organization. Systems supported by Information technology are applicable in major field of supply chain management products and services including design, production, marketing and sales, customer service and logistics. In planning production material requirement planning has tremendous impact on the supply chain.

1.2.3.1 Order fulfilment cycle

Order fulfilment cycle is the complete process from point of sales inquiry to delivery of a product to the customer. Sometimes Order fulfillment is used to describe the act of distribution or the logistics function, however, in the broader sense it refers to the way firms respond to customer orders. Firms that have a competitive advantage in order fulfillment have better internal information capabilities than those that do not. They use information systems that collect and make data available to all supply chain partners. Finally, they have a focus on customer service and are driven by what the customer says and does.

Organizations world-wide follow different order fulfillment strategies based on the P: D ratio, whereby P is defined as the production lead-time, i.e. how long it takes to manufacture a product, and D is the demand lead-time, i.e. how long customers are willing to wait for the order to be completed. These are:

- **Engineer-to-Order (ETO) - (D>>P)** Here, the product is designed and built to customer specifications.
- **Build-to-Order (BTO) or Make-to-Order (MTO) - (D>P)** Here, the product is based on a standard design, but component production and manufacture of
the final product is linked to the order placed by the final customer's specifications.

- **Assemble-to-Order (ATO)** - (D<P) Here, the product is built to customer specifications from a stock of existing components. This assumes a modular product architecture that allows for the final product to be configured in this way.

- **Make-to-Stock (MTS) or Build-to-Forecast (BTF)** - (D=0) Here, the product is built against a sales forecast, and sold to the customer from finished goods stock.

- **Digital Copy** - (D=0, P=0) Where products are digital assets and inventory is maintained with a single digital master. Copies are created on-demand, downloaded and saved on customers' storage devices.

### 1.2.3.2 Warehouse Management System

A warehouse is a facility in the supply chain to consolidate products to reduce transportation cost, achieve economies of scale in manufacturing or in purchasing [19] or provide value-added processes and shorten response time [20]. Warehousing has also been recognized as one of the main operations where companies can provide tailored services for their customers and gain competitive advantage. There are various types of warehouses: they can be classified into production warehouses and distribution centers [21] and by their roles in the supply chain they can be classified as raw materials warehouses, work-in-process warehouses, finished good warehouses, distribution warehouses, fulfillment warehouses, local warehouses direct to customer demand, and value-added service warehouses [22].

A warehouse management system or WMS primarily aims to control the movement and storage of materials within a warehouse and process the associated transactions, including shipping, receiving, put-away and picking. A warehouse management system (WMS) is a database-driven computer application, to improve the efficiency of the warehouse by directing cutaways and to maintain accurate inventory by recording warehouse transactions. The systems also direct and optimize stock based on real-time information about the status of bin utilization. It often utilizes Auto ID Data Capture (AIDC) technology, such as barcode scanners, mobile computers, wireless LANs (Local Area Network) and potentially Radio-frequency
identification (RFID) to efficiently monitor the flow of products. Once data has been collected, there is either batch synchronization with, or a real-time wireless transmission to a central database. The database can then provide useful reports about the status of goods in the warehouse.

The primary function of a warehouse control system is to receive information from the upper level host system, most often being the warehouse management system, and translate it for the daily operations. A common goal is to ensure a situation where warehouse employees never have to retype information because it already lies in one system or is collected automatically. Warehouse control system is usually the interface that is used to manage processes, people and equipment on the operational level.

1.3 Motivation

The performance measures and metrics play a crucial role in the success of an organization because they affect strategic, tactical and operational planning and control. Performance measurement and metrics have an important role to play in setting objectives, evaluating performance, and determining future courses of actions [2]. Harrington states that “If you cannot measure it, you cannot control it. If you cannot control it, you cannot manage it. If you cannot manage it, you cannot improve it”. In fact, the lack of relevant performance measures has been recognized as one of the major problems in process management and the management of supply chain [23]. The output of the processes enabled by the supply chain must be measured and compared with a set of standards. In order to be controlled, the process parameter values need to be kept within a set limit and remain relatively constant. This will allow comparison of planned and actual parameter values, and once done, the parameter values can be influenced through certain reactive measures in order to improve the performance or re-align the monitored value to the defined value [2]. Many companies have not succeeded in maximizing their supply chain’s potential because they have often failed to develop the performance measures and metrics needed to fully integrate their supply chain for maximizing effectiveness and efficiency. Thus, control of processes in a supply chain is crucial in improving performance and can be achieved through measurement.
1.4 Problem Definition

Business today requires better information across a wider scope than the traditional and often linear, financial measures, to achieve understanding of the factors that create the foundation of future success. The problem that the supply chains are facing is that, though individual stakeholders are maximizing their profits, lack of communication is leading to sub-optimization on the whole system. Stakeholders tend to make their operational plans in isolation without consulting other members of the supply chain. Thus, individual profits are earned at the cost of the overall supply chain profitability. The most beneficial aspect of performance measurement is identifying problem areas and focusing attention on actions that will have the best impact on overall business performance. Effective performance measurement is the tool that guides management in a direction that will produce meaningful results at the process level, which in turn tie directly to organizational goals. World-class manufacturers are continually tracking process performance factors that ultimately impact business success, such as order-to-delivery cycle time, throughput, inventory levels, operating expense and customer satisfaction.

Effective Supply Chain Performance Measurement is critical to the survival of organizations in the global competitiveness. The tracking of various processes through different metrics and controlling the processes, results in improving the competitiveness of the organization. To assess supply chain strategies and evaluate proposed changes that impact the entire enterprise, supply chain managers must be able to confidently predict the performance under various scenarios. This seemingly impossible task has spurred a search for better software methodologies to help decision makers, analyze the design and operation of the supply chain. A model gives planners a realistic view of what will happen in their supply chain under circumstances that do not currently exist, but might occur.

1.5 Objectives and scope of the research work

Most research on supply chain management concerns developed countries. Consequently, there is a lack of significant study of supply chain performance in developing countries, in general, and India, in particular. For both types of the countries, while there are studies of general supply chain management, there is scant
research on the performance measurement of supply chain management. In addition, supply chain management is growing in importance in a number of developing countries. Therefore, this thesis focuses on a supply chain performance measurement framework that applies to the manufacturing sector in a developing country context, specifically, India. This thesis aims to design and develop supply chain performance measurement framework. Use of modelling approaches such as simulation, analytical hierarchy process methodology, order cycle management and warehouse management system for measuring performance and aiding in decision making at various levels of supply chain macro processes enables the organisation to be competitive.

Five specific research objectives were used to attain the overall objective and are as stated below:

- To conduct an empirical study on supply chain performance measurement in medium-sized industries and develop a conceptual framework of supply chain performance measurement
- To develop a model for supply chain performance measurement using analytic hierarchy process methodology.
- To develop a model for measuring the performance of a consumer electronics supply chain using simulation.
- To identify the business performance parameters and to design and develop software for an order cycle of a manufacturing industry.
- To compare the performances of manual and automated warehouse management system.

The scope of the research work is as follows:

i. The empirical study is restricted to medium-sized manufacturing industries in India.

ii. AHP model considers only 8 factors for defining a supply chain strategy.

iii. Simulation modelling process is confined to material and information flow and financial flow is not considered.

iv. Order fulfilment software is restricted to procurement and manufacturing cycle.

v. A single case study is used to analyze the cost benefits of Warehouse management systems.
1.6 Thesis organization

The thesis is organised into eight chapters to cover all the objectives mentioned above. The organisation of each chapter is as follows:

Chapter One provides an overall introduction to the thesis, including the background of the study, introduction to important concepts used, problem definition, the objectives and scope.

Chapter Two explains the academic approaches and key concepts used in the thesis. It presents literature on supply chain management, performance measurement and supply chain performance measurement systems. It also discusses on various modelling approaches that are used for decision making in organisations. These key concepts and approaches help to establish and justify the study’s theoretical basis and they assist in an understanding of the subsequent procedures adopted in the thesis.

Chapter Three details the survey methodology used in this thesis to derive the framework. There are details of the survey method used and of the processes of data collection employed in the fieldwork. There is also a discussion of research ethics in relation to preparation for the field work and also its application, a discussion of the approach to data analysis, and consideration is also given to limitations of the research.

Chapter Four provides a detailed analysis of the performance measurement in order to prioritize the metrics based on the supply chain by using the analytic hierarchy process methodology. The detailed analysis of the supply chain performance measurement was based on the performance measurement factors that were presented in the study’s conceptual framework.

Chapter Five gives the complete details of simulation modelling used in order to improve the performance of the supply chain. Data related to consumer electronic industry is taken and material and information flow are simulated using ARENA package. Results of various utilization and lead times are analysed.

Chapter Six deals with the order fulfilment cycle model and the business performance parameters used to measure its effectiveness. It elaborates on the details of software
which is developed to demonstrate the order fulfilment cycle and results after implementation of the same.

Chapter Seven presents a tool that can be used when developing a systems justification in a warehouse, identifying benefit categories of warehouse management system to consider in the business case, and discusses areas of opportunity within the various benefit categories.

Chapter Eight presents the overall research conclusions and the final remarks. The chapter reviews the theoretical purpose, implications and the contribution of the thesis. Finally, the chapter concludes by making recommendations for future research.
Fig. 1.2 Organization of the thesis