PERFORMANCE MEASUREMENT OF AN AUTOMOTIVE SUPPLY CHAIN

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CANDIDATE'S DECLARATION

I hereby declare that the work done in this project entitled **"Performance Measurement of an Automotive Supply Chain"** in the partial fulfillment for the award of degree of "MASTER OF TECHNOLOGY" with specialization in "PRODUCTION ENGINEERING" submitted to Delhi Technological University, is an authentic record of my own work carried out under the supervision of Mr. Pravin Kumar, Assistant Professor, Department of Mechanical Engineering, Delhi Technological University. I have not submitted the matter in this dissertation for the award of any other Degree or Diploma or any other purpose whatsoever.

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CERTIFICATE

This is to certify that dissertation entitled **"Performance Measurement of an Automotive Supply Chain"** being submitted by **ALPNA SINGH** in the partial fulfillment for the award of degree of "**MASTER OF TECHNOLOGY"** with specialization in "**PRODUCTION ENGINEERING"** submitted to **Delhi Technological University,** is a bonafide work carried out by her under my guidance and supervision.

The matter in this dissertation has not been submitted to any other university or institute for the award of any degree.

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ABSTRACT

Supply chain management has been a major component of competitive strategy to enhance organizational productivity and profitability. In recent years, organizational performance measurement and metrics have received much attention from researchers and practitioners. Performance measurement and metrics have an important role to play in setting objectives, evaluating performance, and determining future courses of actions.

Supply chain management creates value for companies, customers and stakeholders interacting throughout a supply chain. The strategic dimension of supply chains makes it paramount that their performances are measured. Improving supply chain performance has become one of the critical issues for gaining competitive advantages for companies.

To meet objectives, 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. Thus, control of processes in a supply chain is crucial in improving performance and can be achieved through measurement.

In this report, a literature review on performance measurement in supply chain is done to promote a better understanding of the importance of SCM performance measurement. Various systems and approaches used for measuring performance has been studied in which the concept of balanced scorecard approach was selected in this study. The construction of balanced scorecard and the process of its implementation in the enterprise is introduced, and areas for future research are suggested.

Also, a balanced scorecard is developed for automobile industry with a case study of a company ABC Ltd. Finally, a hierarchy-based framework is proposed based on interpretive structural modeling (ISM) approach to understand the relationships among different measurement variables of supply chain performance measurement system.

Keywords: Performance; Performance measurement; Supply chain management; Balanced scorecard, Interpretive structural modeling (ISM).

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LIST OF ABBREVIATIONS

ABC	Activity-based costing
ABC Ltd.	ABC Limited
ABM	Activity-Based Management
aCRM	Analytical CRM
AHP	Analytic hierarchy process
BHP	Brake Horsepower
BSC	Balanced scorecard
CBU	Completely Built Unit
CFL	Compact Fluorescent Lamp
CIC	Customer Interaction Center
CO_2	Carbon dioxide
CRM	Customer Relationship Management
CSI	Customer Service Index
CSS	Customer Service and Support
CTI	Computer Telephony Integration
CVA	Customer Value Analysis
DEA	Data Envelopment Analysis
EFQM	European Foundation Quality Management
EMA	Enterprise Marketing Automation
ERP	Enterprise Resource Planning
EVA	Economic Value Added

X

FDI	Foreign Direct Investment

GM	General Motors
HM	Hindustan Motors
HMIL	Hyundai Motor India Limited
IPO	Initial Public Offering
IQ	Initial Quality Study
IS	Information System
IT	Information Technology
JD	James David
LCA	Life-Cycle Analysis
LNG	Liquid Nitrogen Gas
LPG	Liquid Petroleum Gas
MCA	Multi-Criteria Analysis
mn	million
MUV	Multi Utility Vehicle.
N2N	End to End
OEM	Original Equipment Manufacturer
P-BOM	Production Bill of Materials
PEG	Pair-wise Efficiency Game
PGP	Pre-emptive goal programming
PI	Performance indicator

PLM	Product Lifecycle Management

PM	Performance measurement
PMS	Performance measurement system
QR	Quantitative Restriction
R & D	Research & Development
ROI	Return on Investment
SCM	Supply Chain Management
SCOR	Supply chain operations reference model
SFA	Sales Force Automation
SUV	Sports Utility Vehicle
SWOT	Strengths, Weaknesses, Opportunities and Threats
T 5	T number represents the tube diameter in eights of an inch (T5 = 5/8ths= 16mm)
TQM	Total Quality Management
WEF	World Environment Foundation

CHAPTER 1

INTRODUCTION

1.1 Introduction

Many firms look to continuous improvement as a tool to enhance their core competitiveness using supply chain management. 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 to maximize effectiveness and efficiency. Lee and Billington (1992) observed that the discrete sites in a supply chain do not maximize efficiency if each pursues goals independently. They point to incomplete performance measures existing among industries for assessment of the entire supply chain. Measurements should be understandable by all supply chain members and should offer minimum opportunity for manipulation (Schroeder et al., 1986). Performance studies and models should be created so that organizational goals and achievement of those goals can be measured, thus allowing the effectiveness of the strategy or techniques employed to be accessed.

Most companies realise the importance of financial and non-financial performance measures, however they have failed to represent them in a balanced framework. According to Kaplan and Norton (1992), while some companies and researchers have concentrated on financial performance measures, others have concentrated on operational measures. Such an inequality does not lead to metrics that can present a clear picture of organizational performance. For a balanced approach, Maskell (1991) suggests that companies should understand that, while financial performance measurements are important for strategic decisions and external reporting, day to day control of manufacturing and distribution operations is often handled better with non-financial measures. Another area where inequality persists is deciding upon the number of metrics to be used. Quite often companies have a large number of performance measures to which they continue to add based on suggestions from employees and consultants. They fail to realise that performance assessment can be better addressed using a trivial few—they are not really trivial, but instead are those few areas most critical to success. The metrics that are used in performance measurement and improvement should be those that truly capture the essence of organizational performance. A measurement system should facilitate the assignment of metrics to where they would be most appropriate. For effective performance measurement and

improvement, measurement goals must represent organisational goals and metrics selected should reflect a balance between financial and non-financial measures.

1.2 Performance Measurement

The ability to measure the performance of operations can be seen as an important prerequisite for improvement, and companies have increased the capabilities of their performance measurement systems (PMSs) over the last years (Fawcett and Cooper, 1998). Performance measurement (PM) in the context of a supply chain becomes more important. The reason is obvious: companies start looking at ways to improve operational performance through a better integration of operations across subsequent echelons and separate functions in the value chain.

Several developments have created a need for companies to improve their supply chain management. First, cross-functional co-operation needs to be improved along the supply chain to offer shorter delivery times, more flexibility and faster introduction of new products. Many companies are organized functionally, i.e. around subsequent stages of production, which makes it difficult to control the supply chain. Serving customers better requires synchronization of functions such as marketing, sales, distribution, manufacturing, and purchasing. Second, better synchronization is not only important across functional boundaries, but also across national boundaries. Spanning these boundaries has especially occurred in Europe, where many companies have moved from strong national organizations with local production, products and customers, to an organization where production has become more specialized and one factory serves a specific part of the product range for the whole of Europe. Sales and marketing have become partly centralized. This moves demand management, product allocation, marketing, and distribution to a European level. So there is a need to manage the supply chain on a European scale (Abrahamsson and Brege, 1997). A third development is that streamlining of Operations across a chain of separate companies has become more important because this creates opportunities to offer better service to end consumers against lower costs for the supply chain in its totality. However, information systems for costing and PM have generally not been very helpful for managing operations, because such systems were based on overly simplified models of manufacturing activities and resource consumption, which produced inaccurate cost data. Moreover, in many companies there was a lack of non-financial measures (Johnson and Kaplan, 1987).

A performance indicator (PI) is a variable that expresses quantitatively the effectiveness or efficiency or both, of a part of or a whole process, or system, against a given norm or target (Fortuin, 1988). PM is the activity of measuring performance using PIs. A PMS is a system (software, databases, and procedures) to execute PM in a consistent and complete way. A PI also is called ‘‘performance metric’’.

1.3 Supply Chain Management

The challenges associated with getting a product and service to the right place at the right time at the lowest cost intensified as competition in the 1990s intensified and markets became global. Organizations began to realize that it is not enough to improve efficiencies within an organization, but their whole supply chain has to be made competitive. It has been pointed out that understanding and practicing supply chain management (SCM) has become an essential prerequisite to staying in the competitive global race and to growing profitably (Power et al., 2001; Moberg et al., 2002).

The concept of SCM has received increasing attention from academicians, consultants, and business managers alike (Croom et al., 2000; Tan et al., 1998; Van Hoek, 1998). Many organizations have begun to recognize that SCM is the key to building a sustainable competitive edge for their products or services in an increasingly crowded marketplace (Jones, 1998). Despite the increased attention paid to SCM and the expectations from SCM, the literature does not offer much evidence of successful implementations. For example, Boddy et al. (1998) found that more than half of the respondents to their survey considered that their organizations had not been successful in implementing supply chain partnering; Spekman et al. (1998) noted that 60% of supply chain alliances tended to fail. A recent Deloitte Consulting survey reported that only 2% of North American manufacturers ranked their supply chains as world class although 91% of these same manufacturers ranked their SCM as important or critical to their organization’s success (Thomas, 1999). Thus, while it is clear that SCM is important to organizations, effective management of the supply chain does not appear to have been realized.

There is a growing attention on global supply chain management. Supply chain management is a holistic and a strategic approach to demand, operations, procurement, and logistics process management (Kuei et al., 2002). Cross-country activities are normal and to be expected. These activities are often influenced by a supply chain’s social and technical components. Traditionally, the focus of supply chains was on specific functionalities such as purchasing, manufacturing, and

shipping to support logistics operations. The competitive environment of the 21th century requires the delivery of cost, efficiency, high service levels, rapid response, and high quality of products and services. The effective management of technology and quality is the key to increased quality and enhanced competitive position in today's global environment. Kuei et al. (2002) suggest that supply chain quality management should be distinguished from supply chain technology management. The former deals with the social components of the supply chain while the latter addresses concerns of technical systems in managing supply chains. Of interest in this study is the influence of competitive factors in supply chain quality management. Supply chain quality is a key component in achieving competitive advantage.

1.4 Performance Measurement in Supply Chain Management

Many companies are trying to improve supply chain PM, in order to support managing operations across supply chains. It may be useful to think first of two extremes: (1) several functional or regional departments are each responsible for one aspect or one part of the supply chain and only top management is responsible for the total financial results; and (2) a situation in which a management team is responsible for the overall performance of the whole supply chain. Most companies are somewhere in between. But as companies move towards a more integrated Operations Management function across the supply chain, it becomes necessary to measure the performance of the various parts of the supply chain on various dimensions, in a consistent way. There is a need to define and measure performance for the supply chain as a whole and to be able to drilldown to different measures and different levels of detail, in order to understand the causes of significant deviations of actual performance from planned performance. However, many companies seem to be facing serious difficulties in implementing such supply chain-wide PMSs that capture various dimensions of performance at various levels in a consistent way. These difficulties have various causes:

1.4.1 Decentralized, operational reporting history

There is often a history of decentralized reporting with a focus on local operational use within factories, transportation linkages, distribution centers, sales offices, etc. This has led to an uncontrolled growth of reports with many inconsistencies. These inconsistencies have to do with definitions of performance metrics, sources of data for obtaining measures, and ways of presenting reports. Managers who try to construct a total picture of the supply chain from these

reports find themselves confronted with a large volume of (inconsistent) information in a format that does not support integrated analysis.

1.4.2. *Deficient insight in cohesion between metrics*

Since current reporting has an operational focus, the metrics are used to monitor sub-processes of the supply chain. These pieces of information are analyzed on an individual basis rather than in cohesion. This makes it hard to focus attention in an effective way and causes a lack of overview. This not only makes management to feel discomfort, but it also can lead to missing opportunities.

1.4.3. *Uncertainty what to measure*

Often uncertainty exists about what exactly should be measured on a supply chain level. Since current reports mainly cover parts of the supply chain, it is likely that certain high-level metrics are lacking. This adds to the manager's discomfort.

1.4.4. *Poor communication between reporters and users*

Communication between the creators and users of reports is often poor. The creators often hardly know their audience and the exact purpose of the reports. This results in poor readability and limited usefulness. The users on the other hand sometimes do not know why they receive a certain report and so they do not use it at all. The lack of interaction make the reports outdated in relation to the business as well as user preferences.

1.4.5. *Dispersed IT infrastructure*

Companies use many information systems that are linked in some way. The dispersed IT infrastructure produces a number of issues. Firstly, it adds to the lack of data integrity between the reports. Since considerable overlap exists between the systems, certain data can be extracted from multiple sources and this often leads to inconsistency. Secondly, the infrastructure does not provide visibility over the supply chain, owing to the absence of connectivity. Thirdly, certain systems are not designed for reporting uses or cannot provide data at reasonable cost at all.

These five complexes of difficulties raise the question how supply chain PM can be improved.

1.5 Motivation for this research

With supply chain now comprising a key element in corporate competitiveness, some firms have come to view this function as the cornerstone of their differentiation strategy (Waters and Waters, 2007). Supply chain performance can be measured both in terms of customers' level of satisfaction – since they remain the ultimate judges of how much value is actually being created

at a logistics level – and the costs incurred. Evaluating supply chain performance is a complex undertaking, in part because this is a transversal process involving several actors cooperating to achieve given logistical and strategic objectives. Such evaluations become particularly important in situations, where supply chains are considered a key factor of corporate success.

A number of fields such as purchasing and supply, logistics and transportation, operations management, marketing, organizational theory, management information systems, and strategic management have contributed to the explosion of SCM literature. From the myriad of research, it can be seen that a great deal of progress has been made toward understanding the essence of SCM.

Despite the use of the latest process improvement techniques and capable management, a firm's neglect of its customers may lead to disaster (Kordupleski et al., 1993). In fact, the pressure to revitalize manufacturing over the last decade has been rooted in customers' demand for a greater variety of reliable products with short lead times (Draaijer, 1992).

As customer expectations are dynamic in nature (Shepetuk, 1991), organizations need to assess them regularly and adjust their operations accordingly (Takeuchi and Quelch, 1983). Doyle (1994) writes that satisfying customer needs is the central purpose of any business and Dibb et al. (1994) describe customer satisfaction as the major aim of marketing. The clear message is that the more attention a company pays to researching its customer base in order to identify customer needs, the more rewarding the exchange transaction in the supply chain will be for that company (Carson et al., 1998). Organizations can outperform their competition by exceeding, not just satisfying, the needs of their customers. Since customers are the central element of this strategy, this theoretical construct is formulated based on the importance given to customers in the execution of strategic planning, quality initiatives, product customization, and responsiveness (Stalk et al., 1992; Ahire et al., 1996; Carson et al., 1998; Tan et al., 1999).

1.6 Objectives of the present report

The objectives of the present report are as follows.

- To gain an insight into performance measurement of a supply chain.
- To investigate the issues in supply chain performance measurement.
- To study the different measures of supply chain performance measurement.
- To study the balanced scorecard for performance measurement of a supply chain.
- To investigate the issues of development of Balanced Scorecard.
- To understand the supply chain management in ABC Ltd.
- To develop the balanced scorecard for automobile industry.

- To examine the developed balanced scorecard in ABC Ltd.
- To understand the relationships among different performance measures of supply chain performance measurement and to understand their driving power and dependence.

1.7 Research Methodology

The tools used in this research are:

1. *Balanced Scorecard*: The balanced scorecard (BSC) is the most widely applied performance management system today. The BSC was originally developed as a performance measurement system in 1992 by Dr. Robert Kaplan and Dr. David Norton at the Harvard Business School. Unlike earlier performance measurement systems, the BSC measures performance across a number of different perspectives such as a financial perspective, a customer perspective, an internal business process perspective, and an innovation and learning perspective. Through the use of the various perspectives, the BSC captures both leading and lagging performance measures, thereby providing a more "balanced" view of company performance. Leading indicators include measures, such as customer satisfaction, new product development, on-time delivery, employee competency development, etc. Traditional lagging indicators include financial measures, such as revenue growth and profitability. The BSC performance management systems have been widely adopted globally, in part, because this approach enables organizations to align all levels of staff around a single strategy so that it can be executed more successfully.
2. *Interpretive Structural Modeling (ISM)*: ISM is an interactive learning process whereby a set of different directly related elements are structured into a comprehensive systematic model (Lee, 1999). The method is interpretive as the judgment of the group decides whether and how the items are related. Its structure is extracted from the complex set of items, it is a modeling technique, and as such, the specific relationships and overall structure are portrayed through a digraph model (Mandal & Deshmukh, 1993; Pandey et al. 2005).

   It is used for establishing relationships among the performance measures of supply chain performance measurement system. It is also employed to find the key variables which are of strategic nature and management is required to carefully focus on them to improve other dependent variables of the system.

1.8 Research Overview

Supply chain management creates value for companies, customers and stakeholders interacting throughout a supply chain. The strategic dimension of supply chains makes it paramount that their performances are measured. In today's performance evaluation processes, companies tend to refer to several models that will differ in terms of corporate organisation, the distribution of responsibilities and supply chain maturity.

In this report, a literature review on performance measurement in supply chain is done to promote a better understanding of the importance of SCM performance measurement alongwith an overview of different methods and models to measure performance of supply chain.

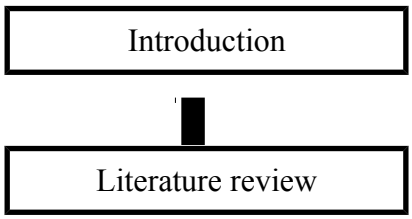
An extensive literature review was undertaken to understand the various perspectives of the balanced scorecard. Based on this literature review and an insight into automobile industry, a balanced scorecard was developed. Balanced Scorecard incorporated customer, internal business, innovation and learning, and financial perspectives for the automobile industry. The developed balanced scorecard is studied with a case study of ABC Ltd.

To understand the relationships among different measurement variables of supply chain performance measurement system, a hierarchy-based framework is proposed based on interpretive structural modeling (ISM) approach. This framework helps to understand the relative importance of the variables in measurement of supply chain performance. It also helps to delineate the most important variables related to performance measurement of supply chain which requires more attention from the supply chain professionals.

1.9 Organisation of the report

The organisation of the thesis is shown in figure 1.1.

Chapter 1



Chapter 2

Chapter 3

Chapter 4

Chapter 5

Chapter 6

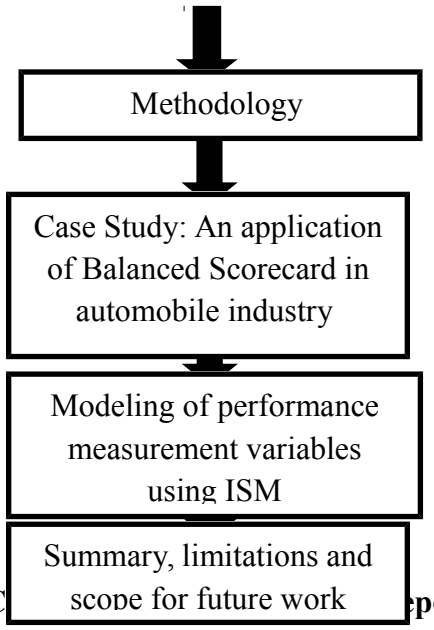


Figure 1.1: C eport

A brief description of all the chapters is as follows.

Chapter 1

It contains an introduction to performance measurement and supply chain management. Further this chapter deals with performance measurement in SCM. Motivation of research and objectives of this research have been presented. A brief introduction to Balanced Scorecard and Interpretive structural modeling (ISM) is provided. Finally, an overview of chapterization scheme of the dissertation has been reported in this chapter.

Chapter 2

This chapter contains a classification of literature related to performance measurement, performance management, tools used for performance measurement, performance measurement in supply chain, supply chain management in automobile industry, development of balanced scorecard, etc. This chapter also includes selection of research methodologies used in this research such as balanced scorecard and interpretive structural modeling.

Chapter 3

It presents the methodology used in this research, namely Balanced Scorecard (BSC) and Interpretive Structural Modeling (ISM). It provides a general overview of balanced scorecard.

This chapter also includes the advantages of Balanced Scorecard. A brief introduction to ISM is provided.

Chapter 4

It includes an application of Balanced Scorecard in automobile industry with a case study. It presents a general overview of the company ABC Ltd. alongwith its manufacturing facilities. It also provides SWOT Analysis of the company.

The selection of the perspectives of the balanced scorecard for the automobile industry is accomplished based on the literature review. The balanced scorecard for automobile industry is developed. The critical choices made in selections of the perspectives of the balanced scorecard are discussed. The developed balanced scorecard is analysed with a case study of ABC Ltd.

Chapter 5

In this chapter, a hierarchy-based framework is proposed based on interpretive structural modeling (ISM) approach to understand the relationships among different measurement variables of supply chain performance measurement system. Based on the literature review and the opinion of the experts, different variables (performance measures) to measure the performance of a supply chain are identified. These variables have been modeled using interpretive structural modeling (ISM) to provide a framework for the effective deployment of management strategies to implement supply chain performance measurement system. On the basis of driving and dependence power, these variables are further categorized as independent, dependent, linkage, and autonomous variables. Managerial implications of the results are also discussed in this chapter.

Chapter 6

This chapter presents the summary of the research. Research findings and major implications of this research have also been presented in this chapter. The chapter concludes with the limitations of the present study and scope for future research.

1.10 Conclusion

In this chapter, an overview of the context related to this research has been presented. Performance measurement in supply chain, as a field of research is introduced as the prime focus

for the present work. Motivation and objectives of this research have been presented in this chapter. A brief description of research methodology to be used in this research has also been presented. In the research overview, a brief summary of the entire research reported in this thesis has been presented. The organization scheme of the chapters in this thesis is also presented.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Organisational performance has always exerted considerable influence on the actions of companies. Consequently, the ways and means of accurately measuring this performance is perceived as being an increasingly important field of research for both organisations and academics alike. Indeed, in the last 15 years or so performance measurement (PM) has been seen to occupy the minds of academics in an ever-increasing number of fields. The mid to late nineties seem to have seen the peak of this activity.

Neely (1999) estimated that between 1994 and 1996, some 3615 articles on performance measurement were published alongside the statistic that in 1996 books on the subject appeared at a rate of one every 2 weeks in the USA alone. A vast array of disparate information concerning PM has been made available through the efforts of a number of researchers in different

functional silos (Marr & Schiuma, 2003) and the field is now well recognised as being an important part of the manufacturing strategy literature (Dangayach and Deshmukh, 2001).

2.2 An overview of quotes on performance

This section of the report concentrates on some of the most popular authors in the field of performance measurement, which represents, the most proliferating field of research in studies of contemporary business performance. Authors in this research field are drawn from an increasingly diverse set of research fields, each drawing upon different customs and meanings, and with differing requirements from the term performance, as Table 2.1 demonstrates.

Table 2.1 depicts a number of contemporary and past performance measurement writers (or co- or joint-authors) and specific quotes from their works. In essence, different usages of performance which are readily accessible in the performance measurement literature can be seen in the Table 2.1.

Table 2.1: An overview of quotes on performance

S.N.	Researcher	Quote
1.	Ho (2008)	Performance refers to the achievements, in quality and quantity, of an individual or group work.
2.	Connor (1996)	Performance may have two connected senses: one of ‘‘acting’’, perhaps for the private benefit of the firm in a business context (i.e., by the application and interpreting of performance procedures); and the other by ‘‘enacting, in the sense of playing out, or impersonating’’ these to the public at large (i.e., by suppressing, enlarging, emphasising, or ignoring various aspects of the discovered performance).
3.	Carlson (1996)	He considers performance to be ‘‘an essentially contested concept’’ where there is only ‘‘futility. . .[in] seeking some overarching semantic field to cover such seemingly disparate usages as the performance of an actor, of a schoolchild, of an automobile’’;
4.	Phelan (1993)	‘‘performance cannot be saved, recorded, documented, or otherwise

		participate in the circulation of representations of representations''; instead ''performance implicates the real through the presence of living bodies"
6.	Lebas (1995)	Performance is defined as: . . .about deploying and managing well the components of the causal model(s) that lead to the timely attainment of stated objectives within constraints specific to the firm and to the situation. Performance, he says, ''is never objective, it is only a way of defining where one wants to go''
7.	Wholey (1996)	''Performance'' is an interesting concept. ''Performance'' is not an objective reality out there somewhere waiting to be measured and evaluated.

2.3 Literature Classification Scheme

The literature is presented under the following categories:

- General overview of Performance Measurement
  - Performance measurement system
  - Performance Management
  - Tools used for performance measurement
- General overview of Supply Chain
  - Supply Chain Performance Measurement System
  - Overview of different methods and models to measure performance of supply chain

In this classification, there are various categories and each category has specific articles. Each article is put under specific category to provide the overview of various aspects related to the study of performance measurement in supply chain.

2.3.1 General overview of Performance Measurement

PM is evolving at a considerable rate to combat new organisational realities; owing to the fight for industrial supremacy, the concept of performance, as it is measured and evaluated, is undergoing a transformation in modern business organisations.

2.3.1.1 Performance measurement system

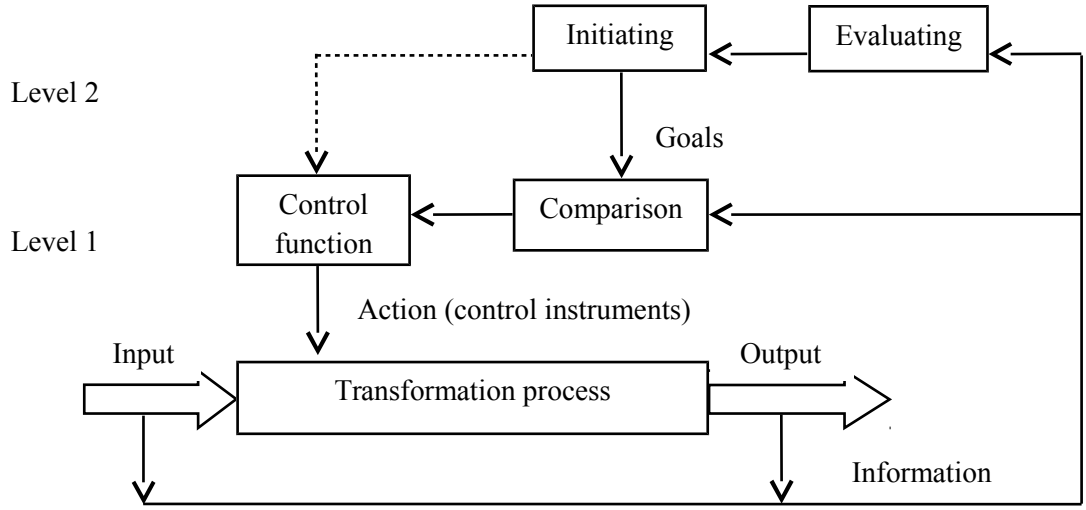


Figure 2.1: Process control loops *(Lohman, 1999)*

PM is an activity that managers perform in order to reach predefined goals that are derived from the company's strategic objectives. Figure 2.1 illustrates this idea by taking a systems perspective on the control of an organization (Lohman, 1999).Two levels of control can be seen. At the operational level, a comparison of input and output values with predefined goals takes place. If there is a discrepancy between the actual value of the PI and the desired goal, knowledge about the behavior of the organization is used to find an appropriate action, e.g. modifying the process. This is the control function. At the tactical or strategic level the control loop is used to evaluate and adapt control level 1, by changing goals if necessary. With these two control loops, PM extracts the right process information and provides goal information needed to evaluate performance (comparison) as well as goals (evaluation). ''Right'' process information means that the information should be relevant for the level of control (strategic, tactical, or operational) and the company's strategic objectives.

PM is based on the firm's strategy. It aims to support the implementation and monitoring of strategic initiatives. The selection of performance measures and the setting of targets for these

measures are seen as concrete formulations of the firms' strategic choices. Both financial and nonfinancial measures are needed to translate the strategy into specific objectives that provide guidelines for operational action for middle and lower management. The actual results achieved for the various measures reflect how well the firm succeeds in achieving these strategic choices (Eccles, 1991). Reviewing the ''actuals'' versus ''planned'' may lead to taking corrective actions in order to increase the likelihood of achieving the goals. But the results may also lead to challenging and adjusting these goals and strategic choices (Nanni et al., 1992).

PM is also based on the characteristics of a firms' operations, which need to be reflected in the definitions of performance measures used. A performance measure is seen as a metric to quantify the efficiency and effectiveness of operations (Neely et al., 1995).

The development of a PMS may conceptually be separated into phases of design, implementation, and use (Bourne et al., 2000).The design phase is about identifying key objectives and designing measures. In the implementation phase, systems and procedures are put in place to collect and process the data that enable the measurements to be made regularly. In the use phase, managers review the measurement results to assess whether operations are efficient and effective, and the strategy is successfully implemented. This may also lead to challenging the strategic assumptions. The design, implementation, and use of a set of performance measures are not a one-time effort: a firm should install processes that ensure continuous review of the system [Beamon and Ware (1998), Bourne et al. (2000), Medori and Steeple (2000)]. Review processes imply that a measure may be deleted or replaced, the target may change, and the definition of measures may change. Neely et al. (1995) has described a typical development process as discussed below:

Step 1: Clearly define the firm's mission statement.

Step 2: Identify the firm's strategic objectives using the mission statement as a guide (profitability, market share, quality, cost, flexibility, dependability, and innovation).

Step 3: Develop an understanding of each functional area's role in achieving the various strategic objectives.

Step 4: For each functional area, develop global performance measures capable of defining the firm's overall competitive position to top management.

Step 5: Communicate strategic objectives and performance goals to lower levels in the organization. Establish more specific performance criteria at each level.

Step 6: Assure consistency with strategic objectives among the performance criteria at each level.

Step 7: Assure the compatibility of performance measures used in all functional areas.

Step 8: Use the PMS.

Step 9: Periodically re-evaluate the appropriateness of the established PMS in view of the current competitive environment.

The process is often iterative, whereby measures are developed and adjusted as more information about strategy, customers, processes, etc. becomes available. The appropriate measures are derived from such information in several rounds to review and revise the measures. The availability of data is one of the considerations in the design process. There is also much attention for updating performance measures once they have been implemented. Kaplan and Norton (1993) emphasize using documents, interviews, and executive workshops for gathering information and building consensus.

Various approaches can be used to design the PMS (Lohman, 1999) based on (Davies, 1982):

1. Asking: Techniques to find out the requirements of managers, such as interviews, group discussions, planning meetings, and surveys, are most often used to develop a PMS.

2. Prototyping: Instead of focusing primarily on a thorough analysis of the information needed, an initial set of requirements is specified and a prototype system is built. Through interaction with users of the system (managers), requirements are added or changed until the user is satisfied.

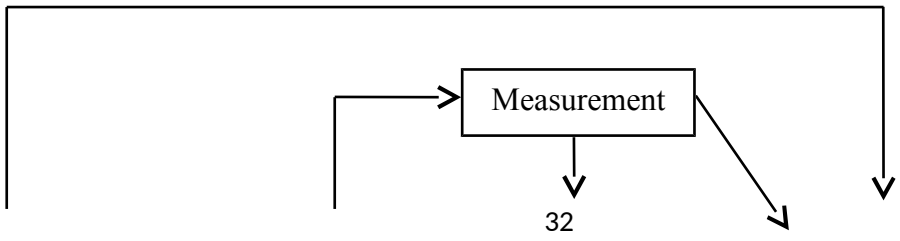
3. Planning methods: Methods that design appropriate measures based on the characteristics of the firm, such as strategy, processes, and customers. For example, a method could be followed to determine a few areas (critical success factors) that dictate the success of the firm. For such areas

critical success factors are described, which leads to the definition of measures that capture these factors.

4. Existing reports: Often a useful source of information to be used to design the PMS. Implicit in many approaches for designing performance measures is a ‘‘green field approach’’ that does not pay explicit consideration to existing measures. However, in many settings it is realistic to acknowledge that reports relevant for managing operations already exist at various levels in the organization, within and outside the operations function. Medori and Steeple (2000) have discussed the relationship with existing measurement systems; their design method includes an ‘‘audit’’ step to compare the newly defined desired performance measures with the measures that already exist. However, this is merely one element of a process that includes typical steps such as defining a firms’ manufacturing strategy through competitive priorities, linking success factors to the competitive priorities, defining measures, implementation of measures, and executing periodic maintenance. The ‘‘audit’’ step may lead to eliminating some existing measures and identifying gaps in the current measurement system.

2.3.1.2 Performance Management

Amaratunga and Baldry (2002) define performance management as the use of performance measurement information to effect positive change in organizational culture, systems and processes, by helping to set agreed-upon performance goals, allocating and prioritizing resources, informing managers to either confirm or change current policy or programme directions to meet these goals, and sharing results of performance in pursuing those goals. Performance measurement and performance management follow one another in an iterative process; management both precedes and follows measurement, and in doing so creates the context for its existence (Lebas, 1995). Fig. 2.2 presents a simplified schematic representation of the performance management process, as depicted by Smith and Goddard (2002).



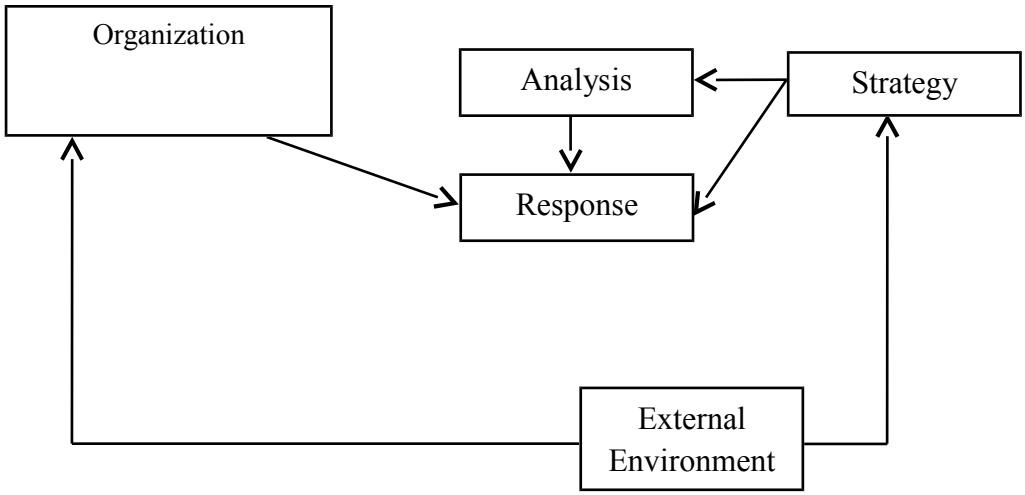


Figure 2.2: Schematic representation of Performance Management process
(Smith & Goddard, 2002)

A decade ago the PM literature was often content with trying to represent the processes defined by the three inner boxes of Figure 2.2: labelled measurement, analysis and response. As time has passed, more complex frameworks and systems have evolved, so that today the whole of the figure is almost encompassed. PM today has moved towards examining the organisation as a whole, and impacting to a greater extent upon strategy. Finally, inter-organisational PM systems will have an impact outside the organisation – in the external environment.

Andersen et al. (2006) comment on the lack of a performance management definition in the literature, and the continual process of linking performance measurement to performance management in a number of ‘‘light weight’’ definitions. Where definitions do exist, they are likely to be diverse in their focus, however a useful one is proposed by Folan et al. (2006): ‘‘performance management is the management of the system put in place by an entity (with a pre-determined socially constructed reality) that has chosen a relevant viewpoint of itself (its objective) towards which it means to progress, using a set of recognizable characteristics as its measurement apparatus (performance measurement) to monitor this progress’’. This definition makes the requisite distinction between performance management and performance measurement, and utilises Lebas’s (1995) contention of the successive nature of performance management.

For performance assessment the analysis of Bourguignon and Chiapello (2005) can be put, who, using a trial-inspired model, worked to develop a three-step model of performance assessment, consisting of:

(1) instrumentation—the step used to determine the preconditions of assessment;

(2) evaluation—the step for the actual production of a value judgement;

(3) consequences—where the value judgements reached result in numerous consequences.

From their analysis it is clear that performance assessment implies more than simple measurement; indeed, measurement only physically occurs in their three-step model in the second step ‘‘evaluation’’, after the preparatory seeds have been sown in the first step ‘‘instrumentation’’. In its turn it can be conjectured that performance assessment itself is an actively employed tool of the performance management environment, which, as we determined earlier, encompasses performance measurement and results in an evolving performance management arena, progressively changing as the strategic objective is evaluated and updated (or reset) for the future.

These views are encapsulated in Figure 2.3, which offers a model of the relationships between the three terms performance management, performance assessment, and performance measurement, plus the position that performance holds in relation to these—a combination of the research of Lebas (1995), Bourguignon and Chiapello (2005), Folan et al. (2006).

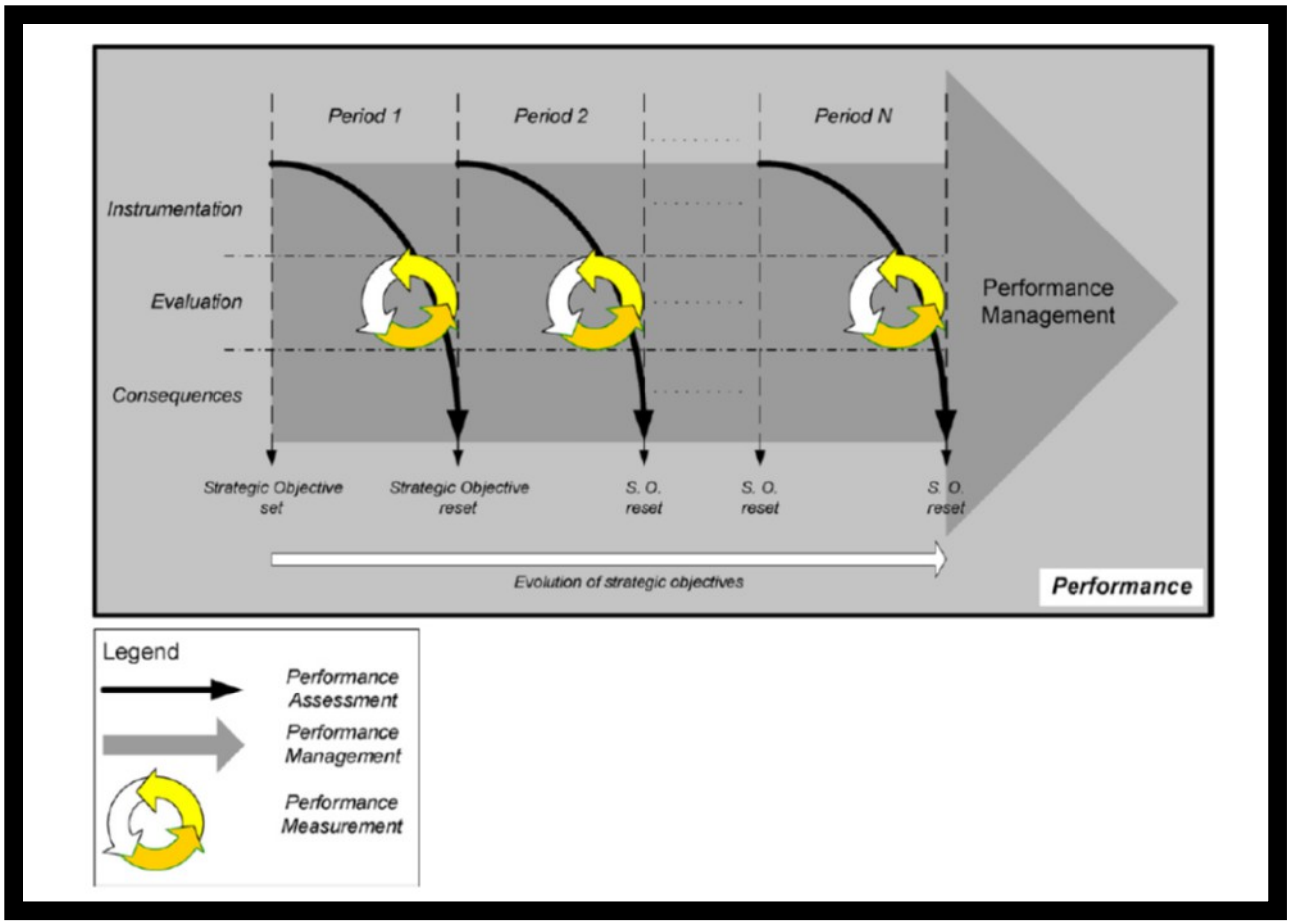


Figure 2.3: Relationships of performance management, performance assessment and performance measurement inside the performance box. *(Folan et al., 2007)*

The figure 2.3 traces the terms performance, performance management, performance measurement and performance assessment, their interactions and meanings, together and separately. The position of each in the figure can be noted: the large arrow represents the omnipresent nature of performance management—it is often holistically conceived and hence exists often in an unconscious state in the organisation (or inter-organisation); the curved descending arrow represents the periodic nature of performance assessment, a tool actively employed in the performance management environment when the performance objective is set and reset – note it comes to an end once it delivers its assessment report, and comes to life once a new objective is set – hence, it is periodic in nature; and the position of performance measurement itself in the evaluative box of performance assessment – this also occurs periodically as part of performance assessment.

The encapsulating box denotes performance, which is depicted as promoting one coherent vision of performance inside of which performance management, performance measurement and performance assessment all reside. This performance box is important, as it not only assures us that it is erroneous to assume that we can treat any one term – performance management, performance measurement or performance assessment – separately from the rest of the performance system; but it also informs us that the choice of any one of these immediately places constraints upon the others to be chosen. The choice of a particular performance measurement technique, for example, immediately constrains our choice of assessment and management techniques, and even impacts upon the type of performance adduced inside the performance box; in much the same way, management, measurement and assessment techniques must be considered en masse, so to speak, and aligned with performance aspirations, and not chosen separately as implicitly recommended in the research. Considering tools for performance management, performance measurement and performance assessment together helps to streamline the performance system implemented inside the performance box; considering them separately causes many integration problems for the entity trying to implement their view of performance, as each tool may suffer from inadequate or irregular integration with the others.

This model is novel for its approach to the problem of performance it takes: it begins with determining the meaning and content of the term performance itself; and using discoveries from this, it stipulates appropriate methodologies and tools accordingly. To treat performance in such a manner is to keep measurement, assessment and management integrated with each other, without recourse to the usual methods of piecemeal adaptation formerly favoured.

2.3.2 Tools used for performance measurement

It is important to understand why measuring an organization's performance is both necessary and vital. An organization operating without a performance measurement system is like an airplane flying without a compass, a Formula One race car driver guiding his car blindfolded, or a CEO operating without a strategic plan. The purpose of measuring performance is not only to know how a business is performing but also to enable it to perform better. The ultimate aim of implementing a performance measurement system is to improve the performance of an organization so that it may better serve its customers, employees, owners, and stakeholders.
If one "gets" performance measurement right, the data generated will tell the user where the business is, how it is doing, and where it is going. In short, it is a report card for a business that

provides users with information on what is working well and what is not. With this in mind, this section provides an overview of the various performance measurement systems used today by enterprises to drive improvements in overall organizational performance.

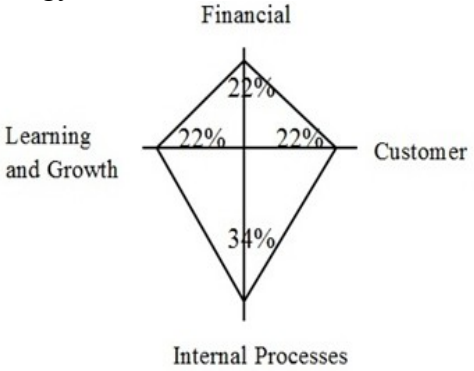
A performance measurement system enables an enterprise to plan, measure, and control its performance according to a pre-defined strategy.

The major performance measurement systems in use today are profiled below (in order of global adoption) and include

- The Balanced Scorecard
- Activity-based Costing and Management
- Economic Value Added (EVA)
- Quality Management
- Customer Value Analysis/Customer Relationship Management
- Performance Prism

The Balanced Scorecard

The balanced scorecard (BSC) is the most widely applied performance management system today. The BSC was originally developed as a performance measurement system in 1992 by Dr. Robert Kaplan and Dr. David Norton at the Harvard Business School. Unlike earlier performance measurement systems, the BSC measures performance across a number of different perspectives such as a financial perspective, a customer perspective, an internal business process perspective, and an innovation and learning perspective. Through the use of the various perspectives, the BSC captures both leading and lagging performance measures, thereby providing a more "balanced" view of company performance. Leading indicators include measures, such as customer satisfaction, new product development, on-time delivery, employee competency development, etc. Traditional lagging indicators include financial measures, such as revenue growth and profitability. The BSC performance management systems have been widely adopted globally, in part, because this approach enables organizations to align all levels of staff around a single strategy so that it can be executed more successfully.



Perspective	# of Metrics	Weight
Financial	5	22%
Customer	5	22%
Learning and innovation	5	22%
Internal Processes	9	34%
	24 measures	100%

Figure 2.4: Example of an "ideal" balanced scorecard
Source: Norton and David (2000), Beware: The unbalanced scorecard

Figure 2.4 is drawn from an article written by Dr. David Norton. The brief article explained the need for balancing the number of measures in all four perspectives, with greater emphasis on process measures, because the process perspective is the primary domain through which organizational strategy is implemented.

As a result of continued research and innovations over the last 15 years, the BSC has gone through an evolutionary process of improvement, from performance measurement (1990–1996) to performance management (1996–2000), to becoming a globally recognized best practice for strategic management (2001–to present). In fact, the benefits a firm can obtain from properly implementing the BSC include the following.

- Translating strategy into more easily understood operational metrics and goals;
- Aligning organizations around a single, coherent strategy;
- Making strategy everyone's everyday job, from CEO to the entry-level employee;
- Making strategic improvement a continual process; and
- Mobilizing change through strong, effective leadership.

The balanced scorecard will be discussed in detail in chapter 3.

Activity-based Costing and Management

Traditional cost accounting permeates most organizations and is characterized by arbitrary allocations of overhead costs to items being produced. Typically, the company's total overhead is allocated to goods produced based on volume-based measures (labor hours, machine hours, etc.). The underlying assumption is that there is a relationship between overhead and the volume-based measure. Activity-based costing (ABC) was developed to provide better insight into how overhead costs should be allocated to individual products or customers. Businesses that do not use ABC typically only make simple adjustments to allocate overhead costs that do not accurately fit elsewhere. Businesses that use ABC link expenses related to resources supplied to the company to the activities performed within the company. Through the use of ABC, expenses are allocated from resources to activities and then to products, services, and customers.

Activity-Based Management (ABM) is a discipline that focuses on the management of activities to maximize the profit from each activity and to improve the value received by the customer. This discipline includes cost-driver analysis, activity analysis, and performance measurement. ABM draws on ABC as its major source of information.

Using the ABC approach, companies get insights into profitable and profitless activities based on a customer or a product viewpoint. ABC then is a way of measuring which of the firm's activities generate revenues in excess of costs and, as a result, provide keen insight into what is really

providing value for customers (Meyer and Marshall, 2002). ABC is used by many organizations that implement the BSC because ABC enables businesses to more accurately define and measure their metrics.

Firms that implement an ABC methodology are able to

- Identify the most and least profitable customers, products, and channels;
- Determine the true contributors to (and detractors from) financial performance;
- More accurately predict costs, profits, and resource requirements associated with changes in production volumes, organizational structure, and resource costs;
- More easily identify the root causes of poor financial performance;
- Better track costs of activities and work processes; and
- Provide front-line managers with cost intelligence to drive improvements.

While firms will likely benefit from ABC, the system is mainly an accounting and cost-based method of viewing and analyzing an organization and its activities. ABC also lacks the strategic and nonfinancial elements that are captured in the BSC. Thus, most successful firms use ABC to manage costs and gain insight into their internal competitive advantages. ABC is particularly valuable initially as a management accounting and reporting tool, but has also proved valuable as providing metrics for use in the BSC's internal process perspective. In other words, successful firms use ABC in combination with the BSC to drive the achievement of a firm's strategy and competitive advantage.

Economic Value Added (EVA)

Stern Stewart Corporation developed in 1982 the Economic Value Added (or, more simply EVA) as an overall measure of organizational performance. EVA is both a specific performance measure and the basis for a larger performance measurement framework. According to Stern Stewart, EVA is a financial performance metric that is most directly linked to the creation of shareholder value over time. The definition of EVA is net operating profit less an appropriate charge for the opportunity cost of all capital invested in an enterprise. Mathematically it is

EVA = Net Operating Profit After Taxes – (Capital × Cost of Capital)

EVA is designed to give managers better information and motivation to make decisions that will create the greatest shareholder wealth. Since EVA is a single metric (although it can cascade down and across an enterprise to evaluate the performance of specific investments) it is complementary to the BSC and can be included in a BSC framework (for example, as a financial perspective measure). Using EVA alone has been found to cause managers to invest in less risky, cost-reducing activities rather than in growth activities. Also, because it is a pure financial model, EVA does not serve as a vehicle for articulating a strategy. When coupled with the BSC,

the tradeoffs between short-term productivity improvements and long-term growth goals can be managed (Kaplan and Robert, 2001)

Some criticize EVA as being a very complex framework that relies on complicated calculations. The "Cost of Capital" calculation is particularly difficult to calculate and prone to errors that lead to grossly misleading results. Also, EVA is not easily understood by the majority of employees because of its complex framework and calculations.

Quality Management

Over the past few decades, many firms have adopted various quality programs, such as Total Quality Management (TQM), Six Sigma, European Foundation Quality Management (EFQM), and The Baldridge National Quality Program. Such Quality Programs aim to assist organizations to improve the quality of the manufacturing and service offerings. A central tenet for all of these programs is business performance measurement. For example, The Baldrige National Quality Program measures businesses in seven categories and the EFQM in nine. (Kaplan et al., 2001)

Table 2.2: Framework Comparison of Baldridge and EFQM Criteria
Source: Baldridge, EFQM Publications (2001)

Baldridge Categories	EFQM Criteria
Leadership	Leadership
Human Resource Focus	People
Strategic Planning	Policy and Strategy
Process Management	Processes
Customer and Market Focus	Customer Results
Information and Analytics	Key Performance Indicators
Business Results	People Results, Society Results Partnerships and Resources

Although Quality Programs focus a firm on continuous improvement, they are not well suited to measuring relative performance among differing enterprises in different industries. A 2001 Balanced Scorecard Report noted the differences and synergies between the Quality Frameworks and the BSC:

• The BSC emphasizes explicit causal links through strategy maps and cascaded objectives more than the quality programs do.

• The BSC programs rely on benchmarking approaches.
• The BSC sets strategic priorities for process enhancements.
• The BSC integrates budgeting, resource allocation, target setting, reporting, and feedback on performance into ongoing management processes.
• These elements enable the BSC to be a central management tool for an upgraded and more effective performance measurement system and strategy management process.

Customer Value Analysis and Customer Relationship Management

Customer Value Analysis (CVA) and Customer Relationship Management (CRM) techniques are enabling businesses to improve performance, to measure that improvement, and to focus a firm on the value of its customers. Moreover, CVA and CRM technologies are providing firms with better data integration and, hence, better measurement regarding customers. Given the obvious strategic importance of customers, it is natural for businesses to begin exploring more robust ways of measuring customer and business activities directly related to customers.

Several CVA/CRM frameworks have evolved over the years. One illustrative framework decomposes the customer problem down to three top-level areas (with further decomposition beneath each of the three) (Rust et al., 2000):

1. Value equity refers to the customers' perceptions of value
2. Brand equity refers to the customers' subjective appraisal of the brand
3. Retention equity refers to the firm building relationships with customers and encouraging repeat-purchasing

These three areas correspond to three distinct disciplines in the CVA/CRM and marketing literature (brand management, customer value analysis, and customer loyalty analysis) - each with its own detailed measurement approaches. The implications for organizational performance measurement systems are clear: measuring business activities and outcomes regarding customers is becoming increasingly complex and increasingly important to the successful execution of a firm's strategy.

Proponents of the BSC note that the BSC framework includes the customer as one of four perspectives, while CVA and CRM techniques fail to account for important noncustomer aspects of a business. CVA and CRM are often used by BSC practitioners to drive improvements in the customer perspective of the BSC. In other words, the benefits of CVA and CRM technologies are increasingly used in a BSC framework evaluation.

Performance Prism

Many alternative and "customized" frameworks continue to be developed based on the breakthrough BSC framework developed by Kaplan and Norton in 1992. The "Performance Prism" is an example of one such "customized" BSC framework.

In the "Performance Prism," companies view their organizations from five perspectives, rather than the four traditional perspectives of the BSC. These five perspectives are

• Stakeholder Satisfaction – Who are the key stakeholders and what do they want and need?
• Strategies – What strategies do we have to put in place to satisfy the wants and needs of these key stakeholders?
• Processes – What critical processes do we require if we are to execute these strategies?
• Capabilities – What capabilities do we need to operate and enhance these processes?
• Stakeholder Contribution – What contributions do we require from our stakeholders if we are to maintain and develop these capabilities?

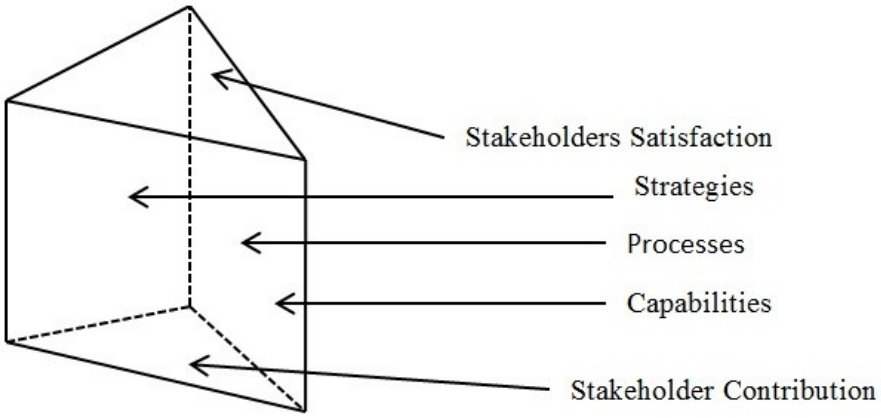


Fig. 2.5: Illustartion of the five facets of the "Performance Prism"
Source: Perspectives on Performance: The Performance Prism. Professor Any Neely. Cranfield School of management, Undated Paper
(http://www.som.cranefield.ac.uk/som/research/centres/cbp/downloads/prismarticle.pdf)

The "Performance Prism" is relatively new, having been developed by a major consulting firm and the Cranfield School of Management in 2000. Its first significant implementation was in 2001, and it illustrates the flexibility of the BSC framework to be adapted and applied to the various needs of businesses.

2.3.3 General overview of Supply Chain

A supply chain is generally defined as a network of physical and decision-making activities connected by material and information flows that cross organizational boundaries (Van der Vorst, 2000). According to Lambert and Cooper (2000) there are four main characteristics of a supply chain: first it goes through several stages of increasing intra- and inter-organizational, vertical coordination. Second, it includes many independent firms, suggesting that managerial

relationship is essential. Third, a supply chain includes a bi-directional flow of products and information and the managerial and operational activities. Fourth, chain members aim to fulfill the goals to provide high customer value with an optimal use of resources.

2.3.3.1 Supply Chain Performance Measurement

In 1992, Lee and Billington found that no adequate supply-chain metrics exist, and firms, even if they are participating in coordinated supply chains, only aim at achieving their own performance standards. (Beamon, 1999) looked at performance indicators used in supply-chain modelling and concluded that "current supply chain performance measurement systems are inadequate because they rely heavily on the use of cost as primary measure, they are not inclusive, they are often inconsistent with the strategic goals of the organization, and do not consider the effects of uncertainty". A few years later, Gunasekaran et al. (2001) reviewed the literature of performance metrics of supply chains again and concluded that there is still a lack of a balanced approach with regards to financial as well as non-financial indicators and the number of performance indicators to be used. Furthermore, no distinction is made between indicators of operational, tactical and strategic level. In their work Gunasekaran et al. (2001) develop a conceptual model for supply-chain performance at three levels: strategic, tactical and operational. There seems to be consensus about the fact that no supply-chain measurement system exists that is inclusive, universal and measurable as well as consistent (Beamon, 1998). There is less agreement, however, on the matter of what such a system should look like. Korpela et al. (2002) attempted to demonstrate how the analytic hierarchy process (AHP) can be used for supporting the supply-chain development process. Murphy et al. (1996) conducted a two-stage study, where the first stage gave an overview of performance indicators and their dimensions used in literature from 1987 to 1993 and the second stage examined the relationship between performance variables and the existing performance dimensions. In their work Murphy et al. (1996) used 19 performance indicators, mostly being of financial nature such as net income or return on investments. In 1999, Beamon (1999) suggested a system of three dimensions: resources (i.e. efficiency of operations), output (i.e. high level of customer service) and flexibility (i.e. ability to respond to a changing environment). Persson and Olhager (2002) adhered to this three-dimension system. Based on results of a simulation model they concluded that good quality and short lead-times in integrated and synchronized supply chains lead to superior performance. The payoff in terms of total cost is more than proportional to the improvements in quality and lead-times.

Li and O'Brien (1999) suggested a model to improve supply-chain efficiency and effectiveness based on four criteria: profit, lead-time performance, delivery promptness and waste elimination. Their model analyses the supply-chain performance at two levels: the chain level and the operational level. At the chain level, assumptions for these four criteria are set for each supply-chain stage so that the supply-chain performance can meet the customer service objectives. At the operations level, manufacturing and logistics procedures are optimized under the given objectives and three different strategies. The results of the model revealed that lead-time performance is the most influential factor for the choice of the strategy.

Berry and Naim (1996) and later on Li and O'Brien (1999) emphasize that the efficiency of supply chains can generally be improved by reducing the number of manufacturing stages, reducing lead-times, working interactively rather than independently between stages and speeding up the information flow. Efficiency and effectiveness were also used in the work of Lai et al. (2002) to evaluate the supply chain performance in transport logistics. Lai et al. identified three dimensions of supply-chain performance in transport logistics. Those dimensions are service effectiveness for shippers, operational efficiency and service effectiveness for consignees. Within these dimensions they identified four performance indicators such as responsiveness, reliability, costs and assets.

Van de Vorst (2000) distinguished several performance indicators for food supply chains on three levels: supply chain, organization and process. At supply chain level five indicators are distinguished: product availability, quality, responsiveness, delivery reliability and total supply-chain costs. At organization level again five indicators are distinguished: inventory level, throughput time, responsiveness, delivery reliability and total organizational costs. Finally at process level four indicators are distinguished: responsiveness, throughput time, process yield and process costs. Thonemann and Bradley (2002) follow the line of Eppen (1979) and analyse the effect of product variety on supply-chain performance, measured in terms of expected lead-time and expected cost at the retailer level in a single-manufacturer and multiple-retailer model. They showed that underestimating the cost of product variety leads companies to offer product variety that is greater than optimal. The authors also demonstrate how supply-chain performance can be managed by reducing the set-up time, the unit-manufacturing time, the number of retailers or the demand rate. In 2003, Claro et al. built an integrated framework for Dutch potted-plant

and flower production that aimed at the combination of constructs on the transaction, dyadic and business-environment level for testing their impact on relational governance and performance. Each of these three levels consists of different determinants. Determinants of transaction level are exchange mode, human and physical transaction-specific assets, determinants of dyadic level are length of business interaction and organizational trust, and finally, determinants of business environmental level are network intensity and environmental instability. As an indicator of relational governance they used joint planning and joint problem solving and as indicator of performance they used sales growth rate and perceived satisfaction. The results revealed that the dimensions of relational governance not related to perceived satisfaction.

2.3.3.2 Overview of different methods and models to measure performance of supply chain

Different methods exist that can incorporate multiple performance indicators into one measurement system. Some of the best-known are the Supply-Chain Council's Supply-Chain Operations Reference (SCOR) model, the Balanced Scorecard, Multi-Criteria Analysis, Data-Envelopment Analysis, Life-Cycle Analysis, and Activity-Based Costing.

The Supply-Chain Council's SCOR model is a standard supply-chain process reference model designed to fit all industries (Supply-Chain Council, 2004).This model provides guidance on the types of metrics decision-makers can use to develop a balanced approach towards measuring the performance of an overall supply chain. The SCOR model advocates a set of supply-chain performance indicators as a combination of: 1) reliability measures (e.g., fill rate, perfect order fulfillment); 2) cost measures (e.g., cost of goods sold); 3) responsiveness measures (e.g., order fulfillment lead-time); and 4) asset measures (e.g., inventories). The SCOR model directly addresses the needs of supply-chain management at the operational level. One of the tenets of the SCOR model is that a supply chain must be measured and described in multiple dimensions. These dimensions include reliability, responsiveness, flexibility, cost, and efficiency of asset utilization. The SCOR model is a cross-industry model that decomposes the processes within a supply chain and provides a best-practice view of supply-chain processes. The advantages of the SCOR model are that it takes into account the performance of the overall supply chain; it proposes a balanced approach by describing performance of the supply chain in multiple dimensions. Disadvantages include the fact that SCOR is very operations-oriented and does not attempt to describe all relevant business processes or activities such as sales and marketing, research and technology developments, product developments and post-delivery customer

support. Secondly, and related tot the previous disadvantage, SCOR assumes but does not explicitly address training, quality, information technology and administration (Supply-Chain Council, 2004). Scientific research using the SCOR model is limited. Based on the SCOR model (developed by Stephens, 2000). Lai et al. (2002) used the model to evaluate supply-chain performance. Lai et al. identified three dimensions of supply chain performance in transport logistics, which are service effectiveness for shippers, operational efficiency, and service effectiveness for consignees. Based on these three dimensions a 26-item supply-chain performance measurement instrument was constructed, which was tested empirically and found to be reliable and valid for evaluating supply-chain performance in logistics. Wang (2003) related product characteristics to supply-chain strategy in order to analyse a product-driven supply chain selection, and adopted SCOR model level-1 performance metrics as the decision criteria for supplier selection. Based on the SCOR model they developed an analytic hierarchy process (AHP) with overall objective to achieve optimal supplier efficiency. Then, authors developed an integrated multi-criteria decision making methodology based on AHP and pre-emptive goal programming (PGP) so that it takes into account both qualitative and quantitative factors in supplier selection. They found that integrated AHP-PGP methodology can select the best set of multiple suppliers to satisfy suppliers' capacity constraint.

The Balanced Scorecard is a popular performance measurement scheme initially developed by Kaplan and Norton (1992). This method employs performance metrics from financial (e.g., cost of manufacturing and cost of warehousing), customer (e.g., on-time delivery and order fill rate), business process (e.g., manufacturing adherence-to-plan), innovation and technology perspective (e.g. new-product development cycle time). By combining these different perspectives, the balanced scorecard helps a manager to understand the interrelationships and trade-offs between alternative performance metrics and leads to improved decision making.

This method is not specifically designed for supply chains but could be adapted to focus on supply-chain performance. The Balanced Scorecard is more tactical and strategically oriented compared with the SCOR model, which is an operation oriented method.

The advantages of the Balanced Scorecard are that it uses four performance dimensions, both financial and non-financial, which ensures that management is given a balanced view on performance. Finally, a top-level strategy and middle management level actions are clearly connected and appropriately focused.

Disadvantages are that this approach requires considerable thoughts and effort to develop an appropriate scorecard, the scorecard does not include market-oriented performance indicators, and complete implementation should be staged (Coronel, 1998).

The Activity-Based Costing (ABC) method is based on accounting methods and involves breaking down activities into individual tasks or cost drivers, while estimating the resources (i.e., time and costs) needed for each one. Costs are then allocated based on these cost drivers, such as allocating overhead either equally or based on less-relevant cost drivers. This approach allows for better assessing the productivity and costs of a supply-chain process. By means of the ABC method companies can more accurately assess, e.g., the costs of services for a specific customer or the costs of marketing a specific product. Hence, businesses can understand the factors that drive each major activity, the costs of activities, and the relationship between activities and products. ABC analysis does not replace traditional financial accounting, but provides a better understanding of performance by looking at the same numbers in a different way (Lapide, 2000).

The advantages of ABC are that it gives more than just financial information and it recognizes the changing cost behaviour of different activities as they grow and mature. Disadvantages are that ABC, like the Balanced Scorecard, is not developed for supply chains but could be adapted. Furthermore, data collection can be costly and time-consuming. While it is difficult to determine appropriate cost drivers in ABC for businesses, this may even prove to be a bigger challenge for supply chains. ABC focuses primarily on costs.

Traditional accounting is focused on short-term financial results like profits and revenues, providing little insight into the success of an enterprise towards generating long-term value to its shareholders. To overcome this problem, the estimation of a company's Economic Value-Added (EVA) was introduced. This method is based on the assumption that shareholder value is increased when a company earns more than its cost of capital. Unlike Balanced Scorecards, which offer a functional focus toward performance, the EVA offers a project focus. EVA attempts to quantify value created by an enterprise, basing it on operating profits in excess of capital employed (through debt and equity financing). EVA metrics are less useful for measuring detailed supply-chain performance. They can be used, however, as the supply-chain metrics within an executive-level performance scorecard, and can be included in other measurement systems such as, e.g., the Logistics Scoreboard approach (Lapide, 2000). The advantages of EVA are that it explicitly considers the cost of capital and allows projects to be viewed separately.

Disadvantages of EVA are its difficulties with computations and allocation of EVA among divisions.

Multi-Criteria Analysis (MCA) establishes preferences between options by reference to an explicit set of objectives that the decision-maker has identified, and for which he or she has established measurable criteria to assess the extent to which the objectives have been achieved. This method is designed to support decision makers facing complex, multi-dimensional problems (Romero and Rehman, 2003). Several techniques exist, like direct analysis of the performance matrix, multi-attribute utility theory, linear additive models, procedures that use qualitative data inputs and so on. The following steps are carried out by the decision-makers in MCA: 1) identify the feasible alternatives or preferred outcomes; 2) identify the criteria by which to judge these outcomes; 3) apply appropriate weights on each of the criteria that reflect their particular preferences.

One of the biggest advantages of MCA is that it facilitates a participatory approach to decision making. Another advantage is that the interactive nature of the approach enables both analyst and decision-maker to learn more about the problem. Finally, it is suitable for problems where monetary values of the effects are not readily available. On the other hand, although MCA does not necessarily require quantitative or monetary data, the information requirements to derive the weights can be considerable. Furthermore, despite the use of explicit weights in MCA, the analyst may unintentionally introduce implicit weights during the evaluation process that may lead to results that cannot be explained.

Life-Cycle Analysis (LCA) involves making detailed measurements of input use and environmental waste during the production of a product, from the mining of the raw materials used in its production and distribution through to its use, possible reuse or recycling, and its eventual disposal. LCA has thus far focused on the environmental burden a product poses throughout its life. It offers possibilities for extension to economic performance, when combined with the life-cycle cost assessment method (Azapagic and Clift, 1999; Hagelaar and Van der Vorst, 2002; Carlsson-Kanyama et al., 2003).

Using the life-cycle cost-assessment method it is possible to integrate economic and environmental cost information into the LCA framework and assess the cost and environmental effects associated with the life cycle of a product or process. The advantage of this method lies in the fact that LCA allows the establishment of comprehensive baselines of information on a

product's or processor's resource requirement. Secondly, it allows identifying areas within a product's life cycle where the greatest reduction of environmental burdens can be achieved. LCA has two main disadvantages. First, it is a data-intensive methodology. Second, the proliferation of conflicting life-cycle analyses on the same products (environmental indexes assigned to each type of material can be influenced by the criteria and priority in developing the indices) are causing customers' confusion and a lack of confidence in the LCA methodology.

Hagelaar and van der Vorst (2002) used Life Cycle Assessment (LCA) to structure environmental supply chains. Their main objectives were: 1) to develop guidelines for managers of supply chains from an environmental perspective; 2) to relate a supply chain to its environmental performance; and 3) to assess the applicability of LCA as a tool for environmental supply-chain management. They concluded that if chains use LCA as a management instrument, they may have to adjust the chain structure to meet requirements set for the use of that instrument. In their paper they argue that in line with a differentiation between environmental-care chain strategies and environmental chain performances, a differentiation between types of LCA should be made, i.e., between compliance-process and market oriented LCAs. To execute these different types of LCAs, the chain structure should be adjusted to meet the specific requirements of these types. They found that the choice of the type of LCA is conditional on factors external and internal to the chain such as competition, governmental laws, consumer preferences (external) and budget, knowledge, technology, cooperation (internal), etc. Thus the integration of different types of LCAs in the chain brings about a different chain structure.

Data Envelopment Analysis (DEA) measures the efficiency of a firm (chain) relative to the efficiency of competitors. The problem with respect to efficiency in supply chains is that beside direct outputs, which are delivered directly to the market, a firm also produces output that is input to a firm in the next stage. These intermediate outputs are intermediate inputs to the firm in the adjacent stage, next to the direct inputs. Contributions of Zhu (2003) in this field are a first step towards measuring supply-chain efficiency. The method allows inclusion of various dimensions, e.g. economic and environmental performance. The problem with measuring supply-chain efficiency using the DEA model is that it requires an enormous amount of data, while data gathering is one of the most complex issues in a supply-chain context.

The advantages of DEA modelling are numerous. DEA takes a systems approach, which means that it takes into account the relationship between all inputs and outputs simultaneously. DEA

generates detailed information about the efficient supply chain within a sample and which supply chains can be used as a benchmark. DEA does not require a parametric specification of a functional form to construct the frontier. Thus there is no need to impose unnecessary restrictions on the functional forms that very often become a cause of distorted efficiency measures. DEA has the disadvantage of being a deterministic approach, which implies that statistical noise may be confounded with inefficiency.

Talluri et al. (1999) studied the importance of a partner selection process in designing efficient value chains. They propose a two-stage framework, where the first stage involves identification of efficient candidates for each type of business process (manufacturing, distribution, etc.) using DEA and the second stage encompasses the use of an integer goal-programming model to select an effective combination of the efficient business processes. Talluri and Baker (2002) proposed a multi-phase mathematical programming approach for effective supply-chain design. They developed a combination of multi-criteria efficiency models based on game theory concepts and linear integer-programming methods. The first phase evaluates suppliers, manufacturers and distributors in terms of their efficiencies with respect to input used and output generated. The model developed in this phase is a combination of a DEA model and a Pair-wise Efficiency Game (PEG). These methods generate an efficiency score for each candidate. The second phase includes the application of an integer-programming model, which optimally selects candidates for supply-chain network design by integrating efficiency scores from the first phase, demand and capacity requirements, and location constraint. The third phase identifies the optimal routing for all individuals in the network by solving a minimum-cost transhipment model.

Table 2.3: Advantages and disadvantages of methods to assess supply chain performance
(Aramyan et al., 2006)

Methods	Advantages	Disadvantages
Activity-Based Costing (ABC)	• Gives more than just financial information • Recognizes the changing cost behavior of different activities	• Costly data collection • Difficulties to collect initially required data • Difficulties to determine appropriate and acceptable costs drivers
Balanced	• Balanced view about the	• Not a quick fix

Scorecard	performance • Financial and non-financial factors • Top-level strategy and middle-management-level actions are clearly connected and appropriately focused	• Complete implementation should be staged
Economic Value Added (EVA)	• Considers the cost of capital • Allows projects to be viewed separately	• Computation difficulties • Difficult to allocate EVA among divisions
Multi-Criteria Analysis (MCA)	• A participatory approach to decision-making • Enables decision-maker to learn more about the problem • Suitable for problems where monetary values of the effects are not readily available	• Information requirements to derive the weights can be considerable • Possibility to introduce implicit weights leading to results that cannot be explained
Life-Cycle Analysis (LCA)	• Allows to establish comprehensive baselines of information on a product's or processor's resource requirement • Allows to identify areas where the greatest reduction of environmental burdens can be achieved • Possibility to assess the cost and environmental effects associated with the life cycle of a product or process	• Data-intensive methodology • Lack of confidence in the LCA methodology
Data-Envelopment Analysis (DEA)	• All inputs and outputs are included • Generates detailed information about the efficient firms within a sample • Does not require a parametric specification of functional form	• Deterministic approach • Data-intensive
Supply-Chain Council's SCOR Model	• Takes into account the performance of the overall supply chain • Balanced approach • Performance of the supply chain in multiple dimensions	• Does not attempt to describe every business process or activity • Does not explicitly address training, quality, information technology and administration

It is clear from Table 2.5 that all described methods have their advantages and disadvantages. Therefore, there is a need to consider carefully all arguments for and against the selected method to measure supply-chain performance. It is also possible to combine two different methods to measure supply-chain performance. For instance, Balanced Scorecard can be combined with EVA, because the EVA method is project-focused, while Balanced Scorecard is functional-focused. Nevertheless, when using combination of different performance measurement methods, great care needs to be taken to avoid conflicts between different performance matrices used to evaluate the performance of the chain in different dimensions.

2.3.4 Supply Chain of Automobile Industry

The supply chain of automobile industry in India is very similar to the supply chain of the automotive industry in Europe and America. The orders of the industry arise from the bottom of the supply chain i.e., from the consumers and goes through the automakers and climbs up until the third tier suppliers. However the products, as channelled in every traditional automotive industry, flow from the top of the supply chain to reach the consumers. Automakers in India are the key to the supply chain and are responsible for the products and innovation in the industry.
The description and the role of each of the contributors to the supply chain are discussed below:

Third Tier Suppliers: These companies provide basic products like rubber, glass, steel, plastic and aluminium to the second tier suppliers.

Second Tier Suppliers: These companies design vehicle systems or bodies for First Tier Suppliers and OEMs. They work on designs provided by the first tier suppliers or OEMs. They also provide engineering resources for detailed designs. Some of their services may include welding, fabrication, shearing, bending etc.

First Tier Suppliers: These companies provide major systems directly to assemblers. These companies have global coverage, in order to follow their customers to various locations around the world. They design and innovate in order to provide “black-box” solutions for the requirements of their customers. Black-box solutions are solutions created by suppliers using their own technology to meet the performance and interface requirements set by assemblers.

First tier suppliers are responsible not only for the assembly of parts into complete units like dashboard, breaks-axel-suspension, seats, or cockpit but also for the management of second-tier suppliers.

Automakers/Vehicle Manufacturers/Original Equipment Manufacturers (OEMs): After researching consumers' wants and needs, automakers begin designing models which are tailored to consumers' demands. The design process normally takes five years. These companies have manufacturing units where engines are manufactured and parts supplied by first tier suppliers and second tier suppliers are assembled. Automakers are the key to the supply chain of the automotive industry. Examples of these companies are Tata Motors, Maruti Suzuki, Toyota, and Honda. Innovation, design capability and branding are the main focus of these companies.

Dealers: Once the vehicles are ready they are shipped to the regional branch and from there, to the authorised dealers of the companies. The dealers then sell the vehicles to the end customers.

Parts and Accessory: These companies provide products like tires, windshields, and air bags etc. to automakers and dealers or directly to customers.

Service Providers: Some of the services to the customers include servicing of vehicles, repairing parts, or financing of vehicles. Many dealers provide these services but, customers can also choose to go to independent service providers.

2.3.5 Supply Chain Management of Automobile Industry

SCM is the management of a network of interconnected businesses involved in the ultimate provision of product and service packages required by end customers. Supply chain management spans all movement and storage of raw materials, work-in-process inventory, and finished goods from point of origin to point of consumption (supply chain).

The automobile industry has undergone significant structural and other changes in the last decade or so. In view of the present globalisation, implementation of lean production and the development of modularisation have changed the relationships between automobile assemblers (OEMs) and their suppliers, especially those in the first tier. Stiff competition among manufacturers will result in more mergers or acquisitions. The challenges automobile manufacturers and suppliers face include improving quality, meeting cost reduction targets and developing time to market.

All this is driving the organizations towards greater product differentiation using cutting edge R&D, innovative sales and marketing approaches, and increasing focus on boosting efficiencies in manufacturing and supply chain. Hence, in the age of e-business and global outsourcing, supply chain management (SCM) plays a crucial role in many of these areas. SCM is a best-in-class, high-performance solution which can be utilized by the world's leading automobile manufacturer, logistics and distribution companies, and retailers to blend the demand chain with the supply chain. SCM helps in demand forecasting; taking an order; giving an accurate promise date; sourcing and manufacturing the right goods; position inventory properly; pick, pack, and efficient transhipment; most importantly, SCM makes a world of difference to the manufacturers by maintaining a minimal finished goods inventory.

Supply chain management flow is divided into:

a) Product flow

b) Information flow

c) Finance flow

The product flow is nothing but movement of goods from supplier to customers and also in case of any customer returns or service requirements. The information flow covers updating the status of the delivery as well as sharing information between suppliers and manufacturers. The finance flow encompasses credit terms, payment schedules and consignment and title ownership arrangements. Supply chain management has two types of software planning application and execution applications. While planning application is utilised to determine the best way to fill the order, execution software determines the physical status of goods, the management of materials and financial information of all parties involved. Rapid surge in global sourcing of auto components has also become a challenge for manufacturers and suppliers although sourcing has reduced the cost of production substantially. Auto component manufacturers and all tiers of the supply chain have immense opportunities to enhance their entire supply chain process with the successful implementation of SCM solution.

2.3.6 Development of Balanced Scorecard

In order to put the Balanced Scorecard (BSC) to work, companies should articulate goals for time, quality, performance and service and then translate these goals into specific measures. Firms should stop navigating only by financial measures but with combination of operational measures for day-to-day business operations too.

In building a firm specific balanced SCM scorecard, following steps are recommended (Bhagwat & Sharma, 2007):

(1) Create awareness for the concept of balanced SCM scorecard in the organization;

(2) Collect and analyze data on the following items:

- Corporate strategy, business strategy and SCM strategy;
- Specific objectives and goals related to corporate strategy, business strategy and SCM strategy;
- Traditional metrics already in use for SCM evaluation;
- Potential metrics related to four perspectives of balanced scorecard;

(3) Clearly define the company specific objectives and goals of the SCM function for each of the four perspectives;

(4) Develop a preliminary balanced SCM scorecard based on the defined objectives and goals of the enterprise and the approach outlined in the paper;

(5) Receive comments and feedback on the balanced SCM scorecard from the management, and revise it accordingly;

(6) Achieve a consensus on the balanced SCM scorecard that will be used by the organization; and

(7) Communicate both the balanced SCM scorecard and its underlying rationale to all stakeholders.

It is essential to have a common understanding of the SCM related tasks in the organization and also the well defined specific goals and objectives before developing the balanced SCM scorecard. The metrics included in the balanced SCM scorecard should meet three criteria. They should be quantifiable, easy to understand, and ones for which data can be collected and analyzed in cost-effective manner. It is recognized that certain attributes do not have metrics that

can be measured directly in quantitative terms. In such cases, it will be important to relate these attributes to other ones that can be quantifiable.

Kaplan and Norton (1996) also stress the importance of adhering to three principles in order to develop BSC that is more than a group of isolated and eventually conflicting strategies and measures:

- Build in cause-and-effect relationships;
- Include sufficient performance drivers;
- Provide a linkage to financial measures.

Cause-and-effect

A strategy is a set of assumptions about cause-and-effect. If cause-and-effect relationships are not adequately reflected in the BSC, it will not translate and communicate firm's vision and strategy. These cause- and- effect relationships can involve several or all four of the perspectives in the BSC framework. For example, flexibility of service systems to meet particular customer needs (internal business operations perspective) will be more likely to meet customer expectations (customer perspective). Higher level of customer expectations will lead companies to supply more innovative products and services (learning and growth perspective). This in turn will increase the market share and profitability (financial perspective).

Performance drivers

A well built BSC will include an appropriate mix of outcome measures and performance drivers. Outcome measures like total supply chain cycle time without performance drivers like buyer–supplier partnership level do not communicate how the outcomes are to be achieved. Furthermore, performance drivers without outcome measures may enable the achievement of short-term operational improvements, but will fail to reveal whether the operational improvements have been translated into enhanced financial performance.

A company may invest resources significantly in maintaining buyer–supplier partnership and coordination in order to improve day-to-day business operations. If, however, there is no outcome measure for buyer–supplier partnership (e.g., faultless deliveries), it will be difficult for companies to determine whether its strategy has been effective. Outcome measures are more or less generic, but performance drivers are more company-specific and will often be based on the particular strategy that is being pursued.

Linkage to financial measures

The ultimate aim of a balanced SCM scorecard will be to support management in a manner that improves the overall financial performance of the enterprise. ‘‘A failure to convert improved operational performance into improved financial performance should send executives back to the drawing board to rethink the company’s strategy or its implementation plans’’ (Kaplan & Norton, 1996). Further, we must continuously keep in mind the fact that measurements are not enough, since they must be use and acted upon by the management. The BSC is not only an operational tool, but it can also be the foundation for strategic management system.

The following steps may be appropriate in order to implement effectively the balanced SCM scorecard as a strategic management system:

- Clarify and translate the vision and strategy into specific action programs;
- Link strategic objectives to team and individual goals;
- Link strategic objectives to resource allocations;
- Review performance data on a periodic basis and adjust the strategy as appropriate.

2.4 Literature Review on research methods

Greater epistemological insight into the field can be gained by examining the specific research methodologies that are used.

2.4.1 Balanced Scorecard

The applications of Balanced Scorecard found in the literature are given in the Table 2.4.

Table 2.4: BSC applications found in the literature

S.N.	Researcher	Remarks
1.	Michalska (2005)	The construction of the Balanced Scorecard and the process of its implementation in the enterprise is introduced. The usage of the Balanced Scorecard in one of Polish enterprise of metallurgic industry for the measurement of overall enterprise’s effectiveness is introduced.
2.	Sandstrom and Toivanen (2001)	Product development and design are connected to the management system of the company. The performance analysis is based on the balanced scorecard (BSC) concept and advanced cost accounting techniques. The theoretical part developed in their work has been applied in the case of a company which specializes in the manufacture of soapstone fireplaces and building stone.
3.	Maris et al. (1998)	Their work develops a balanced scorecard for information systems (IS) that measures and evaluates IS activities from the following

		perspectives: business value, user orientation, internal process, and future readiness. Case study evidence suggests that a balanced IS scorecard can be the foundation for a strategic IS management system provided that certain development guidelines are followed, appropriate metrics are identified, and key implementation obstacles are overcome.
4.	Tohidi et al. (2010)	Their emphasis is on Strategic Planning in Iranian educational organizations (especially schools). Although there are lots of problems in educational organizations, strategic planning is used rarely. The results of their work might be useful for managers of educational and related organizations, relating their internal processes to strategies and make them applicable. Using the BSC tool, the author shows how a Strategy Map is planned for educational organizations and how necessary data are gathered with interviews held with managers who had planned strategies for their organizations and who had not.

2.4.2 Interpretive Structural Modeling (ISM)

ISM has been applied by a number of researchers (Table 2.5) to develop a better understanding of the systems under consideration.

Table 2.5: ISM applications found in literature

SN	Researchers	System under consideration
1.	Pravin Kumar et al. (2008)	Agile manufacturing system
2.	Pravin Kumar et al. (2008)	Flexibility
3.	Chidambaranathan et al. (2007)	Supplier development
4.	Tsai Chi Kuo et al. (2009)	Product service system
5.	Mandal and Deshmukh (1994)	Vendor selection
6.	Jharkharia and Shankar (2005)	IT enablement of supply chain.
7.	Ravi and Shankar (2005)	Reverse logistics.
8.	Faisal et al. (2006)	Risks mitigation in supply chain.
9.	Qureshi et al. (2007)	Logistics outsourcing relationships.

2.5 Strengths of contemporary research

Approaches for developing PMSs use various ways to gather information, and there is much attention for an iterative process in which measures are developed and adjusted as more information becomes available about strategy, customers, processes, and the availability of data. There is also much attention for updating performance measures once they have been implemented.

2.6 Gaps in contemporary literature

There is far less literature that provides an understanding of how the process of developing a PMS is impacted by existing measures (or new measures that are being developed simultaneously as a result of other initiatives) at various levels both within and outside the operations function.

2.7 Conclusion

The PM literature shows clear tendencies to merge with the separate body of performance management research, as— throughout its evolution—it has continually encroached upon areas that research influences.

In summary, PM yields a fundamental type of management information needed for controlling operations. It creates focus, triggers corrective action, is the basis for evaluating performance, and may help challenging and improving strategic choices. Both the management accounting literature and the operations literature focus on the connections between strategy and PM—the role of PM as translating strategy into concrete goals and monitoring the delivery of strategy—and between Operations and PM—measures need to capture the relevant characteristics of the underlying operational processes.

Different measurement methods to measure performance of supply chain and the advantages and disadvantages of these methods have been discussed.

It is important to underline that the Balanced Scorecard is the useful tool in supporting management processes and it permits the estimation of a firm through different perspectives (financial, customers, internal processes, knowledge and development). This method is unique, mostly due to two elements: it brings all workers closer to a strategy and permits the estimation of the degree of realization of this strategy and firm's working not only through the financial results.

In this chapter, a classification of literature related to performance measurement, performance management, tools used for performance measurement and performance measurement in supply chain are reported. Also, the literature review related to supply chain management in the automobile industry has been reported. The development approach of the balanced scorecard is discussed. This chapter also included selection of research methodologies used in this research such as balanced scorecard and interpretive structural modeling.

CHAPTER 3

METHODOLOGY: BSC & ISM

3.1 Introduction

Nowadays, producers who produce products, which are not a source of advantage for the customer, do not have the right of existence. The essence of organization's working means its products to customer (Marciniak, 2002). Changing and growing requirements and needs of customers will demand from the organization, the new form of management, the new approach especially to estimation of the activities' effectiveness, monitoring of realized strategy and also in its translating the aims and tasks for each divisions and cells in the enterprise (Cholewicka-Gozdzik, 2002).

The Balanced Scorecard is the tool, which permits presentation of the shape of the different areas of working of the organization, which gives exact information on the theme of the observed object (Cholewicka-Gozdzik, 2002). With this aim The Balanced Scorecard uses coherent system of financial and outside financial ratios to present the estimation of the state of the organization. By using this card, it is possible to present the organization's strategy as a set of aims necessary for the realization of the firm's mission.

3.2 The Balanced Scorecard and its development

The Balanced Scorecard was first introduced in the early 1990s through the work of Robert Kaplan and David Norton of the Harvard Business School. Since then, the concept has become well known and its various forms widely adopted across the world (Rigby, 2001).

By combining financial measures and non-financial measures in a single report, the Balanced Scorecard aims to provide managers with richer and more relevant information about activities

they are managing than is provided by financial measures alone. To aid clarity and utility, Kaplan and Norton proposed that the number of measures on a Balanced Scorecard should also be constrained in number, and clustered into four groups (Kaplan and Norton, 1992, 1993). Beyond this, the original definition of Balanced Scorecard was sparse. But from the outset it was clear that the selection of measures, both in terms of filtering (organisations typically had access to many more measures than were needed to populate the Balanced Scorecard) and clustering (deciding which measures should appear in which perspectives) would be a key activity. Kaplan and Norton proposed that measure selection should focus on information relevant to the implementation of strategic plans, and that simple attitudinal questions be used to help determine the appropriate allocation of measures to perspectives (Kaplan and Norton, 1992).

3.3 General overview of balanced scorecard

The Balanced Scorecard is simply the set of measures (ratios) selected from four areas: financial, customer, internal processes, development and learning and their relations (Fig. 3.1) (Kaplan and Norton, 2001).

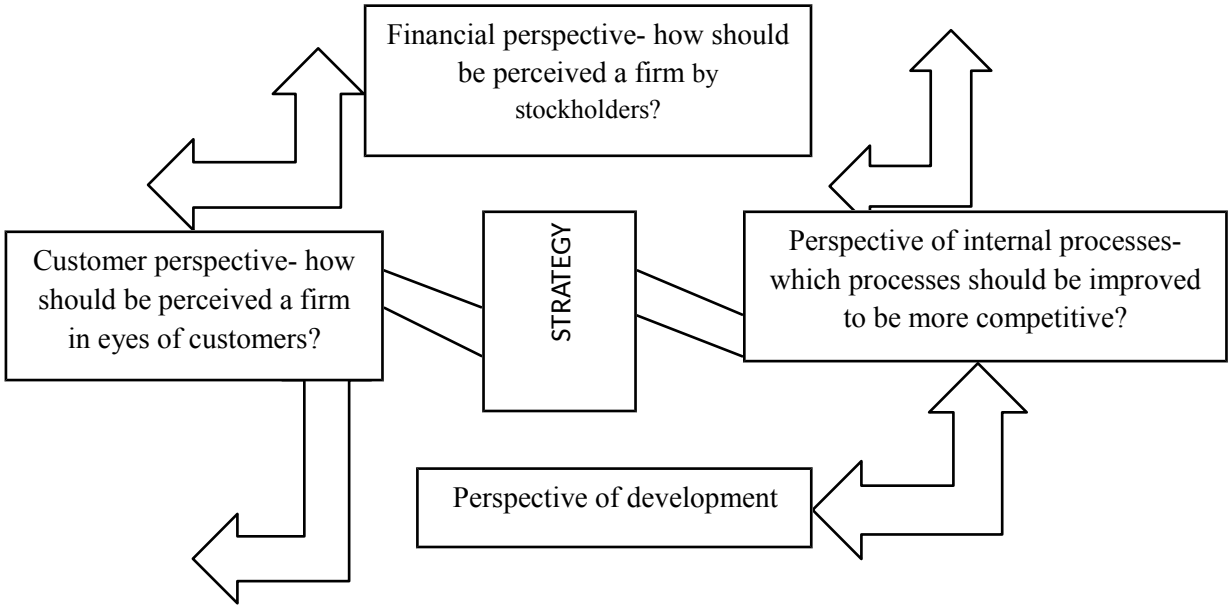


Figure 3.1: Elements of the balanced Scorecard
(Kaplan and Norton, 2001; Lisiecka, 2002)

The Balanced Scorecard is a system of measurement, which serves the management of the firm's strategy in a long period of time.

The Balanced Scorecard can be used for:

• construction of firm's strategy and initiation of its realization,

• monitoring of realization, strategy and solid process of its verification,

• translating the aims of each division, cell, team and individual worker of the firm's strategy

• analysis of cause–effect relationships appearing among all the processes which are realized in the organization,

• prognosis of the future based on real measurements referring to the past,

• motivation, which favours realization-selected strategy and complex effectiveness expressed by the financial and outside financial measures, short- and long-term.

Kaplan and Norton, creators of The Balanced Scorecard, observed that traditional systems of measurement of effectiveness used by organizations based on financial measures are inadequate in present time, because they do not present the complex effectiveness of organization. A good level of financial measures does not guarantee the firm's success, because obtaining high rentability or other ratios does not explain the real reasons of obtained state for example; it can be an example of a temporarily improving situation in the market (Cholewicka-Gozdzik, 2002)

The Balanced Scorecard is a basis of firm management system in this quality management, which is directed on realization of the strategy and through this, on growing its effectiveness (Kaplan and Norton, 2001).

The Balanced Scorecard is a set of measures, which serves to connect the vision and strategy, expressed in form of real aims and serves to the measurement of progress in realization of the strategy. Ratios are integrated in related perspectives (categories), which have both financial and outside financial character, qualifying the results of activities and stimulating the enterprise's development (Lisiecka, 2002)

In the card, effectiveness of activity is examined in four perspectives (Marciniak, 2002; Lisiecka, 2002):

- financial perspective: measures the present financial success of a firm,
- customer perspective: shows the sources of this success, which are market position and customer satisfaction,

- perspective of internal operational processes: it is measured by the processes' effectiveness,
- perspective of development: shows the abilities to changes and further development of a firm. Each perspective contains the general principles, measures and aims, and each firm individually qualifies and chooses aims and measures (Table 3.1).

Table 3.1: The Balanced scorecard *(Michalska, 2005)*

Perspectives	Principles: what do we want to achieve?	Measures: how do we measure?	Aim: realization of principles
Financial perspective Customer perspective Perspective of internal processes Perspective of development			

These basic areas are usually sufficient, but only if they are exactly defined for every organization. In case if it appears necessary, the number of perspectives can be enlarged, or one perspective can be replaced by the other. The choice and defining the areas depend on the character of the brand or specific situation, in which the organization works (Kaplan and Norton, 2001). The precise qualification of these perspectives can efficiently execute the measurement of selected ratios, that is to say what is measured; an aim, in which manner; a measure, which value is expected, and which was reached by the organization. Except for partition of The Balanced Scorecard on four basic perspectives, the further partition of every perspective is possible, making more detailed problems in frames of each perspective, in the aim of research of factors influencing the founded strategic aim (Lisiecka, 2002)

Measures of effectiveness contained in the card should be well-chosen, so that the synthetic manner showed how the enterprise efficiently and effectively realizes defined tasks. The basis of effectiveness of the inspection of activity by using The Balanced Scorecard is the comparison of the current values of measures with their values from the past period or with approach values (Marciniak, 2002).

The Balanced Scorecard contains the following ratios (Marciniak, 2002; Lisiecka, 2002)

• financial: these are traditional measures of success, such as:

- profit,
- profit rate,
- cash-flow,
- sale height,
- participation in market.

Financial measures sum up the easily measured economic effects of activities. They show whether implementing and realization of the strategy contribute to the improvement of the firm's economic results.

• customer: refers to degree of meeting the customer's needs, which are as follows:

- level of prices,
- customers' rankings,
- agreement of deliveries with orders,
- time of the realization orders,
- participation in market,
- percentage of customers conquered,
- percentage of customers kept,
- customers' satisfaction,
- acquaintance of brand.

In customer perspective, firms, customers and segments of market are identified, in which they intend to compete.

The Balanced Scorecard makes it possible for the firm to assign the main measures of the realization of the aims referring to customer, final segments of customers and market. It also permits the precise identification of value offered to customers and market segments.

• internal processes: refer to effectiveness of production processes as follows:

- length of cycle,
- number of failures,
- production on one worker,
- complaint ratio,
- percentage of accepted offers.

In this perspective, activities and key processes must be identified for realization of the aims formulated in customer and financial perspectives. It can distinguish here three groups of processes:

(a) innovative processes: in which the enterprise investigates the apparent and hidden needs of a customer, and then creates a product or service to meet these needs,

(b) operational processes: in which the enterprise creates a product and delivers it to a customer,

(c) processes of after-sale service: refers to increase in the value of work, changes of cost structure, etc.

• development:

- rotation of workers
- expenses on new technologies,
- expenses on workers' training,
- time of introducing innovation on a market.

This perspective embraces the aims and measures determining the development of the organization.

Measures expressing the grade of realization of the accepted aims have characteristic results, it means a reference to the past state or prognostic character, which permits foreseeing the development of a situation in future periods. It results from the cause–effect relations appearing between aims and measures in each perspective (Fig. 3.2) (Marciniak, 2002).

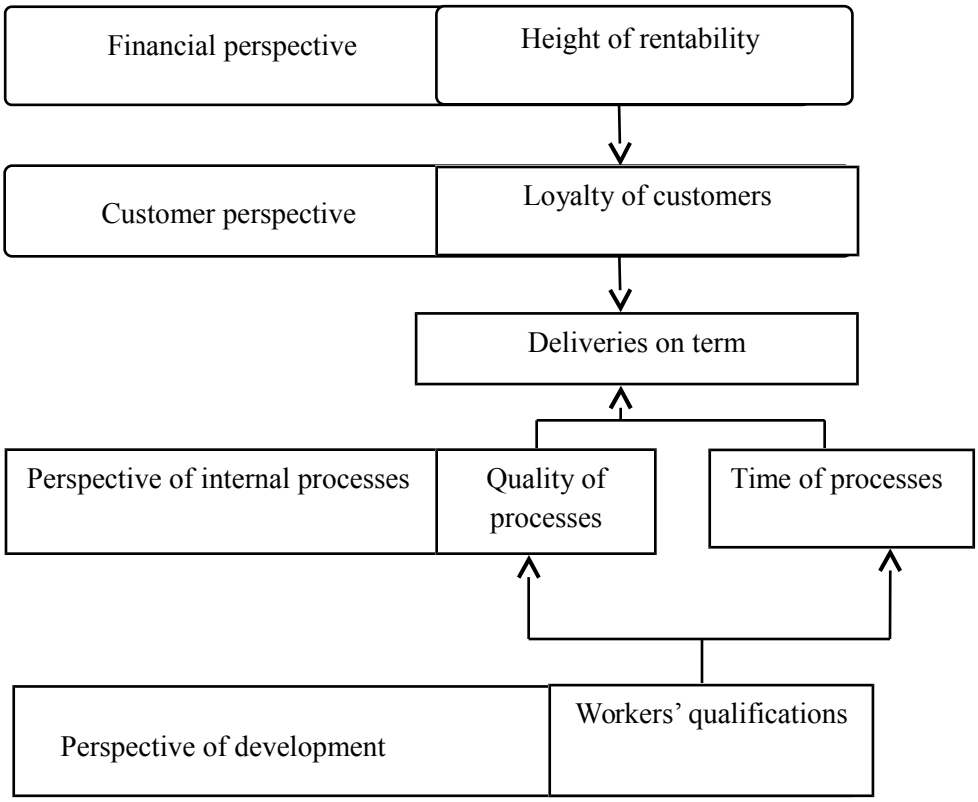


Figure 3.2: The chain of cause-effect relationship *(Marciniak, 2002)*

The Balanced Scorecard does not replace the financial measures used in the enterprise to date, but it acts as a supplement.

The measures should be (Kaplan and Norton, 2001):

• related to strategic aims of a firm,

• controlled: it is possible to influence on a value of measure through activities in frames of credited responsibility,

• directed on activities: it is possible to undertake the initiatives in the aim of improvement of effectiveness,

• simple: the rules of their calculations are easy and understandable,

• sure: they cannot be manipulated,

• possible to cascade: can be interpreted on the different levels of the organization,

• measured: it is possible to express them by numbers without carrying on the great costs.

In effectiveness estimation of strategy realization of the firms' activities, by using The Balanced Scorecard, the basis is the comparison of current amount of measures to their planned amounts and analysis of the reasons of these deviations. At the same time, it is possible to execute the coordinate comparative analyses of the amounts of measures obtained by the best firm in a given brand, which is the so-called benchmarking. The managing personnel can compare the efficiency of the activities and time of development of their own organization with the best firms (Cholewicka-Gozdzik, 2002).

The Balanced Scorecard does not resign from the existing financial ratios based on the historic data. But instead of presenting, the results of which were reached in the past, it concentrates on the aims, which the firm plans and wants to achieve in the future. The Balanced Scorecard is simply a system of related perspectives, equivalent from the point of view of essentiality, on which lies the strategy of a firm and in which is realized the monitoring of the organization's behaviour (Kaplan and Norton, 2001).

The Balanced Scorecard permits the firm's management to exit outside the narrow functional frames and achieve a general look at efficiency of the realization of the firm's strategy.

The aims of BSC are as follows (Marciniak, 2002):

• choice of measures following the results of implementing and working of a strategy,

• showing of activities, thanks to measurements,

• possibility of correcting activities in every moment, when only deviations appear,

• system of measurement should not contain financial measures influencing the financial results,

• choice of proper measures explains the essence of a strategy and contributes to its acceptance by the whole organization. The Balanced Scorecard makes possible, the introduction of four management processes, which separately or in connection contribute to relate the long-term strategic aims of a firm with the operational activities. There are as follows (Lisiecka, 2002):

• finishing up the vision and strategy of a firm: it helps managers in building the consensus relating to the vision and strategy of a firm,

• explanation of the aims and strategic measures and integration with the management systems: it makes possible delivering the strategy to the whole organization. The Balanced Scorecard gives the possibility of assurance that on all levels of organization, the strategy is understood and that both aims of divisions and individuals are related to it,

• planning, marking the aims and undertaking the strategic initiatives: it makes it possible for the firm to integrate the strategic planning with the process of budget creation,

• improving monitoring systems of strategy realization and learning about the organization: it gives the firm possibility of the so-called strategic learning. The informatic system and monitoring system of strategy realization existing in a firm concentrate on whether principal management of a firm, managers of divisions and individual workers know their own financial aims. By using The Balanced Scorecard, a firm can monitor the short-term results in three additional perspectives and evaluate the strategy in the light of obtained successes. Relations between the above management processes are presented in Figure 3.3.

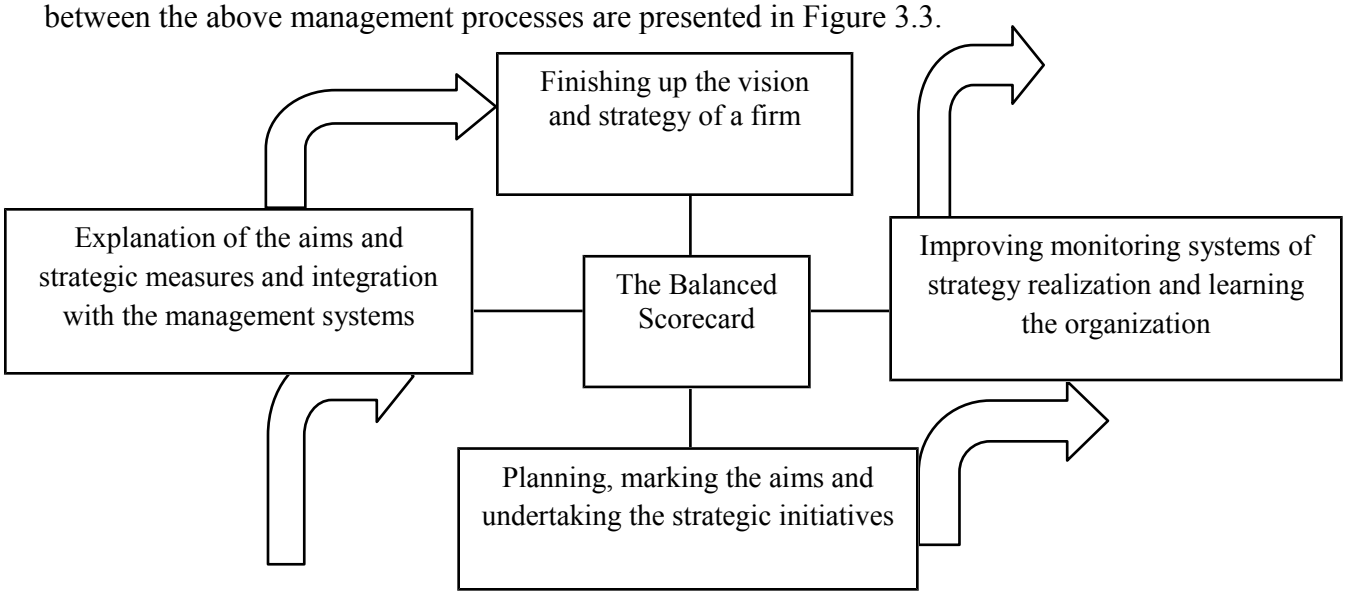


Figure 3.3: The Balanced Scorecard as a method of the strategy implementation
(Kaplan and Norton, 2001)

Elaboration and implementation of The Balanced Scorecard by an organization depends on the organization's character and environment. It means that the organization has to possess the

knowledge on the theme of weak and strong sides of a firm and exactly know the rules of working of The Balanced Scorecard (Rummler and Brache, 2000).

Implementation process of The Balanced Scorecard should be based on the following rules (Kaplan and Norton, 2001):

- exact qualification, well-fitting to the aim of the implementation of principles and correct realization of the first project work; this permits the avoiding of failures, which can come to light and strongly influence the organization in the future, verification of listed documents or execution of the audit and possible finishing up the real vision, mission and strategy of a firm, its organizational cultures and business environment,
- choosing and very exact qualification of measures: how and what will be counted and from where the source documents come,
- participation of workers of the organization (management level) in process of the implementation of The Balanced Scorecard,
- the Balanced Scorecard should be "flexible", it means that workers of the organization can be introduced to the changes brought by it,
- in the implementation process, the rule of "small steps" should be used, so as to introduce the Balanced Scorecard in stages.

3.4 Advantages of Balanced Scorecard

The advantages of implementing The Balanced Scorecard are as follows (Michalska, 2005):

• efficient implementation of the strategy through system integration of strategic management of the organization,

• translation of the strategy to detailed operational aims,

• possibility of continuous monitoring of the degree of the strategy realization, current information about this in which degree planned strategy was realized and in which stage on the way to realization of the vision is the firm,

• growing the firm's value,

• simple description and effective communication of a strategy on all levels of the organization,

• making from the strategy, the platform of integration and coordination of the initiatives and investments,

• working of the inspection system of organization directed to the future and the future financial results,

• directing activities of the whole organization and all supplies on realization and achieving planned strategic aims,

• connection to the strategy with everyday assignments and with operations of each person and department,

3.5 Interpretive Structural Modeling (ISM)

The types of organization that have successfully used ISM for addressing a wide range of problems and especially for strategic items which involve high profit impact and high supply risk include the aerospace and defense industries, education institutions, non-profit organization, etc. ISM can be used at a high level of abstraction such as needed for long-range planning. It can also be used at a more concrete level to process and structure details related to a problem or activity such as process design, career planning, strategic planning, engineering problems, product design, process re-engineering, complex technical problems, financial decision making, human resources, competitive analysis, and electronic commerce (Li et al., 2003; Banwet and Arora 1999, Rajesh et al., 2007). Mandal and Deshmukh (1993) have analyzed important supplier selection criteria to obtain an ISM, which shows the interrelationship of the criteria and their level.

The ISM will be discussed in detail in chapter 5.

3.6 Conclusion

By the use of the Balanced Scorecard, the enterprise can monitor the results in four perspectives and estimate the strategy in the light of obtained successes. Firms, which are able to translate their own strategy on a system of measurement of progresses of strategy realization through the set of results, have a greater chance of its realization. These firms can present their aims in greater details, and the management can concentrate their attention on key factors for the organization's success and undertake activities and investments, which better serve in the realization of the strategic aims.

If we create a system, which monitors the degree of implementation of the strategic principles and assure us that these principles are not only an assignment for management personnel but that all workers identify with them, then estimation of the enterprise will be based not only on financial ratios, but also on running out into the future data, qualifying the organization's degree of competition. Only such a look at organization provides a reflection of the real situation of the firm in the market, permits proper allocation of financial expenses and management concentration on some of the most important aims. By this, it can be stated that the idea of the Balanced Scorecard contributes in obtaining the full information in relation to present and future state of every organization, in which it has been successfully implemented.

CHAPTER 4

CASE STUDY

4.1 Introduction

ABC Ltd. was established in Feb 1981 through an Act of Parliament, to meet the growing demand of a personal mode of transport caused by the lack of an efficient public transport system. It was established with the objectives of - modernizing the Indian automobile industry, producing fuel efficient vehicles to conserve scarce resources and producing indigenous utility cars for the growing needs of the Indian population. A license and a Joint Venture agreement were signed with the Suzuki Motor Company of Japan in Oct 1983, by which Suzuki acquired 26% of the equity and agreed to provide the latest technology as well as Japanese management practices. Suzuki was preferred for the joint venture because of its track record in manufacturing and selling small cars all over the world. There was an option in the agreement to raise Suzuki's equity to 40%, which it exercised in 1987. Five years later, in 1992, Suzuki further increased its equity to 50% turning ABC Ltd. into a non-government organization managed on the lines of Japanese management practices.

ABC Ltd. created history by going into production in a record 13 months. ABC Ltd. is the highest volume car manufacturer in Asia, outside Japan and Korea, having produced over 5 million vehicles by May 2005. ABC Ltd. is one of the most successful automobile joint ventures, and has made profits every year since inception till 2000-01. In 2000-01, although ABC Ltd. generated operating profits on an income of Rs 92.5 billion, high depreciation on new model launches resulted in a book loss.

4.1.1 Company history and background: The Evolution

ABC Ltd.'s history of evolution can be examined in four phases: two phases during pre-liberalization period (1983-86, 1986-1992) and two phases during post-liberalization period (1992-97, 1997-2002), followed by the full privatization of ABC Ltd. in June 2003 with the launch of an initial public offering (IPO).The first phase started when ABC Ltd. rolled out its first car in December 1983. During the initial years ABC Ltd. had 883 employees, a capital of Rs. 607 mn and profit of Rs. 17 mn without any tax obligation. From such a modest start the company in just about a decade (beginning of second phase in 1992) had turned itself into an automobile giant capturing about 80% of the market share in India. Employees grew to 2000 (end of first phase 1986), 3900 (end of second phase 1992) and 5700 in 1999. The profit after tax increased from Rs 18.67 mn in 1984 to Rs. 6854.54 mn in 1998 but started declining during 1997-2001.

During the pre-liberalization period (1983-1992) a major source of ABC Ltd.'s strength was the wholehearted willingness of the Government of India to subscribe to Suzuki's technology and the principles and practices of Japanese management. Large number of Indian managers, supervisors and workers were regularly sent to the Suzuki plants in Japan for training. Batches of Japanese personnel came over to ABC Ltd. to train, supervise and manage. ABC Ltd.'s style of management was essentially to follow Japanese management practices.

The company offers a wide range of cars across different segments. It offers 15 brands and over 150 variants - Maruti 800, Omni, Eeco, Alto, Alto-K10, A-star, WagonR, Swift, Ritz, Estilo, Gypsy, Grand Vitara, SX4, Swift DZire and Kizashi. In an environment friendly initiative, in August 2010, Maruti Suzuki introduced factory fitted CNG option on 5 models across vehicle segments. These include Eeco, Alto, Estilo, Wagon R and SX4.
In fiscal 2009-10, Maruti Suzuki became the only Indian company to manufacture and sell One Million cars in a year.

ABC Ltd. has employee strength over 8,500 (as at end March 2011)
In 2010-11, the company sold over 1.27 mn vehicles including 1,38,266 units of exports. With this, at the end of March 2011, ABC Ltd. had a market share of 44.9 per cent of the Indian passenger car market.

The Path to Success for ABC Ltd. was as follows:

(a) teamwork and recognition that each employee's future growth and prosperity is totally dependent on the company's growth and prosperity

(b) strict work discipline for individuals and the organization

(c) constant efforts to increase the productivity of labor and capital

(d) steady improvements in quality and reduction in costs

(e) customer orientation

(f) long-term objectives and policies with the confidence to realize the goals

(g) respect of law, ethics and human beings.

The "path to success" translated into practices that ABC Ltd.'s culture approximated from the Japanese management practices.

ABC Ltd. adopted the norm of wearing a uniform of the same color and quality of the fabric for all its employees thus giving an identity. All the employees ate in the same canteen. They commuted in the same buses without any discrimination in seating arrangements. Employees reported early in shifts so that there were no time loss in-between shifts. Attendance approximated around 94-95%. The plant had an open office system and practiced on-the-job training, quality circles, kaizen activities, teamwork and job- rotation. Near-total transparency was introduced in the decision making process. There were laid-down norms, principles and procedures for group decision making. These practices were unheard of in other Indian organizations but they worked well in ABC Ltd. During the pre- liberalization period the focus was solely on production. Employees were handsomely rewarded with increasing bonus as ABC Ltd. produced more and sold more in a seller's market commanding an almost monopoly situation.

4.1.2 SWOT Analysis of ABC Ltd.

The SWOT analysis includes the strengths, weaknesses, opportunities and threats. The SWOT analysis of ABC Ltd. is as follows-

Strengths-

(1) *The Quality Advantage*

ABC Ltd. owners experience fewer problems with their vehicles than any other car manufacturer in India (J.D. Power IQS Study 2004). The Alto was chosen No.1 in the premium compact car segment and the Esteem in the entry level mid - size car segment across 9 parameters.

(2) *A Buying Experience Like No Other*

ABC Ltd. has a sales network of 307 state-of-the-art showrooms across 189 cities, with a workforce of over 6000 trained sales personnel to guide ABC Ltd. customers in finding the right car.

(3) *Quality Service Across 1036 Cities*

In the J.D. Power CSI Study 2004, ABC Ltd. scored the highest across all 7 parameters: least problems experienced with vehicle serviced, highest service quality, best in-service experience, best service delivery, best service advisor experience, most user-friendly service and best service initiation experience.

92% of ABC Ltd. owners feel that work gets done right the first time during service. The J.D. Power CSI study 2004 also reveals that 97% of ABC Ltd. owners would probably recommend the same make of vehicle, while 90% owners would probably repurchase the same make of vehicle.

(4) *One Stop Shop*

The customers will find all car related needs met under one roof at ABC Ltd. The ABC Ltd. is set to provide a single-window solution for all car related needs whether it is easy finance, insurance, fleet management services, exchange.

(5) *The Low Cost Maintenance Advantage*

The acquisition cost is unfortunately not the only cost customers face when buying a car. Although a car may be affordable to buy, it may not necessarily be affordable to maintain, as some of its regularly used spare parts may be priced quite steeply. Not so in the case of a ABC Ltd. It is in the economy segment that the affordability of spares is most competitive, and it is here where ABC Ltd. shines.

(6) *Lowest Cost of Ownership*

The highest satisfaction ratings with regard to cost of ownership among all models are: Zen, Wagon R, Esteem, 800, Alto and Omni.

(7) *Technological Advantage*

ABC Ltd. has introduced the superior 16 * 4 Hypertech engines. This new technology harnesses the power of a brainy 16-bit computer to a fuel-efficient 4-valve engine to create optimum engine delivery. This means every ABC Ltd. owner gets the ideal combination of power and performance from his car.

Weaknesses-

(1) The cost involved in R&D and infrastructure is low in India as compared to other country.

(2) Indian is growing as an export hub along with the Indian Market growing altressively into becoming an attractive one for investors.

(3) Lack of experience with foreign market.

(4) Comparatively new to diesel cars.

(5) Heavy import tarrifs on fully built imported models.

Opportunities-

(1) Prospectives buyers from the two wheeler segment.

(2) Increased purchasing power of Indian middle class category.

(3) Huge export market such as Europe, America and other Indians car.

Threats-

(1) The threat of ABC Ltd. faces is the growing competition in compact cars.

(2) Threats from Chinese manufacturers.

(3) There is a threat to ABC Ltd.

models ageing. ABC Ltd. models like 800 which is in market for the last twenty years and other like Zen and Esteem which have also entered the decline phase are the other threats.

(4) Competition from second hand cars and TATA Nano.

4.1.3 SCM in ABC Ltd.

The company works jointly with its suppliers to develop new products, achieve high localization levels, and reduce cost. With a large number of variants under the 15 running models, the supply chain management is especially challenging. Company's A-Star model alone has around 750 variations, some of them would be cosmetic and a few others deep rooted so as to conform to different emission norms in different countries. The supply chain solution enables the concerned product reach in time, be it the type of fabric used, the audio system, the tyres or the specific engine and transmission systems. The entire inventory management has also been fully automated and integrated with its vendors.

4.1.3.1 Key Challenges of ABC Ltd.

When it comes to its operation and supply chain, ABC Ltd.'s key challenges include:

- Achieving a lean supply chain
- Managing effectively the variations in the components for various models
- Managing continuous supply-demand matching and optimization
- Achieving efficient use of materials and other resources
- Managing demand and customer expectations
- Enabling ABC Ltd, suppliers and dealers to constantly adapt their strategies, processes and systems to meet dynamic market needs.

4.1.3.2 Key SCM Initiatives of ABC Ltd.

Due to stiff competition and cost leadership of ABC Ltd., lean manufacturing and zero inventory are its goals. The supply chain management of ABC Ltd. represents one of the best examples of lean manufacturing in the country. The manufacturing plants have been almost fully linked to IT systems and all inventory and processes are networked. Every component-set has a bar coded tag which helps to monitor the movement of materials right from suppliers to the Trim line. This helps to know exactly how much inventory is present on the assembly lines (using the P-BOM (Production Bill of Materials)).

4.1.4 Manufacturing facilities of ABC Ltd.

The manufacturing facilities of ABC Ltd. in India are-

- Gurgaon Manufacturing Facility
- Manesar Manufacturing Facility

Both manufacturing facilities have a combined production capacity of 1,250,000 vehicles annually.

4.1.4.1 Gurgaon Manufacturing Facility

The Gurgaon Manufacturing Facility has three fully integrated manufacturing plants and is spread over 300 acres (1.2 km^2). All three plants have an installed capacity of 350,000 vehicles annually but productivity improvements have enabled it to manufacture 700,000 vehicles annually. The Gurgaon facilities also manufacture 240,000 *K-Series* engines annually. The entire facility is equipped with more than 150 robots, out of which 71 have been developed in-house. The Gurgaon Facilities manufactures the 800, Alto, WagonR, Estilo, Omni, Gypsy and Eeco.

4.1.4.2 Manesar Manufacturing Facility

The Manesar Manufacturing Plant was inaugurated in February 2007 and is spread over 600 acres (2.4 km^2). Initially it had a production capacity of 100,000 vehicles annually but this was increased to 300,000 vehicles annually in October 2008. The production capacity was further increased by 250,000 vehicles taking total production capacity to 550,000 vehicles annually. The Manesar Plant produces the A-star, Swift, Swift DZire and SX4.

Manesar plant of ABC Ltd. has won a 2007 Nikkei "Monozukuri" Award. The award reflects a high independent evaluation of technological advances and Japanese-style quality control used at the Manesar plant, which is as strategically important to Suzuki as the Kosai and Iwata plants in Japan. Manesar plant of ABC Ltd. produces more than 100,000 vehicles per year for the rapidly growing Indian domestic market and for export to Europe, the Middle East, and Africa. Constructed on a 2,400,000m^2 site, it has automatic systems for 70% of its welding processes and 80% of its painting processes. Some of its production facilities are even more advanced than those used at Suzuki plants in Japan, and its personnel take part in seminars on Japanese production techniques in order to maximize quality.

The Nikkei "Monozukuri" Awards are sponsored by Nihon Keizai Shimbun (also known as Nikkei), Japan's premier publisher of financial, business, and industry news. They are given in recognition of craftsmanship- and technology-related excellence (for example, innovations and

production systems that realize exceptional productivity; training programmes that pass on advanced skills; and automation achieved through digitization of skilled tasks.

4.2 Development of balanced scorecard for the automobile industry

In the Balanced scorecard, effectiveness of activity is examined in four perspectives (Marciniak, 2002, Lisiecka, 2002)

- financial perspective: measures the present financial success of a firm,
- customer perspective: shows the sources of this success, which are market position and customer satisfaction,
- perspective of internal operational processes: it is measured by the processes' effectiveness,
- perspective of development: shows the abilities to changes and further development of a firm.

The following perspectives are selected for the development of the balanced scorecard:

- customer perspective
  - Customer relationship
  - Customer satisfaction
- perspective of development:
  - Innovation
  - Range of products and services,
  - Threats or substitutes (competitors)
  - Environmental aspects
- perspective of internal operational processes:
  - Waste reduction
  - Time compression

- financial perspective

  - Cost associated with assets and return on investment
  - Total inventory cost.

4.3 Customer perspective: Customer relationship

Customer relationship comprises the entire array of practices that are employed for the purpose of managing customer complaints, building long-term relationships with customers, and improving customer satisfaction (Aggarwal, 1997; Claycomb et al., 1999; Tan et al., 1998).

Noble (1997) and Tan et al. (1998) consider customer relationship management as an important component of SCM practices. The growth of mass customization and personalized service is leading to an era in which relationship management with customers is becoming crucial for corporate survival (Wines, 1996). Close customer relationship allows an organization to differentiate its product from competitors, sustain customer loyalty, and dramatically extend the value it provides to its customers (Magretta, 1998).

4.3.1 Customer Relationship Management (CRM) at ABC Ltd.

In these competitive times the challenge is to keep inventing newer ways of doing things to keep the customers in your fold. Over the last few years, the company strengthened the existing practices and experimented with many new initiatives by way of kaizens (continuous improvements) to delight its customers. These initiatives ranged from product design and quality to network expansion, and included new service programs to meet unsaid needs of customers. The company has retained its competitive edge by offering high quality products. In the field, the products are supported by rapidly expanding networks. The company has diverse networks for new cars, spares, service, pre owned cars and soon, and all of them were in expansion mode last year to enable the company get closer to the customer. The company takes great pride in sharing that customers have rated ABC Ltd. first once again in Customer Satisfaction Survey conducted by independent body, J.D. Power Asia Pacific. It is 9th time in a row. The company was first Car Company in India to launch a Call Centre in the year 2000.The award mirrors the company's commitment towards “Customer Obsession”.

In order to achieve a 'single view of customers' and a platform for 'marketing for one', ABC Ltd. embarked on an analytical CRM (aCRM) project. The aCRM project has improved customer segmentation and targeting. It helps marketers assess which prospects are most likely to transact and also identifies those who are bogged down in a sales process and need assistance. Empowered by a CRM, the car-maker can find and acquire potential customers, nurture and retain those the company already has, entice former customers back into the fold, and trim marketing and client servicing costs.

Customer Relationship Management (CRM) includes the methodologies, technology and capabilities that help an enterprise manage customer relationships. The general purpose of CRM

is to enable organizations to better manage their customers through the introduction of reliable systems, processes and procedures.

Customer Relationship Management is a corporate level strategy which focuses on creating and maintaining lasting relationships with its customers. Although there are several commercial CRM software packages on the market which support CRM strategy, it is not a technology itself. Rather, a holistic change in an organization's philosophy which places emphasis on the customer.

Management at ABC Ltd. believes that a successful CRM strategy cannot be implemented by simply installing and integrating a software package. Changes must occur at all levels including policies and processes, front of house customer service, employee training, marketing, systems and information management. To be effective, the CRM process has been integrated with end-to-end across marketing, sales, and customer service.

The objectives of CRM at ABC Ltd. are:

- To identify customer success factors.
- To create a customer-based culture.
- To adopt customer-based measures.
- To develop an end-to-end process to serve customers.
- To recommend what questions to ask to help a customer solve a problem.
- To recommend what to tell a customer with a complaint about a purchase.
- To track all aspects of selling to customers and prospects as well as customer support.

Before implementing the CRM segment the management at ABC Ltd. did a survey to identify what profile aspects it feels are relevant to its business, such as what information it needs to serve its customers, the customer's past financial history, the effects of the CRM segment and what information is not useful. Being able to eliminate unwanted information is a large aspect of implementing CRM systems.

4.3.1.1 Architecture of CRM at ABC Ltd.

There are three parts of application architecture of CRM at ABC Ltd. -

- Operational CRM- automation to the basic business processes (marketing, sales, service)
- Analytical CRM (aCRM)- support to analyze customer behavior, implements business intelligence alike technology

- Collaborative CRM- ensures the contact with customers (phone, email, fax, web, sms, and post)

Operational CRM

Operational CRM at ABC Ltd. includes customer contact (sales, marketing and service). Tasks resulting from these processes are forwarded to employees responsible for them, as well as the information necessary for carrying out the tasks and interfaces to back-end applications are being provided and activities with customers are being documented for further reference.

Operational CRM provides the following benefits-

- Delivers personalized and efficient marketing, sales, and service through multi-channel collaboration
- Enables a 360-degree view of the customer while you are interacting with them
- Sales people and service engineers can access complete history of all customer interaction with the company, regardless of the touch point .

The operational part of CRM typically involves three general areas of business at ABC Ltd.-

- Sales force automation (SFA)
- Customer service and support (CSS)
- Enterprise marketing automation (EMA)

Sales force automation (SFA)

SFA automates the critical sales and sales force management functions of ABC Ltd., i.e., lead/account management, contact management, quote management, forecasting, sales administration, keeping track of customer preferences, buying habits, and demographics, as well as performance management. SFA tools are designed to improve field sales productivity. Key infrastructure requirements of SFA are mobile synchronization and integrated product configuration.

Customer service and support (CSS)

CSS at ABC Ltd. automates the service requests, complaints, product returns, and information requests. The internal help desk and inbound call-center support for customer inquiries have been evolved into the "customer interaction center" (CIC), using multiple channels (Web, phone/fax,

face-to-face, kiosk, etc). Key infrastructure requirements of CSS include computer telephony integration (CTI) which provides high volume processing capability, and reliability.

Enterprise marketing automation (EMA)

EMA of the company provides information about the business environment, including competitors of ABC Ltd., industry trends, and macro environmental variables. It is the execution side of campaign and lead management. The intent of EMA applications is to improve marketing campaign efficiencies. Functions include demographic analysis, variable segmentation, and predictive modeling occur on the analytical (Business Intelligence) side. Integrated CRM software is often also known as "front office solutions." of ABC Ltd. This is because they deal directly with the customer of the company. ABC Ltd. uses CRM software to store all of their customer's details. When a customer calls at ABC Ltd., the system is used to retrieve and store information relevant to the customer. By serving the customer quickly and efficiently, and also keeping all information on a customer in one place, the management at ABC Ltd. aims to make cost savings, and also encourage new customers.

Analytical CRM (aCRM)

In analytical CRM, data gathered within operational CRM and/or other sources are analyzed to segment customers or to identify potential to enhance client relationship. Customer analysis typically leads to targeted campaigns to increase share of customer's wallet.

Examples of campaigns directed towards customers are:

- Acquisition: Cross-sell, up-sell
- Retention: Retaining customers who leave due to maturity or attrition.
- Information: Providing timely and regular information to customers about ABC Ltd.
- Modification: Altering details of the transactional nature of the customers' relationship.

Analysis of Customer data relates to the following analysis:

- Campaign management and analysis
- Contact channel optimization
- Contact Optimization
- Customer Acquisition / Reactivation / Retention
- Customer Segmentation
- Customer Satisfaction Measurement / Increase
- Sales Coverage Optimization
- Fraud Detection and analysis
- Financial Forecasts

- Pricing Optimization
- Product Development
- Program Evaluation
- Risk Assessment and Management

Collaborative CRM

Collaborative CRM facilitates interactions with customers through all channels (personal, letter, fax, phone, web, e-mail) and supports coordination of employee teams and channels. It is a solution that brings people, processes and data together so company can better serve and retain their customers.

Collaborative CRM provides the following benefits:

- Enables efficient productive customer interactions across all communications channels
- Enables web collaboration to reduce customer service costs
- Integrates call centers enabling multi-channel personal customer interaction
- Integrates view of the customer while interaction at the transaction level

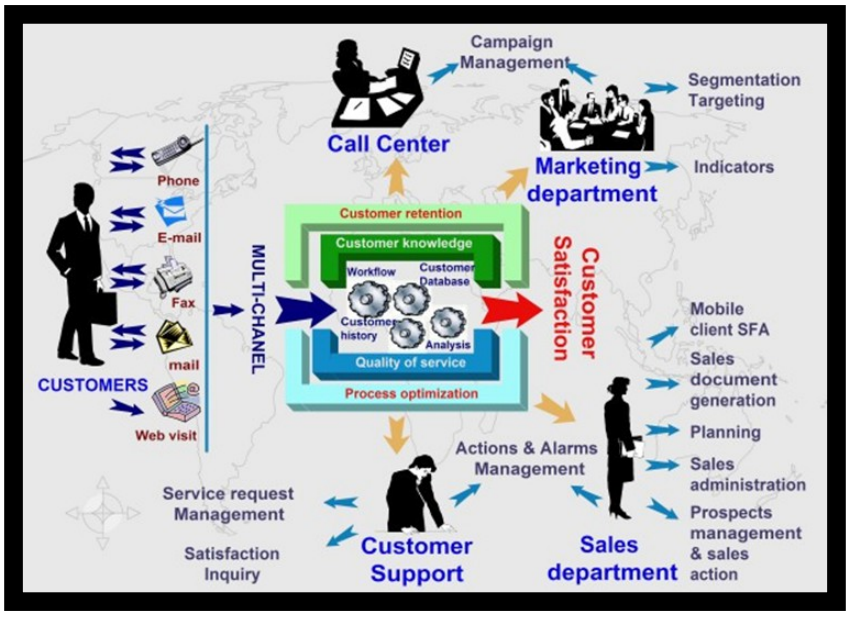


Figure 4.1: Customer Relationship Management (CRM)
Source: http://www.amigolog.com/ConsultancyCRM.phtml

The CRM can be integrated into other cross-functional systems and thereby provide accounting and production information to customers when they want it

4.3.2 Customer satisfaction: Customer centric approach at ABC Ltd.

ABC Ltd.'s customer centricity is very much exemplified by the five times consecutive wins at J D Power CSI Awards. Focus on customer satisfaction is what ABC Ltd. lives with. ABC Ltd. has successfully shed off the public- sector laid back attitude image and has inculcated the customer-friendly approach in its organization culture. The customer centric attitude is imbibed in its employees. ABC Ltd. dealers and employees are answerable to even a single customer complaint. There are instances of cancellation of dealerships based on customer feedback.

ABC Ltd. has taken a number of initiatives to serve customer well. They have even changed their showroom layout so that customer has to walk minimum in the showroom and there are norms for service times and delivery of vehicles. The Dealer Sales Executive, who is the first interaction medium with the ABC Ltd. customer when the customer walks in ABC Ltd. showroom, is trained on greeting etiquettes. ABC Ltd. has proper customer complain handling cell under the CRM department. The ABC Ltd. call center is another effort which brings ABC Ltd. closer to its customer. Their market research department remains on its toes to study the changing consumer behaviour and market needs. ABC Ltd. enjoys seventy percent repeat buyers which further bolsters their claim of being customer friendly. ABC Ltd. is investing a lot of money and effort in building customer loyalty programmes.

4.4 Perspective of development

The perspectives of development selected are innovation, range of products and services, threats or substitutes (competitors) and environmental aspects.

4.4.1 Innovation

The product finalization point measure addresses the increasingly important issue of postponement (Bovet & Sheffi, 1998). The underlying premise of postponement is that creating finished goods that are not immideately sold commits an organisation's resources, which increases the likelihood that it will experience stockouts and markdowns. The goal is to push final product completion as close to the final customer as possible in an effort to reduce inventories and minimize the risk of unsold product. The way to manage postponement is to create product or process innovations that enable a supply chain to reduce the time elapsed between finalization and customer delivery (i.e., complete product assembly late in the supply chain process).

4.4.1.1 Innovative ideas and continuous improvement in ABC Ltd.

India's biggest automobile brand is a number the 800 made by ABC Ltd. The little car, called the 'Fronte' and 'Alto' at different times and in different countries, attained iconic status through constant innovation, price cuts achieved through higher volumes and efficiencies, and lower cost of ownership, to overcome the hugely negative pre-launch perceptions and stay abreast of the best the market had to offer in its category.

In a couple of years, the car that revolutionised Indian motoring may pass into history. ABC Ltd. has decided to stop selling it, along with Omni, in 11 key cities from next year. Under the new emissions rules, only Euro IV-compliant models can be sold in these cities and the cost of upgrading 800 or Omni to the new standards would be prohibitive.

Launched with almost totally imported components, the 800 transformed the car ownership experience in India, and also the automobile component manufacturing industry that supported it. The 800 set new standards on how cars were sold at launch. Forms were sold through banks and, after submission, a computer-generated allotment number was provided so that every applicant knew the date of delivery. For special cases, though, there was a directors' quota. Pricing was structured in a new way too besides the ex-showroom cost of the car, buyers had to pay a delivery charge for transportation to their city.

Finally, the 800 was launched with the ABC Ltd. van (later called the Omni) and buyers could switch models within a certain date - a new option in Indian car buying again. Driven by unprecedented high sales as a result of these innovations, the 800 received additional marketing boosts through its 25-year long life. For example, when other small cars came along to challenge its hegemony, ABC Ltd. relaunched the 800 with easy financing, offering the basic model at Rs 2,399 a month.

This financing package created lakhs of new car buyers who found the monthly installment affordable and comparable to the family travel bill on a 2-wheeler and public transport. And then, there were the engineering innovations that made the 800 the success it was. For example, to cope with water logging on Indian roads that routinely stalled the Hindustan Motors Ambassador and Premier Padmini, engineers raised the air intake pipe of the 800 to the highest level under the car bonnet and placed a small steel plate just ahead of it.

As long as the car moved, the steel plate pushed away the water and created an air pocket that kept the engine running. The car also boasted of virtually waterproof electricals for the first time in the country and this added to its ability to survive flooded streets. Its small size and relatively minute tire size generated equally negative perceptions and many predicted it would collapse on potholed roads, more so given the Indian penchant for overloading cars. In reality, the front strut and rear beam suspension combination, along with front engine-front wheel drive design and unitary shell body (all firsts in India) gave it unprecedented ability to cope with challenging terrain.

The initial model had a 796cc (hence the name 800) engine, producing approximately 34 bhp of power, ran on 12-inch wheels with a kerb weight of around 650 kg, but could seat four adult passengers and a child and convey them at speeds that baffled HM and Premier owners, with fuel consumption of around 15-18 km a liter against the Ambassador's 7-11 km and Padmini's 8-12 km a liter.

Above all, buyers woke up to the outstanding safety provided by the brakes and headlamps of the 800, which were several generations ahead of all other Indian cars of that time. This meant shorter stopping distances to avoid crashes, and much better visibility in darkness or in foggy conditions.

The key initiatives for innovative ideas and continuous improvement in ABC Ltd. are as follows-

- Car pickup & delivery facility for women car owners: The vehicle pickup and delivery before and after service has a strong impact on customer satisfaction. In particular, customers who say that their vehicle was picked up from their doorstep before service and delivered to the same point after service are notably more delighted with their after-sales service experience, compared with customers who do not receive this service.
- ABC Ltd. also launched mission to promote safe driving habits jointly with Institute of Driving Training and Research.
- It also launched Dil Se- a special program for Indians living abroad or NRIs, to facilitate them to gift ABC Ltd. cars online to friends and relatives at home.
- Online club Swift Life is made for all Swift owners. Setting up "Express Service Bays" & "2 - Technician Bays"as the name suggests, the company set out to delight its customers

by offering them faster car service by introducing new concepts such as Express Service Bays & 2-Technicians Bays.

These are done for customers who are hard pressed for time. Both the initiatives undertaken in this direction have helped improve customer interface and also helped increase the productivity and capacity of existing workshops.

- Mega Camps: The company aggressively conducts 'Mega Camps' throughout the country round the year. Activities undertaken during a mega camp include complimentary car wash, AC & Pollution check up, oil and fuel top ups, wheel alignments etc. Apart from mega camps workshop camps like A/C checkup camps, and general check-up camps, Locality camps , Pre monsoon camps etc. are also regularly conducted as part of customer connect initiatives.
- Service at Door Step through ABC Ltd. Mobile Support: Another unique initiative is the door step service facility through ABC Ltd. Mobile Support. ABC Ltd. Mobile Support is a first of its kind initiative and is expected not only to help the company reach out customers in metro cities but also as a mean to reach semi urban /rural areas where setting up of new workshop may not be viable.
- Car Safety device- Immobilizer: The company used technology to meet customer needs and even delight them. Following feedback that the company's cars were more prone to theft owing to their resale value, the company worked on an anti-theft immobilizer or "I-Cats;" system for all its new cars.
- Complete car needs: The company's effort of providing all car-related needs from learning to drive a car at ABC Ltd. Driving Schools to car insurance, extended warranty and eventually exchanging the existing car for a new one under one roof at dealerships also enhances customer satisfaction. The organization needed greater visibility into customer preference, their economical strata, behavior, and needs.

4.4.2 Range of product and services

According to Mapes et al. (1997), a plant that manufactures a broad product range is likely to introduce new products more slowly than plants with a narrow product range. Plants that can manufacture a wide range of products are likely to perform less well in the areas of value added per employee, speed and delivery reliability. This clearly suggests that product range affects supply chain performance.

4.4.2.1 Range of products in ABC Ltd.

ABC Ltd. offers 15 models: 800, Omni, Esteem, Baleno, Alto, Versa, Ritz, Gypsy, A Star, Wagon R, Zen Estilo, Swift, Swift Dzire, SX4, and Grand Vitara. Swift, Swift Dzire, A star and SX4 are maufactured in Manesar, Grand Vitara is imported from Japan as a completely built unit (CBU), remaining all models are manufactured Gurgaon Plant of ABC Ltd.

4.4.3 Threats or substitutes (competitors)

The critical issue facing the Indian passenger car industry is the attainment of break-even volumes. This is related to the quantum of investments made by the players in capacity creation and the selling price of the car. The amount of investment in capacities by passenger car manufacturers in turn depends on the production.

The competitive forces in Indian passenger car market are as follows -

- Threat from the new players: Increasing
  - Most of the major global players are present in the Indian market; few more are expected to enter.
  - Financial strength assumes importance as high are required for building capacity and maintaining adequacy of working capital.
  - Access to distribution network is important.
- Rivalry within the industry: High
  - There is keen competition in select segments. (compact and mid size segments).
  - New multinational players may enter the market.
- Market strength of suppliers: Low
  - A large number of automotive components suppliers.
  - Automotive players are rationalizing their vendor base to achieve consistency in quality.
- Market strength of consumers: Increasing
  - Increased awareness among consumers has increased expectations. Thus the ability to innovate is critical.
  - Product differentiation via new features, improved performance and after-sales support is critical.

- Increased competitive intensity has limited the pricing power of manufacturers.

➢ Threat from substitutes: Low to medium

With consumer preferences changing, inter product substitution is taking place (Mini cars are being replaced by compact or mid sized cars).Setting up integrated manufacturing facilities may require higher capital investments than establishing assembly facilities for semi knocked down kits or complete knocked down kits. In recent years, even though the ratio of sales to capacity (an important indicator of the ability to reach break-even volumes) of the domestic car manufacturers have improved, it is still low for quite a few car manufacturers in India. India is also likely to increasingly serve as the sourcing base for global automotive companies, and automotive exports are likely to gain increasing importance over the medium term. However, the growth rates are likely to vary across segments. Although the Mini segment is expected to sustain volumes, it is likely to continue losing market share; growth in the medium term is expected to be led largely by the Compact and Mid-range segments. Additionally, in terms of engine capacity, the Indian passenger car market is moving towards cars of higher capacity. This apart, competition is likely to intensify in the SUV segment in India following the launch of new models at competitive prices.

4.4.3.1 Threats (competitors) for ABC Ltd.

The competitor analysis of ABC Ltd. with Hyundai Motor India Limited and Tata Motors is given as follows-

- Hyundai Motor India Limited
  - Hyundai Motor India Limited (HMIL) is a wholly owned subsidiary of Hyundai Motor Company, South Korea and is the second largest and the fastest growing car manufacturer in India. HMIL presently markets over 25 variants of passenger cars in six segments.
  - Hyundai's pricing strategy: With the launch of Swift recently a price war was expected to kick in. Immediately after ABC Ltd. raised prices on its debutante Hyundai Motor India hit back with Rs 16,000-19,000 markdown on three new variants of Santro Xing. The company has introduced the XK and XL variants at a lower tag of Rs 3,26,999 and Rs .3,45,999 respectively. The new price variants are

likely to give ABC Ltd.'s existing B-segment models, Zen and WagonR a run for their money. Hyundai has also launched a new non-AC variant of the Santro at Rs 2.79 lakh, a tad higher than what the existing non-AC Santro costs. The next offensive is due from ABC Ltd. With the Santro's new price positioning, Zen and particularly WagonR may be due for a correction, or at least a limited-period subvention.

- Tata Motors
  - Established in 1945, Tata Motors is India's largest and only fully integrated automobile company. Tata Motors began manufacturing commercial vehicles in 1954 with a 15-year collaboration agreement with Daimler Benz of Germany.
  - Tata Indica: The company's passenger car range comprises the hatchback Indica, the Indigo sedan and the Marina, its station wagon variant, in petrol and diesel versions. The Tata Indica, India's first indigenously designed and manufactured car, was launched by Tata Motors in 1999 as part of its ongoing effort towards giving India transport solutions that were designed for Indian conditions. Currently, the company's passenger cars and multi-utility vehicles have a 16-per cent market share.
  - Positioning of Indica: Tata has positioned Indica as `more car per car'. The new car offers more space, more style, more power and more options. Emphasizing the delivery of world class quality. They have tried to redefine the small car market as it has been understood in India.True to its "More car per car" positioning, the Indica CNG offers all the core benefits of the Indica combined with the advantage of CNG.
  - Tata's pricing strategy: After the price war being triggered off by Hyundai being the first company to introduce what came to be known as, pricing based on customer's value perceptions , all others followed suit. Telco's Indica came in the range of Rs 2.56 lakh to Rs 3.88 lakh with 4 models. The price-points in the car market were replaced by price-bands. The width of a price-band was a function of the size of the segment being targeted besides the intensity of competition. The thumb rule being 'the higher the intensity, the wider the price-band.'

4.4.4 Environmental aspects

Environmental issues have started to show their impact on industries globally. Consumers are increasingly opting for more environment-friendly vehicles with lower carbon footprint. Governments have imposed stringent environmental regulations on original equipment manufacturers (OEMs) for emissions control and fuel economy. In the middle of these changes, the global automotive industry is undergoing a fundamental transformation to meet environmental requirements and adapt to new consumer preferences. Government regulations, however, vary significantly from one region to another, adding complexity to the mix of vehicles offered by OEMs. As a result, global OEMs and suppliers are being challenged to constantly update their product portfolios to meet numerous regional regulatory requirements, which are expected to add significantly to their manufacturing costs.

4.4.4.1 Environmental aspects in ABC Ltd.

The 'Golden Peacock Eco-Innovation Award' is given annually to the most innovative product satisfying the customers' long-term needs in a most cost-effective manner. This international certification is awarded to a company only when it demonstrates its commitment and compliance to environmental concerns; ensure quality, especially in terms of customer satisfaction; and taking adequate health and safety measures to contain risks and hazards to its workforce.

The World Environment Foundation (WEF) is one of the leading non-profit, non-governmental organizations solely dedicated to the improvement of the environment and the sustainable development.

ABC Ltd., the leader in Indian car market, has bagged the 'Golden Peacock Eco-Innovation Award' in 2009 for adopting environment friendly technology in its products and processes. The award was presented to the company by the World Environment Foundation during the recently organized 'Global Convention on Climate' in Palampur, Himachal Pradesh. An eminent jury, under the Chairmanship of Justice P N Bhagwati, former Chief Justice of India and Member, United Nations Human Rights Commission, selects the winner. The criterion of the award was based on a product or service, which shows a quantum jump in the usage of current technology to achieve maximum customer satisfaction at a minimum cost.

ABC Ltd. was short-listed for the award for two landmark initiatives taken towards reduction in the green house gas emissions throughout the life cycle.

- First, the company launched K-series engines, that are ready for future emission norms,. This series includes engines that are compliant with BS-III, BS-IV norms (the currently applicable environment norms in India) as well as the Euro-V (for the European markets). These engines are highly fuel efficient while being very low on CO_2 emission. The K series engines are used in the recently launched Ritz as well as A-star in India. The A-star is exported as Suzuki Alto to the European markets. The Alto is Euro-V compliant and has CO_2 emissions as low as 103g/km. ABC Ltd.'s parent company, Suzuki Motor Corporation, Japan has designed the K-series engines with an aim to play an important environmental role globally, by introducing Green Engine technology that is vital for reducing CO_2 emissions and enhancing fuel consumption.
- The second initiative that helped ABC Ltd. bag the award was the company's initiative to use specially designed double-decker railway rakes for dispatching cars as opposed to the conventional use of trailers. This, first of its kind initiative in India helps in transporting cars in highly efficient manner, at much lower costs and impact on environment.

Over the years, through sustained investment on environment friendly technology for both products and processes and in-house innovations, ABC Ltd. has been able to bring down the per unit consumption of precious natural resources like power and water.

All ABC Ltd. production facilities at Gurgaon and Manesar are ISO 14001 certified. ABC Ltd. was the country's first passenger car company to be certified for Environment Management Systems as per ISO 14001:1996 in 1999. The company has based its production operations on the principle of "Smaller, fewer, lighter, shorter and neater". As a shared value system with its parent company, Suzuki Motor Corporation, Japan, this principle defines the environment friendly initiatives at ABC Ltd.

4.5 Perspective of internal operational processes: Waste reduction and Time compression

The perspectives of internal operational processes selected are: Waste reduction, Time compression.

4.5.1 Waste Reduction

Firms practicing SCM seek to reduce waste throughout the supply chain by minimizing duplication, harmonizing operations and systems, and enhancing quality. With respect to duplication, firms at all levels in the supply chain often maintain inventories. Efficiencies can be gained for the chain as a whole if the inventories can be centralized and maintained by just a few points in the distribution process.

The other means to reduce waste is to harmonize operations and systems among supply chain members. Harmonization seeks to achieve uniformity of operations and systems among the firms. Rather than have two different pallet systems, for example, it makes sense for all supply chain participants to use only one. In this way, they can use common equipment in handling and storing pallet loads and gain leverage for the entire supply chain in dealing with pallet vendors.

Also, maintaining the quality of product, operations, and assets is essential to operating a supply chain that is predicated on waste reduction. Products that do not meet customer specifications will undermine the tight time requirements associated with just-in-time deliveries.

4.5.1.1 Waste Reduction in ABC Ltd.

While a full-fledged department co-ordinates environment initiatives, employees and partners contribute in promoting the 'Three R-s': Reduce, Recycle and Reuse so that stress on natural resources is minimal in the manufacturing processes.

Reduce

- *Reducing water use in Air Conditioning Plant:* Water use has been eliminated by introducing air-cooled condensers and closed cycle cooling towers in compressed air plant.
- *Reducing water wastage:* One of the employee-driven initiatives is relentless focus on zero water wastage by following the simple principle of just-in-time water supply. Sensors at various water hoses, closets and wash areas have helped bring down water consumption.
- *Reducing consumption of raw paint:* Multi axes painting robot have been introduced in the Paint Shop within the factory to increase the efficiency of paint transfer and thereby reduce the raw paint consumption. This also reduces the paint sludge (industrial waste) generated from the process.

  Further, colour grouping technique adopted in the painting process has brought down the wastage and paint loss as well as reduced consumption of thinner for flushing out paint.

This has also helped in reducing the paint sludge generation and in turn the Volatile Organic Compound emissions into the atmosphere.

- *Reducing size of machines:* 'Over sizing' is a major cause that brings in energy inefficiency. Rightsizing of equipment and tools is a critical driver in energy saving and the company has revisited the complete production processes for this initiative.
- *Reducing energy consumption:* The shop floor and offices have been designed in such a way that abundant natural light is available throughout the day. Extensive use of translucent polycarbonate sheets on the side walls and roof help to reduce the dependence on artificial light sources. Maximum use of solar energy in form of solar lamps and heaters helps in power conservation, while natural ventilators use wind energy as against electrical energy to keep the rooms cool.
  Other measures to reduce energy consumption:

  - Increased use of energy efficient lighting systems (CFLs, T-5 lights).
  - Optimization of energy efficiency by installing common pumps for electrical efficiency.
  - Installation of automated switch boards for shop floor lights/emergency lights.

- *Reducing Noise Pollution:* By installing 'noise curtains' in certain areas and creating enclosure for compressor, noise pollution has been minimised, providing better working conditions for employees in these areas.

Reuse

- *Waste Heat Recovery:* As a first-of-its-kind initiative in manufacturing, the company is reusing waste gases for steam generation and use in the manufacturing process. The company uses steam turbine to power compressors. Reuse of waste steam from these boilers has eliminated the requirement of electrical motors in the processes.
- *Reuse of packaging material:* In order to reduce the wooden and cardboard waste, almost 100 per cent of the domestic components come in dedicated reusable bins and trolleys to the factory production lines.
- *Reuse of Waste:* Sewage Treatment Plant sludge is reused in horticulture as manure

Recycle

The ABC Ltd.'s plants in Gurgaon and Manesar reutilize the waste water generated. In fact, nearly 50% of the water demand of the plant is met by recycled water.

- Rain Water harvesting: Recharging shafts and water lagoons help in recharging rain water in to the ground.
- Incinerators: State-of the-art incinerators burn industrial wastes at high temperatures. The high temperature in the incinerator helps reducing environmental discharge of harmful gaseous waste
- Secured Landfill Pits: Special landfills have been designed for storage of hazardous waste that cannot be incinerated to ensure that no hazardous material leaks from anywhere. Furthermore, these pits have been designed keeping in mind the properties of the waste so that chemical properties do not interfere with each other.

4.5.2 Time Compression

One of the critical goal of SCM is the compression of order-to-delivery cycle time. When production processes are completed in less time, all entities in the supply chain are able to operate more efficiently, and a primary result is reduced inventories throughout the system.

Time compression also enables supply chain partners more easily to observe and understand the cumulative effect of problems that occur anywhere in the chain and respond quickly. Time compression means that information and products flow smoothly and quickly, which permits all parties to respond to customers in a timely manner while maintaining minimal inventory.

4.5.2.1 Time Compression in ABC Ltd.

The time compression is achieved in ABC Ltd. through the following-

- Slashing product time-to-market through die design automation: Using NX and Teamcenter, ABC Ltd. Die Shop realizes dramatic time savings in press die development cycle; savings include 90 hours in designing draw die structure components. The company was experiencing increasing pressure to introduce new models in a shorter time frame. There was also growing pressure to improve quality and reduce costs. To complicate matters, customer needs and perceptions were no longer gradually evolving, but now rapidly changing. More specifically, certain product development domains represented the greatest opportunity to address these key challenges. These included reducing new tooling development time, reducing die design time, reducing costs by substantially decreasing the need for rework, and improving quality.

ABC Ltd. Die Shop uses a number of traditional and advanced processes in the design, validation, manufacturing and commissioning of its dies, including NX software and Teamcenter software from Siemens PLM Software.

- NX Die Structure Design applications play key role in die design standardization: Data is received from the Product Design Group of ABC Ltd. in NX format. Then the die face, which includes addendum, binder, draw bead, etc., is designed using NX tools. The data is transferred to external computer-aided engineering (CAE) software to do the validation of forming simulation, e.g., addressing wrinkles in the sheet metal folds, thinning, bend and trim line issues, etc.

  Once the simulation is done, the part is tipped to the die position based on CAE feedback and a layout is prepared via NX 2D drafting by taking sections on the parts. The die structures are then built. Finally, it's 2D and 3D machining, die assembly and tryout, and off to production.

  The entire process is similar to that used by other original equipment manufacturers (OEMs), except ABC Ltd. Die Shop has made significant process advancements in a number of areas, especially relative to its die structures preparation and building.
- Templates yield 90 hours saved for draw die structure components: Using NX die design tools, ABC Ltd. Die Shop has built many templates for its die design stage. The designer is presented with the template, which shows the parameters of the parts. The designer simply enters the new product specifications to update the template to the current design. The mating of the standard parts is captured, so that any change to a part reflects the position of the standard parts as well. This substantially accelerates the speed with which die structures are designed.
- Cloning concept: ABC Ltd. Die Shop accomplished this important time reduction through what it describes as its "cloning concept" in which the repeated structures in a design are identified and treated as standard structure parts, creating the primitive or basic template design. Mating points are defined, mounting bodies created, map files identified for positioning, etc., using the template structure.
- Siemens' product lifecycle management (PLM) tools: It used to take approximately 180 hours to build the components of the draw die structure. "Using Siemens' product lifecycle management (PLM) tools, now it takes about 90 hours – a 50 percent improvement."

- Standardization delivers 10 hours saved per die involving cam units: ABC Ltd. Die shop has brought design standardization to its cam unit creation. Instead of modeling each cam one by one, the company has created standard parts to automatically build the cam unit. The company has achieved a time saving of 10 hours per die involving cam units, which translates to potentially exponential savings depending on the project.

- Teamcenter manages family of parts repository, resulting in another 10 hours saved per die for standard parts: ABC Ltd. Die Shop has 75-80 family members in its standard parts library, enabling the quick creation of thousands of standard parts. The family of parts library is managed by Siemens' Teamcenter, which connects people throughout the lifecycle with a single source of product and process knowledge.
  ABC Ltd. Die Shop's leveraging of a family of parts repository has resulted in additional important die development process efficiencies – 10 hours saved per die for standard parts.
- Dynamic collision checking tools of Siemens: ABC Ltd. Die Shop's goal is to do the entire validation in a wholly integrated environment that includes forming simulation, dynamic kinematics simulation, etc. This would essentially eliminate the sometimes awkward and time-draining steps involved in transferring data through the initial graphics exchange specification (IGES), standard for the exchange of product model data (STEP) or other formats. As part of this new approach, the company is also evaluating the dynamic collision checking tools of Siemens to identify and eliminate any interference that may occur during die operations.
- Bill of materials (BOM): The bill of materials (BOM) represents another item that ABC Ltd. Die Shop wants to leverage for time and cost savings. Currently the designers manually enter each material item, including associated data, onto a spreadsheet – a very time-consuming process. The plan is to generate the BOM automatically from the 3D models.

4.6 Financial perspective: Supply chain finance and logistics cost

Determining the total logistics cost can assess the financial performance of a supply chain. It is necessary to decide on a broad level of strategies and techniques that would contribute to the smooth flow of information and materials in the supply chain environment. They are used to

assess the financial performance of supply chain, such as assets cost, return on investment, and total inventory cost.

4.6.1 Cost associated with assets and return on investment

Supply chain assets include accounts receivable, plant, property and equipment and inventories (Stewart, 1995). With increasing inflation and decreased liquidity, pressure is on firms to make the assets sweat, i.e. improve the productivity of their capital. In this regard, it is essential to determine how the costs associated with each asset, combined with its turnover, affects the ‘‘total cash flow time’’. According to Stewart (1995), this can be measured as the average number of days required transforming the cash invested in assets into the cash collected from a customer.

Once the total cash flow time is determined, it can readily be combined with profit with the objective of providing an insight into the rate of return on investment (ROI). This determines the performance that the top management can achieve on the total capital invested in business. As a corollary to this, the logistics management policies have a significant impact on ROI.

For example, superior customer service leads to improved sales and an increased profit, and subsequently, a higher ROI. Likewise, other areas of organization can be explored. By measuring ROI and the impact of the logistics policies on it, significant insights can be gained about the financial health of the supply chain.

4.6.2 Total inventory cost

In a supply chain, inventories range from raw materials, subassemblies and assemblies to finished products, as well as inventories held up in transit. What was traditionally perceived as a buffer in production to cope with uncertainties actually emerged to be one of the reasons for the increase in lead-time (Slack et al., 1995). As customer service requirements constantly increase, effective management of inventory in a supply chain becomes increasingly critical and important. Hence, it is essential that costs associated with inventory

should be evaluated, and proper trade-offs, with suitable performance measures, should be implemented.

In a supply chain, the total costs associated with the inventory (Christopher, 1992; Dobler & Burt, 1996; Lee & Billington, 1992; Levy, 1997; Slack et al., 1995; Stewart, 1995) consists of the following:

• Opportunity cost consisting of warehousing, capital and storage.
• Cost associated with inventory as incoming stock level, work in progress.
• Service costs, consisting of costs associated with stock management and insurance.
• Cost held up as finished goods in transit.
• Risk costs, consisting of costs associated with pilferage, deterioration, damage.
• Cost associated with scrap and rework.
• Cost associated with shortage of inventory accounting for lost sales/lost production.

In dealing with these costs, consideration should also be given to part/material size. A low cost part may have large size, and consequently, a large space requirement. Also, in deciding which cost should be tackled first, Pareto analysis can be used to prioritize the options. In addition, proper trade-offs should be considered in dealing with inventory at various levels in a supply chain. An excellent discussion on this, based on pitfalls and opportunities, is provided by Lee and Billington (1992). In particular, they point out that the cost of reworking stored components due to engineering changes and the risk of obsolescence could inflate the inventory holding costs by 40%. Clearly, not considering such factors may lead to inappropriate choices.

In dealing with inventory in transit, a trade-off is needed because changing the mode of transportation can significantly affect inventory investment and service performance. A faster and more expensive shipping mode may save enough in inventory investment to justify increase in shipping cost, but if inventory costs rates are appropriately chosen. According to Levy (1997), care must also be taken for longer lead-time due to longer distance as it increases the ‘‘volatility’’ of inventories, resulting in either too high or too low inventory levels. This, in turn, can lead to higher administrative costs being incurred, and can be the cause of costs due to lost sales.

Another factor that needs to be measured and dealt with regarding inventory is the accuracy of forecasting techniques. According to Fisher (1997), supply chain in many industries suffers from inventory, owing to their inability to predict demand. A new demand forecasting system that takes sales data from distributor’s computer and combines with on-hand inventory could serve as a technique to deal with this problem. Harrington (1996) shows that using such techniques, Microsoft has been able to keep production schedules open until one week, and make what the market will accept. Therefore, measuring inventory at supply, production, distribution and scrap

levels as well as accuracy of forecasting techniques, can provide an insight into the cost performance and reduce the lead-time in a supply chain.

4.6.3 Pricing strategy in ABC Ltd. - catering to all segments

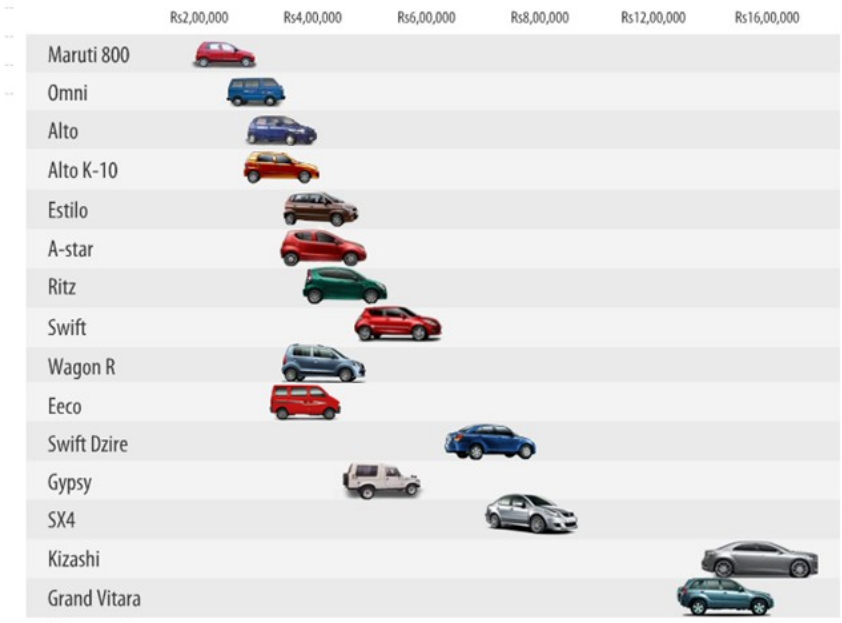


Figure 4.2: Prices of various models
Source: www.marutisuzuki.com

ABC Ltd. caters to all segment and has a product offering at all price points. ABC Ltd. gets 70% business from repeat buyers who earlier had owned a ABC Ltd. car. Their pricing strategy is to provide an option to every customer looking for up gradation in his car. Their sole motive of having so many product offering is to be in the consideration set of every passenger car customer in India. Every price point is covered as follows-

- *Offering one stop shop to customers or creating different revenue streams:* ABC Ltd. has successfully developed different revenue streams without making huge investments in the form of MDS, N2N, ABC Ltd. Insurance and ABC Ltd. Finance. These help them in making the customer experience hassle free and helps building customer satisfaction.

- *ABC Ltd. Finance:* In a market where more than 80% of cars are financed, ABC Ltd. has strategically entered into this and has successfully created a revenue stream for ABC Ltd. This has been found to be a major driver in converting a ABC Ltd. car sale in certain cases. Finance is one of the major decision drivers in car purchase. ABC Ltd. has tied up with 8 finance companies to form a consortium. This consortium comprises Citicorp Maruti, Maruti Countrywide, ICICI Bank, HDFC Bank, Kotak Mahindra, Sundaram Finance, Bank of Punjab and IndusInd Bank Ltd. (erstwhile-Ashok Leyland Finance).
- *ABC Ltd. Insurance**:*** Insurance being a major concern of car owners. ABC Ltd. has brought all car insurance needs under one roof. ABC Ltd. has tied up with National Insurance Company, Bajaj Allianz, New India Assurance and Royal Sundaram to bring this service for its customers. From identifying the most suitable car coverage to virtually hassle-free claim assistance it's the dealer who takes care of everything. ABC Ltd. Insurance is a hassle-free way for customers to have their cars repaired and claims processed at any ABC Ltd. dealer workshop in India.
- *True Value:* Initiative to capture used car market: Another significant development is ABC Ltd.'s entry into the used car market in 2001, allowing customers to bring their vehicle to a ' ABC Ltd. True Value' outlet and exchange it for a new car, by paying the difference. They are offered loyalty discounts in return. This helps them retain the customer. With ABC Ltd. True Value customer has a trusted name to entrust in a highly unorganized market and where cheating is rampant and the biggest concern in biggest driver of sale is trust. ABC Ltd. knows its strength in Indian market and has filled this gap of providing trust in Indian used car market. ABC Ltd. has created a system where dealers pick up used cars, recondition them, give them a fresh warranty, and sell them again. All investments for True Value are made by dealers. ABC Ltd. has build up a strong network of 172 showrooms across the nation. The used car market has a huge potential in India. The used car market in developed markets was 2-3 times as large as the new car market.
- *N2N Fleet Management:* N2N is the short form of End to End Fleet Management and provides lease and fleet management solution to corporates. Its impressive list of clients who have signed up of this service include Gas Authority of India Ltd, DuPont, Reckitt Benckiser, Sona Steering, Doordarshan, Singer India, National Stock Exchange and Transworld. This fleet management service include end-to-end solutions across the

vehicle's life, which includes Leasing, Maintenance, Convenience services and Remarketing. Car maintenance is a time-consuming process, especially if you own a fleet. ABC Ltd.'s N2N Fleet Management Solutions for companies, takes care of the A-Z of automobile problems. Services include end-to-end backups/solutions across the vehicle's life: Leasing, Maintenance, Convenience services and Remarketing.

- *ABC Ltd. Driving School:* ABC Ltd. has established this with the goal to capture the market where there is inhibition in buying cars due to inability to drive the car. This brings that customer to ABC Ltd. showroom and ABC Ltd. ends up creating a customer.
- *Playing on cost leadership:* ABC Ltd. is the price dictator in Indian automobile industry. It's the low cost provider of car. The lowest car on road is from ABC Ltd. stable i.e. 800. ABC Ltd. achieves this through continuous improvements in operational efficiency and productivity. The impressive sales and profits were the result of major efforts within the company. ABC Ltd. also increased focus on vendor management. ABC Ltd. consolidated its vendor base. This has provided its vendors with higher volumes and higher efficiencies. ABC Ltd. does that by working with vendors, assuring them that for every drop in price, volumes will go up. ABC Ltd. is now encouraging its vendors to develop R&D capability for specialized components. Based upon such activities, product competitiveness in the market will further increase.

4.6.4 Enterprise Resource Planning (ERP)

ERP is an enterprise-wide information system designed to coordinate all the resources, information, and activities needed to complete business processes such as order fulfillment or billing. The system supports most of the business system that maintains in a single database the data needed for a variety of business functions such as Manufacturing, Supply Chain Management, Financials, Projects, Human Resources and Customer Relationship Management.

ABC Ltd. supports business growth with scalable, high-performing ERP System. The open interfaces of Oracle E-Business Suite offered the best integration with our legacy systems. Standardizing on Oracle technology and applications would also lower support costs and ensure easy upgrades in the future.

ABC Ltd. has led India's car market for more than a quarter of a century. The year 2002 saw ABC Ltd. add finance, leasing, insurance, and pre-owned car businesses to its portfolio, increasing the scale of its operations and prompting are view of its processes and systems.

Oracle Consulting was engaged to install a number of Oracle E-Business Suite modules and integrate them with ABC Ltd.'s existing systems. The eight-month project involved managing up to 50 people, including ABC Ltd. staff, Oracle consultants, and employees of third-party organizations. Oracle also assisted ABC Ltd. with change management, a critical part of the process to ensure quick user acceptance. Thorough project management by Oracle Consulting enabled ABC Ltd. to go live on the Oracle applications without any interruptions to its business. By standardizing on a single Oracle platform, the company achieved better control of its finance, procurement, and human resources functions. It also gained a more manageable and scalable platform to support its rapidly expanding business.

Prior to employing Oracle, ABC Ltd. used a number of home-grown systems to manage its various lines of business. Many of these disparate systems could not talk to each other, requiring staff to enter data multiple times and consolidate information to generate management reports. The addition of four new business sectors in 2002 created further pressures, requiring constant monitoring and human intervention to keep the system operating across the hundreds of locations ABC Ltd. serves within India. To support this growth and improve efficiency, the company decided to revamp its information technology systems to provide end-to-end visibility into the organization.

To minimize the impact of the system change on its business, ABC Ltd. decided on a phased migration to Oracle E-Business Suite. As a first step, the company decided to replace its financial, purchasing, and human resources systems with Oracle Financials, Oracle Procurement, and a range of Oracle Human Resources applications. Oracle Consulting was selected to supervise the implementation, including determining ABC Ltd.'s requirements and developing a project plan, designing the system, deploying the software, managing the various parties involved, and providing post-implementation support.

The problem with using multiple systems to manage finances was the lack of control over processes and information quality. Each office followed different workflows, which often meant one division lagged behind another in delivering information. Differing data formats required tedious consolidation, preventing real-time access to critical statistics. With Oracle Financials, ABC Ltd. was able to standardize on a single financial management platform. So standardization has improved financial insight. The company achieved tight control over accounts payable and

accounts receivable, and gained a comprehensive general ledger that assists in the management of all financial information.

ABC Ltd. implemented Oracle Purchasing to manage procurement of capital goods, services, and indirect consumables. Prior to implementing Oracle Purchasing, some subsidiaries had a rudimentary system, while others relied on basic spreadsheets to manage the process. This made it difficult for the organization as a whole to have control over capital and services purchasing, leading to escalating costs and excess inventory.

With Oracle, ABC Ltd. now has a standardized platform to oversee procurement. The streamlined procurement has lowered the costs. The company has set up a list of preferred suppliers to cut down on the number of vendors it deals with and ensure it has control over costs. An automated workflow sends purchase orders along the approvals chain and keeps staff in the accounts payable department aware of all procurement activity.

4.6.5 Net Sales in ABC Ltd.

ABC Ltd.'s revenue has grown consistently over the years. The net sales in ABC Ltd. are provided in Table 4.1.

Table 4.1: Net Sales (Rs. in Million) in ABC Ltd.

Source: www.marutisuzuki.com

Year	Net Sales	Year	Net Sales
2005-06	1,20,034	2006-07	1,45,922
2007-08	1,78,603	2008-09	2,03,583
2009-10	3,01,198	2010-11	3,61,282

Car market leader ABC Ltd. sold a total of 85,565 vehicles in September, 2011. This includes 6,749 units for export.

The disruption in production owing to the labour issue at the Company's Manesar plant during September adversely impacted the sales numbers during the month. The Swift, SX4 and A-star are manufactured at the Manesar plant.

The sales figures for September 2011 are given in Table 4.2.

Table 4.2: ABC Ltd.'s Sales figures for September 2011

Source: www.marutisuzuki.com

Category : Sub-Segment	Models	September			Till September			April '10 - March '11
		2011	2010	% Change	2011-12	2010-11	% Change	
A: Passenger vehicles : Mini	M800, Alto, A-Star, WagonR	37324	48780	-23.5%	234900	252994	-7.2%	573238
A: Passenger vehicles : Compact	Swift, Estilo, Ritz	19722	21749	-9.3%	100515	128585	-21.8%	261799
A: Passenger vehicles : Super Compact	Dzire	9411	8566	9.9%	45383	50361	-9.9%	107955
A: Passenger vehicles : Mid -Size	SX4	196	1965	-90.0%	9909	9959	-0.5%	23317
A: Passenger vehicles : Executive	Kizashi	14	0	0.0%	171	0	0.0%	138
Total A: Passenger Vehicles		66667	81060	-17.8%	390878	441899	-11.5%	966447
B: Utility Vehicles	Gypsy, Grand Vitara	412	266	54.9%	3846	3807	1.0%	5666
C: Vans	Omni, Eeco	11737	13822	-15.1%	78365	75117	4.3%	160626
Total Domestic Sales		78816	95148	-17.2%	473089	520823	-9.2%	1132739
Total Export Sales		6749	12858	-47.5%	60744	76155	-20.2%	138266
Total Sales (Domestic + Export)		85565	108006	-20.8%	533833	596978	-10.6%	1271005

* Kizashi was launched in February 2011.

4.7 Conclusion

The four perspectives and related metrics represent a template rather than definitive strategic SCM measurement system. Future research is recommended in order to determine whether the proposed perspectives and measures are a necessary and sufficient set. Nevertheless, the framework does represent a strategic SCM evaluation tool that can be used to monitor and guide specific projects and general performance improvement efforts. The value of the balanced SCM scorecard rises if it is used to evaluate SCM performance on daily routine basis to coordinate wide range of business operations simultaneously. The management of companies are likely to benefit at all decision levels from a systematic framework based on goals and measures that are agreed upon in advance.

CHAPTER 5

INTERPRETIVE STRUCTURAL MODELING

5.1 Introduction

In recent years, a number of firms realized the potentials of SCM. However, they often lack the insight for the development of effective performance measures and metrics needed to achieve a fully integrated supply chain. Moreover, such measures and metrics are needed to test and reveal the viability of strategies without which a clear direction for improvement and realization of goals would be highly difficult. Lee and Billington (1992) argue that discrete sites in a supply chain do not lead to an improved productivity if each is to pursue its goals independently, which has been the traditional practice. There is, however, a greater need to study the measures and metrics in the context of the following two reasons:

(1) Lack of a balanced approach. Many companies have realized the importance of financial and non-financial performance measures. However, they failed to understand them in a balanced framework.

According to Kaplan and Norton (1992), while some managers and researchers have concentrated on financial performance measures, others have concentrated on operational measures. Such an inequality does not lead to metrics that can present a clear picture of the organizational performance. As suggested by Maskell (1991), for a balanced approach, companies should bear in mind that, while financial performance measurements are important for strategic decisions and external reporting, day-to-day control of manufacturing and distribution operations is better handled with non-financial measures.

Another area where inequality persists is deciding on the number of metrics to be used. Quite often, companies have a large number of performance measures to which they keep on adding based on suggestions from employees and consultants, and fail to realize that performance measurement can be better addressed using a good few metrics.

(2) Lack of a clear distinction between metrics at strategic, tactical, and operational levels. Metrics that are used in performance measurement influence the decisions to be made at strategic, tactical, and operational levels. However, we fail to come across any such classification for supply chain management. Using a classification based on these three levels, each metric can be assigned to a level where it would be most appropriate. For example, in dealing with

inventory, it would be most suitable to assess it from an operational point of view where day-to-day inventory level can be measured and monitored.

In this chapter, performance measures of supply chain have been analyzed using the ISM approach, which shows the interrelationships, and their driving power and dependence. And also through ISM order have been imposed on the complexity of the performance measures which could act as a guide in the supply chain performance measurement. The performance measures in this study have been identified from the literature review and the opinion of the experts.

The main objectives of this chapter are:

- To identify the measures in performance measurement of supply chain;
- To establish the relationship among these identified performance measures;
- To discuss the managerial implications of the ISM model for the performance measures.

5.2 Identification of performance measures of supply chain

The selected performance measures of supply chain are as follows-

1. Employee's Commitment
2. Management's Commitment
3. Logistics Flexibility
4. Manufacturing Flexibility
5. Volume Flexibility
6. Production Flexibility
7. Delivery Performance
8. Quality Performance
9. Cost Performance
10. Productivity
11. Benchmarking
12. Labour Cost
13. Technology
14. Material Cost
15. Perfomance Measurement System of Supply Chain Management

5.3 ISM Methodology and Model Development

Interpretive structural modeling (ISM) is an interactive learning process, which systemizes the different and directly related elements into a structured system (Warfield, 1974; Sage, 1977). It transforms a complex problem into visible, well-defined models serving the purposes (Sage, 1977). It helps in identifying the inter-relationships among variables. It also helps to impose

order and direction on the complexity of relationships among elements of a system. ISM develops a collective understanding of relationships among the performance measures.

ISM is a modeling technique in which the specific relationships of the variables and the overall structure of the system under consideration are presented in a directed graph model. ISM is primarily intended as a group learning process, but it can also be used individually.

The various steps involved in the ISM technique are:

(1) Identification of elements or factors that are relevant to the problem- this could be done by survey or any group problem-solving technique;

(2) Establishing a contextual relationship between the elements with respect to which pairs of elements would be examined;

(3) Developing a structural self-interaction matrix (SSIM) of elements, this indicates pair-wise relationship between elements of the system;

(4) Developing a reachability matrix from the SSIM, and checking the matrix for transitivity – transitivity of the contextual relation is a basic assumption in ISM which states that if element A is related to B and B is related to C, then A is necessarily related to C;

(5) Partitioning of the reachability matrix into different levels;

(6) Based on the relationships given above in the reachability matrix, drawing a directed graph (digraph), and removing the transitive links;

(7) Converting the resultant digraph into an ISM-based model by replacing element nodes with the statements; and

(8) Reviewing the model to check for conceptual inconsistency, and making the necessary modifications.

5.3.1 Structural Self-Interaction Matrix (SSIM)

For analyzing the enablers a contextual relationship of "leads to" is used. To develop contextual relationships among enablers, expert opinions based on various management techniques such as brainstorming, nominal group technique, idea generation, etc. were considered. For expressing the relationship between different performance measures in a supply chain performance measurement system, four symbols have been used to denote the direction of relationship between the parameters i and j (here $i < j$):

(1) V: enabler i will lead to enabler j;

(2) A: enabler j will lead to enabler i;

(3) X: enabler i and j will lead to each other; and

(4) O: enabler i and j have no relationship.

Table 5.1: Structural Self-Interaction Matrix (SSIM)

Enablers	15	14	13	12	11	10	9	8	7	6	5	4	3	2
1 Employee's Commitment	V	O	O	V	V	V	V	V	V	V	V	V	O	A
2 Management's Commitment	V	O	V	V	V	V	V	V	V	V	V	V	V	
3 Logistics Flexibility	V	O	O	O	O	O	O	O	V	O	O	O		
4 Manufacturing Flexibility	V	O	O	O	O	O	O	O	V	V	V			
5 Volume Flexibility	V	O	O	O	O	O	O	O	V	O				
6 Production Flexibility	V	O	O	O	O	O	O	O	V					
7 Delivery Performance	V	O	O	O	O	O	O	O						
8 Quality Performance	V	O	O	O	A	O	O							
9 Cost Performance	V	A	A	A	O	A								
10 Productivity	V	A	A	A	O									
11 Benchmarking	V	O	O	O										
12 Labour Cost	V	O	O											
13 Technology	V	O												
14 Material Cost	V													
15 PMS														

5.3.2 Reachability Matrix

The SSIM has been converted into a binary matrix, called the initial reachability matrix by substituting V, A, X and O by 1 and 0 as per the case. The substitution of 1s and 0s are as per the following rules:

- If the (i, j) entry in the SSIM is V, the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry becomes 0.
- If the (i, j) entry in the SSIM is A, the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry becomes 1.
- If the (i, j) entry in the SSIM is X, the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry also becomes 1.
- If the (i, j) entry in the SSIM is O, the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry also becomes 0.

The initial reachability matrix for the performance measures is shown in Table 5.2. After incorporating the transitivity as described earlier in step (4) of the ISM methodology, the final

reachability matrix with driving power and dependence for each enabler is shown in Table 5.3. Driving power for an enabler is the total number of enablers (including itself) to which it may help to achieve. On the other hand dependence is the total number of enablers (including itself), which may help achieving it.

Table 5.2: Initial Reachability Matrix

Performance Measures	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1 Employee's Commitment	1	0	0	1	1	1	1	1	1	1	1	1	0	0	1
2 Management's Commitment	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
3 Logistics Flexibility	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1
4 Manufacturing Flexibility	0	0	0	1	1	1	1	0	0	0	0	0	0	0	1
5 Volume Flexibility	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1
6 Production Flexibility	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1
7 Delivery Performance	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
8 Quality Performance	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
9 Cost Performance	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
10 Productivity	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1
11 Benchmarking	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1
12 Labour Cost	0	0	0	0	0	0	0	0	1	1	0	1	0	0	1
13 Technology	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1
14 Material Cost	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1
15 PMS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Table 5.3: Final Reachability Matrix

Performance	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**1**	**11**	**1**	**1**	**1**	**1**	**Driver**
1 Employee's Commitment	1	0	0	1	1	1	1	1	1	1	1	1	0	0	1	11
2 Management's Commitment	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	14
3 Logistics Flexibility	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	3
4 Manufacturing Flexibility	0	0	0	1	1	1	1	0	0	0	0	0	0	0	1	5
5 Volume Flexibility	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	3
6 Production Flexibility	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	3

7 Delivery Performance	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	2
8 Quality Performance	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	2
9 Cost Performance	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	2
10 Productivity	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	3
11 Benchmarking	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	3
12 Labour Cost	0	0	0	0	0	0	0	0	1	1	0	1	0	0	1	4
13 Technology	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	4
14 Material Cost	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	4
15 PMS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Dependence	2	1	2	3	4	4	7	4	7	6	3	3	2	1	15	

These driving power and dependencies will be used in the classification of enablers into the four groups of autonomous, dependent, linkage and independent (driver) enablers in MICMAC analysis.

5.3.3 Level Partitions

From the final reachability matrix, the reachability and antecedent set for each factor are found. The reachability set consists of the element itself and other elements to which it may help achieve, whereas the antecedent set consists of the element itself and the other elements, which may help achieving it. Then the intersection of these sets is derived for all elements. The element for which the reachability and intersection sets are same is the top-level element in the ISM hierarchy. The top-level element of the hierarchy would not help achieve any other element. Once the top-level element is identified, it is separated out from the other elements.

Then the same process finds the next level of elements. These identified levels help in building the directed graph and final model. From Table 5.4, it is seen that the performance measurement system is found at level i. Thus, it would be positioned at the top of the ISM hierarchy. This iteration is repeated till the levels of each factor are found out as shown in Table 5.5. The identified levels aids in building the final model of ISM. Figure 5.2 shows levels of all the enablers in directed graph.

Table 5.4: Iteration 1

Performance Measures	Reachability Set	Antecedant Set	Intersection Set	Level

1 Employee's Commitment	1,4,5,6,7,8,9,10,11,12,15	1,2	1	
2 Management's Commitment	1,2,3,4,5,6,7,8,9,10,11,12,13,15	2	2	
3 Logistics Flexibility	3,7,15	2,3	3	
4 Manufacturing Flexibility	4,5,6,7,15	1,2,4	4	
5 Volume Flexibility	5,7,15	1,2,4,5	5	
6 Production Flexibility	6,7,15	1,2,4,6	6	
7 Delivery Performance	7,15	1,2,3,4,5,6,7	7	
8 Quality Performance	8,15	1,2,8,11	8	
9 Cost Performance	9,15	1,2,9,10,12,13,14	9	
10 Productivity	9,10,15	1,2,10,12,13,14	10	
11 Benchmarking	8,11,15	1,2,11	11	
12 Labour Cost	9,10,12,15	1,2,12	12	
13 Technology	9,10,13,15	2,13	13	
14 Material Cost	9,10,14,15	14	14	
15 PMS	15	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15	15	i

Table 5.5: Iteration 2

Iteration	Performance Measure	Reachability Set	Antecedant Set	Intersection Set	Level
v	1	1,4,5,6,7,8,9,10,11,12,15	1,2	1	v
vi	2	1,2,3,4,5,6,7,8,9,10,11,12,13,15	2	2	vi
iii	3	3,7,15		3	iii
iv	4	4,5,6,7,15		4	iv
iii	5	5,7,15		5	iii
iii	6	6,7,15		6	iii
ii	7	7,15		7	ii
ii	8	8,15		8	ii
ii	9	9,15		9	ii
iii	10	9,10,15		10	iii
iii	11	8,11,15		11	iii
iv	12	9,10,12,15		12	iv

iv	13	9,10,13,15		13	iv
iv	14	9,10,14,15		14	iv
i	15	15		15	i

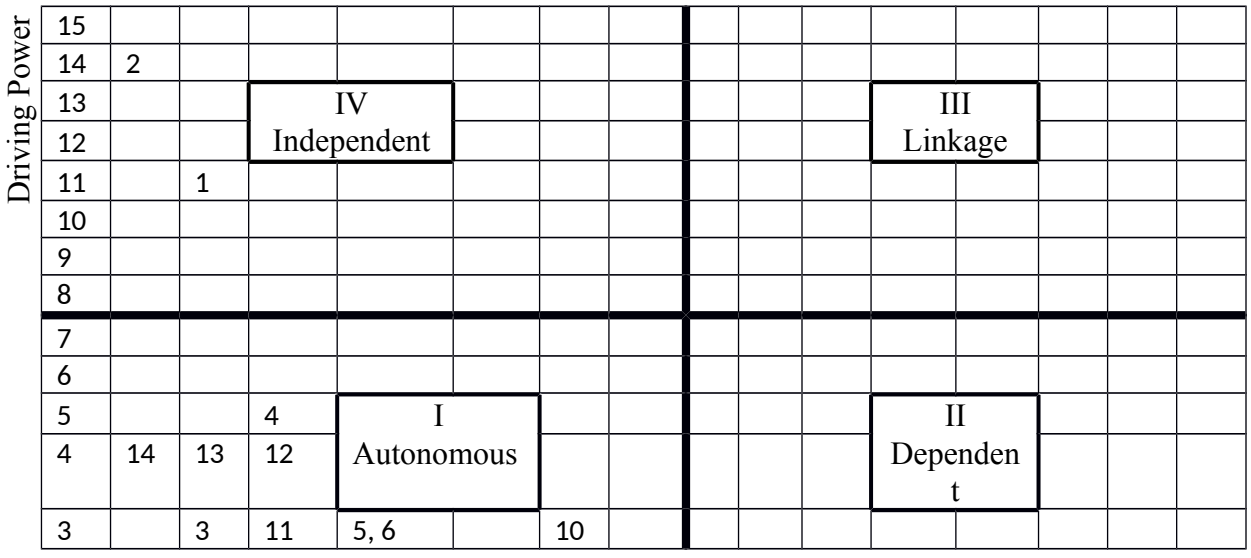
5.4 MICMAC Analysis

The purpose of the MICMAC analysis is to analyze the driver power and the dependence power of the enablers. The enablers are classified into four clusters as shown in figure 5.1. The first cluster consists of the "autonomous enablers" that have weak driver power and weak dependence.

These enablers are relatively disconnected from the system, with which they have only few links, which may be strong. Second cluster consists of the dependent enablers having weak driver power but strong dependence. Third cluster has the linkage enablers having both strong driving power and strong dependence. These enablers are highly unstable in the fact that any action on these enablers will have an effect on others and also a feedback on themselves.

Fourth cluster includes the independent enablers having strong driving power but weak dependence. It is observed that enablers with a very strong driving power called the key enablers, falls into the category of independent or linkage enablers.

The driving power-dependence diagram is constructed on the basis of final reachability matrix, which is shown in Figure 5.1. For an example, it is observed from Table 5.3 that enablers 5 and 6 have a driver power of 3 and a dependence of 4. Therefore, in this Figure, it is positioned at a place corresponding to a driver power of 3 and a dependency of 4.



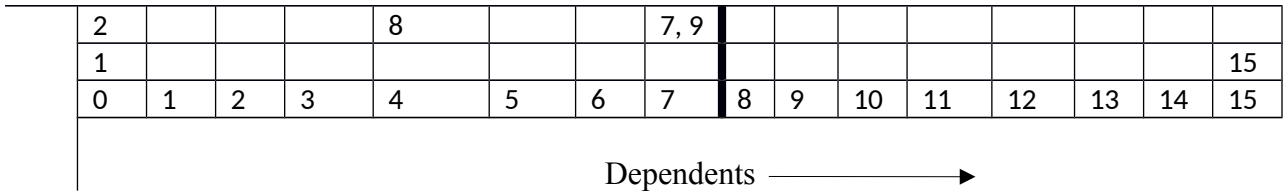


Figure 5.1: Driving power and Dependence Diagram

5.5 Discussion on ISM model for the performance measures of supply chain performance measurement system

The driver-dependence diagram gives some valuable insights about the relative importance and the interdependencies among the performance measures.

Some of the observations from the ISM model, which give important managerial implications, are discussed below.

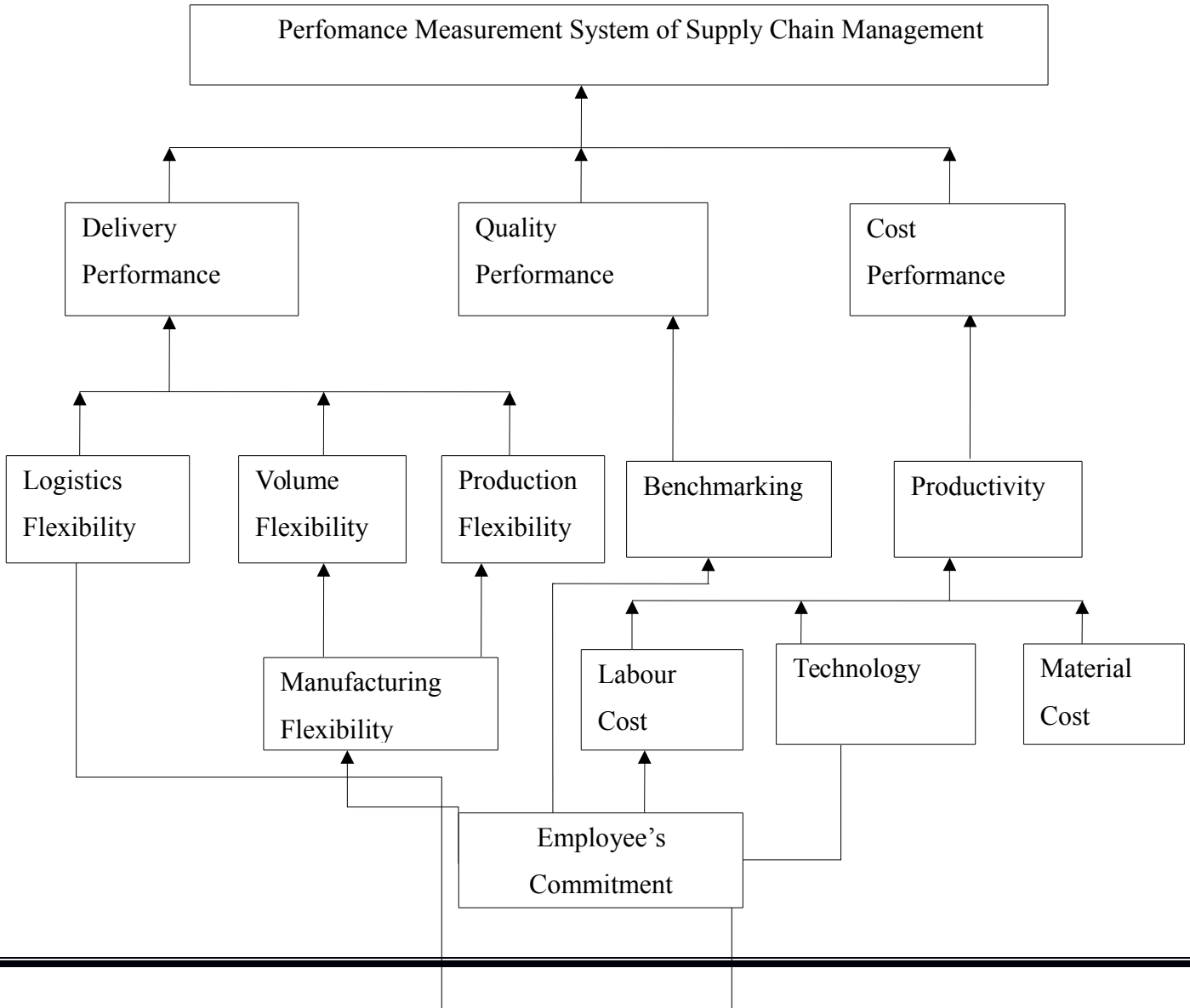
From the ISM model, it is observed that employee's commitment and management's commitment are at the bottom level of the hierarchy implying higher driving power. Therefore, if top management should focus on developing strategies to create awareness about the enhancement of employee's commitment and management's commitment in SCPMS so that the benefits of it can be reaped.

In the driver-dependence diagram, the autonomous barriers seen are manufacturing flexibility, labour cost, technology, material cost, logistics flexibility, volume flexibility, production flexibility, productivity, benchmarking, delivery performance, quality performance, cost performance. These have weak driving power and weak dependence.

It is also observed that performance measurement system is a weak driver but strongly dependent on other performance measures such as employee's commitment, management's commitment, logistics flexibility, manufacturing flexibility, volume flexibility, production flexibility, delivery performance, quality performance, cost performance, productivity, benchmarking, labour cost, technology and material cost.

No barrier is found under the linkage element category possessing a strong driving power along with strong dependence. Therefore, among all the 15 selected performance measures, no barrier is unstable.

It is also observed from the ISM model that two barriers, namely employee's commitment and management's commitment have strong driver power and therefore, these are less dependent on the other performance measures. Thus, it can be inferred that these are strong drivers and may be treated as the important performance measures and efforts must be initiated to achieve the enhancement in employee's commitment and management's commitment.



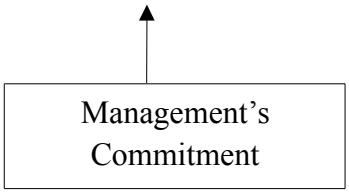


Figure 5.2: ISM based model for performance measures in SCPMS

5.6 Conclusion

This chapter presented ISM based model for the performance measures in a SC as well as for the enablers and the result variables in the context of Indian automobile industry.

The ISM based model brings out the fact that management's commitment is a significant measure affecting the performance measurement.

The iterative process of ISM approach provides an understanding of how the various performance measures of supply chain interact with each other. This is generally important as generally management focuses on one or two of the variables which it thinks are significant without taking into consideration those that may be the real measure for effective performance measurement. The hierarchy based ISM model further delineates those measures which are most important and need more focus.

ISM model developed in this chapter would facilitate top management measures impacting performance measurement in their supply chain. Though ISM is developed on the basis of perception of the experts of supply chain from select industry, the results are quite generic and can be well applied to other supply chains with minor modification. ISM methodology would help top management to focus their efforts towards the roots of the problem. This would

certainly help organisations to be well prepared, thus making their supply chains more efficient and effective.

CHAPTER 6

SUMMARY, LIMITATIONS AND SCOPE FOR FUTURE WORK

6.1 Introduction

Traditionally, the measurement of organizations has been financial; however, our dependence on financial measures of performance has come under criticism in recent years. Critics suggest financial measures are not consistent with today's environment, and that they lack predictive power, reinforce functional silos, may sacrifice long-term thinking, and are not relevant to many levels of the organization.

Many leaders feel they know what is most critical to the success of their organizations. However, it is only through the measurement of these vital indicators that they can accurately reflect their progress on an ongoing basis. The Balanced Scorecard is a powerful tool that enables any organization to pinpoint and track the vital few variables that make or break performance.

The literature review suggests that there are a number of variables which act as measures for performance measurement. Analysis of the interrelationships among these variables is possible using interpretive structural modeling (ISM).The model could provide information to the

managers regarding those measures which should be targeted upon in order to implement supply chain performance measurement system effectively.

6.2 Summary of work done

In this section, first we present the work done towards achieving the research objectives. In the next section, we present the major findings of this research. The main works undertaken in this research include the followings.

- An extensive literature review has been conducted to identify the relevant research issues in the Supply chain performance measurement system.
- Based on literature review, a balanced scorecard was formed for automobile industry.
- Important measures for performance measurement were identified from the review of literature.
- An ISM based model was developed to understand the mutual relationships among the various measures for performance measurement.

6.3 Key findings from the research

Some of the key findings from this research are as follows.

- The major performance measurement systems in use today (in order of global adoption) include the Balanced Scorecard, Activity-based Costing and Management, Economic Value Added (EVA), Quality Management, Customer Value Analysis/Customer Relationship Management and Performance Prism.
- Different methods exist that can incorporate multiple performance indicators into one measurement system. Some of the best-known are the Supply-Chain Council's Supply-Chain Operations Reference (SCOR) model, the Balanced Scorecard, Multi-Criteria Analysis, Data-Envelopment Analysis, Life-Cycle Analysis, and Activity-Based Costing.
- In the Balanced Scorecard, effectiveness of activity is examined in four perspectives: financial perspective, customer perspective, perspective of internal operational processes, perspective of development.
- Customer relationship and customer satisfaction are the prominent supply chain measures in the customer perspective.
- Innovation, range of products and services, threats (competitors) and environmental aspects are the prominent supply chain measures in the perspective of development.
- Waste reduction and time compression are the prominent supply chain measures in the perspective of internal operational processes.
- Cost associated with assets and return on investment and total inventory cost are the prominent supply chain measures in the financial perspective.

- ISM based framework for the performance measures suggests that two performance measures namely employee's commitment and management's commitment have a strong driving power and are less dependent on other measures. Thus, these may be treated as the main measures for performance measurement.
- ISM based model reveals that effective and efficient supply chain can be achieved by continuously improving the variables possessing higher driving power.
- The ISM based modeling of the performance measures indicates that employee's commitment and management's commitment are at the bottom of the model having higher driving power. So, organisations need to more carefully address these performance measures.

6.4 Implications of the research

The findings of this research contribute to the body of SCM literature. These findings not only validate important and widely discussed aspects of SCM but also set out interrelationships among many of these aspects.

The results of the ISM model provide new insights on the supply chain performance measurement system. These insights support the objective of a SCM as a comprehensive and vital strategy than can build and sustain competitive advantage, which ultimately lead to good business performance.

6.4.1 Implications to academicians

- The exhaustive study of various aspects related to supply chain performance may serve as a trigger point for the future research in this area.
- The literature review presented in the research may provide a basis for the future research.
- In this research, a balanced scorecard has been developed and its application has been analysed with the case study of an automobile industry which may motivate the academicians to apply the developed balanced scorecard in other industries with minor modifications.

6.4.2 Implications to managers

Several important managerial implications emerge from this research.

- Management's commitment is the major performance measure in the supply chain performance measurement system. It poses a high driving power. Therefore, management should accord high priorities in achieving this performance measure.

- The case study of the automobile industry has been presented. The learning from this company would be useful to other companies for improving their supply chain performance.
- The balanced scorecard considers a balanced view on four perspectives, viz., customers, internal business process, learning and growth, and financial in supply chain performance measurement system.

6.5 Limitations of this research and scope for future work

As with all the research, this study too has some limitations. In this section, we identify these limitations and offer suggestions for future work.

6.5.1 Scope for future work in performance measurement

The scope for future work in performance measurement is as follows:

- A refinement in the understanding of the links between types of management behavior and the information needed to facilitate better management interventions. The separation of management and strategic control is central to this development and is an area that is well documented; however, there is a need to expand the literature relating to appropriate mechanisms to influence management behaviours more effectively.
- An examination into the ways of reconciling performance reporting with performance management. It is often the case that an organisation's performance management system's data need to have complete 'coverage' of the business, for example metrics on health and safety, operations, finance, human resources, markets etc. (Eagleson & Waldersee, 2000. Kennerley & Neely, 2000). However, in the practical environment this can reduce the relevance to the local unit developing the metrics and diminish ownership of the management system.

6.5.2 Limitations of Balanced Scorecard

The alignment between developments in Balanced Scorecard principles and the theoretical aspects of control and management process are a positive indication that the more modern ideas about Balanced Scorecard design processes and structure are indeed 'better' than the original concept described by Kaplan and Norton, in so far as they are more likely to have a beneficial

consequence for the organisation adopting the tool. However while more recent Balanced Scorecard designs are substantial improvements on original ideas, there is still room for improvement.

6.5.3 Scope for future work in Balanced Scorecard

Potential areas for further refinement and possible topics for future research in balanced scorecard are as follows:

• A consideration of the relationship between Balanced Scorecard application in large organisations and issues relating to intra-unit communications. Balanced Scorecard when cascaded through an organisation can be used as a successful strategic contracting, and strategy communication tool (Shulver et al., 2000) however, its precise utility needs further exploration.

• An examination of the most appropriate ways to translate advances in measurement concepts (e.g. EVA etc.) efficiently into the design processes adopted for BSC, without diminishing 'ownership' of the design work done by managers unfamiliar with the new concepts. EVA appears to offer ways to 'improve' measurement information. However, if the management team themselves are not comfortable working with them, they won't design them into their Balanced Scorecard. But if a consultant 'designs it in', although potentially beneficial, if the management team does not understand them it will probably not own or act upon them. In this scenario the interaction of the Balanced Scorecard with other management concepts and its possible improvement is dependant on the skills and education of the management team.

• Developing an understanding of the benefits of Balanced Scorecard and if possible attaching capital values to pre and post case scenarios. A key criterion for the adoption of the Balanced Scorecard within organisations is the ability to demonstrate value in its adoption.

6.5.4 Scope for future work in automobile industry

The automobile industry faces some major challenges that could determine its future shape. In order to stay ahead, the major players must consider if, when and how they address the following issues-

- Leadership in safety innovation: Once considered a “given”, safety is back on the agenda as more and more vehicles become powered by new technology. Safety can once again become a brand differentiator for both established and new players.

- Pooling knowledge to achieve technical superiority: R & D increasingly requires alliances and joint ventures to spread costs and risks and share knowledge. However, in partenering with others, automotive companies should keep a close eye on profitability and retain the technology, know-how and brand reputation that they are famous for.
- Seeking efficiencies: Despite the extensive rationalization efforts of the past years, many companies are trying to achieve further efficiencies in their processes. Business leaders should seek out the most effective change management approaches to boost such initiatives. Investments in new business segments, like financing and leasing, especially in emerging markets, could open up new areas for profitability.

6.5.5 Future Plans for ABC Ltd.

The future plans for ABC Ltd. are as follows:

- Provide product information, product use information, and technical assistance on web sites that are accessible 24 hours a day, 7 days a week.
- Identify how each individual customer defines quality, and then design a service strategy for each customer based on these individual requirements and expectations.
- Provide a fast mechanism for managing and scheduling follow-up sales calls to assess post-purchase cognitive dissonance, repurchase probabilities, repurchase times, and repurchase frequencies.
- Provide a mechanism to track all points of contact between customer and the company, and do it in an integrated way so that all sources and types of contact are included, and all users of the system see the same view of the customer (reduces confusion).
- Help to identify potential problems quickly, before they occur.
- Provide a user-friendly mechanism for registering customer complaints (complaints that are not registered with the company cannot be resolved, and area major source of customer dissatisfaction).
- Provide a fast mechanism for handling problems and complaints (complaints that are resolved quickly can increase customer satisfaction).
- Use the Internet to engage in collaborative customization or real-time customization.
- Provide a fast mechanism for managing and scheduling maintenance, repair, and on-going support (improve efficiency and effectiveness).

6.5.6 Scope for future work for the developed ISM based model

In this research, ISM based model for the measures for supply chain performance measurement has been developed.This model is not stastically validated. In future extension of this work it is

proposed to apply structural equation modeling (SEM) technique, commonly known as linear structural relationship approach to statistically corroborate the findings from ISM model.

6.6 Conclusion

Performance measurement and improvement studies must be done throughout the supply chain to bring about improved performance in a supply chain and move closer to attainment of the illusive goal of supply chain optimization. All participants in the supply chain should be involved and committed to common goals, such as customer enhanced competitiveness. A performance measurement program for a supply chain should be complete - important aspects of performance in any link are not ignored - and they must be tailored to varying needs of participants. A good SCM program will bring about improved cross-functional and intra-organisational process planning and control and more complete supply chain integration. A supply chain wide performance measurement initiative would seem most appropriate.

This is not to suggest that one party dictate measurement programs for all supply chain participants, but rather that all participants take part in developing a well planned, well coordinated, supply chain-wide performance measurement initiative to which all can and will be committed. A comprehensive control system will be necessary in order to assure effective and efficient performance measurement all along the supply chain, but it must not be done in such a way as to unduly limit the decision making authority of managers in participating organizations.

Care must be exercised in developing such a system in order that it promotes mutually advantageous exchange among participants, so that relationships endure the test of time.

Additional research and practitioner-driven initiatives are needed in the area of SCM performance measurement. Creative efforts are needed to design new measures and new programs for assessing the performance of the supply chain as a whole as well as the performance of each organization that is a part of the supply chain.

Organisation, suppliers and customers should come together to discuss how they will address the measurement and improvement of SCM performance. Industry consortiums, consultants, and researchers could be helpful in promoting SCM performance measurement generally, and in developing measures and measurement techniques specifically. They could play a significant role in helping firms address the present and future challenges of managing supply chains.

REFERENCES

- Abrahamsson, M., & Brege, S. (1997), Structural changes in the supply chain. International Journal of Logistics Management, 8 (1), 35–45.
- Aggarwal, S. (1997), Flexibility management: the ultimate strategy. Industrial Management, 39 (1), 26–31.
- Ahire, S.L., Golhar, D.Y., and Waller, M.A. (1996), Development and validation of TQM implementation constructs. Decision Sciences 27 (1), 25–56.
- Amaratunga, D. and Baldry, D. (2002), Moving from performance measurement to performance management. Facilities, 20 (5–6), 217–223.
- Andersen, B., Henriksen, B., and Aarseth, W. (2006), Holistic performance management: an integrated framework. International Journal of Productivity and Performance Management, 55 (1), 61–78.
- Aramyan L., Ondersteijn C., Kooten O.V., and Lansink A.O. (2006), Performance indicators in agri-food production chains.
- Azapagic, A. and Clift, R. (1999), The application of life cycle assessment to process optimisation. Computers and Chemical Engineering, 23 (10), 1509-1526.
- Banwet, D. K. and Arora R. (1999), Enablers and inhibitors of e-commerce implementation in India—an interpretive structural modeling (ISM) approach. In: Kanda A et al (ed) Operations management for global economy challenges and prospects. Phoenix, New Delhi, 332–341.
- Beamon, B.M. and Ware, T.M. (1998), A process quality model for the analysis, improvement and control of supply chain systems. Logistics Information Management, 11(2), 105–113.
- Beamon, B.M. (1998), Supply chain design and analysis: models and methods. International Journal of Production Economics, 55 (3), 281-294.

- Beamon, B.M. (1999), Measuring supply chain performance. International Journal of Operations and Production Management, 19 (3/4), 275-292.
- Berry, D. and Naim, M.M. (1996), Quantifying the relative improvements of redesign strategies in a PC supply chain. International Journal of Production Economics, 46, 181-196.
- Bhagwat, R. and Sharma M.K. (2007), Performance measurement of supply chain management: A balanced scorecard approach. Computers & Industrial Engineering, 53, 43–62.
- Boddy, D., Cahill, D., Charles, M., Fraser-Kraus, H., and Macbeth, D. (1998), Success and failure in implementing partnering. European Journal of Purchasing and Supply Management, 4(2, 3), 143– 151.
- Bourguignon, A. and Chiapello, E. (2005), The role of criticism in the dynamics of performance evaluation systems. Critical Perspectives on Accounting, 16, 665–700.
- Bourne, M., Mills, J., Wilcox, M., Neely, A., and Platts, K. (2000), Designing, implementing and updating performance measurement systems. International Journal of Operations & Production Management, 20 (7), 754–771.
- Bovet, D. and Sheffi , Y. (1998), The Brave New World of Supply Chain Management. Supply Chain Management Review, 2, No.:19.
- Bowersox, D.J. and Closs, D.J. (1996), Logistical Management. The Integrated Supply Chain Process. McGraw-Hill, New York.
- Carlson, M. (1996), Performance: A Critical Introduction. Routledge, London/ New York, 1–7.
- Carlsson-Kanyama, A., Ekstrom, M.P. and Shanahan, H. (2003), Food and life cycle energy inputs: consequences of diet and ways to increase efficiency. Ecological Economics, 44 (2/3), 293-307.
- Carson, D., Gilmore, A., and Maclaran, P. (1998), Customer or profit focus: an alternative perspective. Journal of Marketing Practice: Applied Marketing Science 4 (1), 26–39.
- Chidambaranathan, S. & Muralidharan, C. and Deshmukh, S. G. (2008), Analyzing the interaction of critical factors of supplier development using Interpretive Structural Modeling—an empirical study. Int J Adv Manuf Technol, 43:1081–1093.
- Cholewicka-Gozdzik, K. (2002), The Balanced Scorecard – tool of estimation the organization's effectiveness. Quality Problems, 2 6.
- Christopher, M. (1992), Logistics and supply chain management. London: Pitman Publishing.

- Claro, D.P., Hagelaar, G. and Omta, O. (2003), The determinants of relational governance and performance: how to manage business relationships? Industrial Marketing Management, 32 (8), 703- 716.
- Claycomb, C., Droge, C., and Germain, R. (1999), The effect of just-in-time with customers on organizational design and performance. International Journal of Logistics Management 10 (1), 37–58.
- Connor, S. (1996), Postmodern performance, in: P. Campbell (Ed.), Analysing Performance, Manchester University Press, Manchester, UK.
- Coronel, P. (1998), Balanced scorecard, performance measurement and reporting. Available: [http:// www.benchmarkingplus.com.au/perfmeas.htm].
- Croom, S., Romano, P., and Giannakis, M. (2000), Supply chain management: an analytical framework for critical literature review. European Journal of Purchasing and Supply Management , 6 (March (1)), 67–83.
- Dangayach, G., and Deshmukh, S. (2001), Manufacturing strategy: literature review and some issues. International Journal of Operations and Production Management, 21 (7), 884– 932.
- Davies, G.B. (1982), Strategies for information requirements determination. IBM Systems Journal, 21 (1), 4–30.
- Dibb, S., Simkin, L., Pride, W.M., and Ferrell, O.C. (1994), Marketing Concepts and Strategies, second European ed. Houghton Mifflin, Boston, MA.
- Dobler, D. W. and Burt , D. N. (1996), Purchasing and Supply Management. New York, NY: The McGraw-Hill Companies.
- Doyle, P. (1994), Marketing Management and Strategy.Prentice-Hall, London.
- Draaijer, D.J. (1992), Market orientedness of improvement programmes in manufacturing: results from field study research. International Journal of Operations and Production Management 12 (7), 24–40.
- Eccles, R.G. (1991), The performance measurement manifesto. Harvard Business Review 69 (January–February), 131–137.
- Eagleson, G. K. and Waldersee, R. (2000), "Monitoring the strategically important: assessing and improving strategic tracking systems", Performance Measurement – Past, Present and Future, 2nd International Conference on Performance Measurement, Cambridge, UK.
- Eppen, G.D. (1979), Effects of centralization on expected costs in a multi-location newsboy problem. Management Science, 25 (5), 498-501.

- Faisal, M. N., Banwet, D. K. and Shankar, R. (2006), "Supply chain risk mitigation: modeling the enablers." Business Process Management Journal, 12 (4), 535-52.
- Fawcett, S.E. and Cooper, M.B. (1998), Logistics performance measurement and customer success. Industrial Marketing Management, 27, 341–357.
- Fisher, L. M. (1997), What is the right supply chain for your product? Harvard Business Review, 105–116.
- Folan, P., Browne, J., and Jagdev, H. (2006), Performance management research: an alternative view to Thorpe and Beasley. CIMRU Working Paper, 24th August, 1–15.
- Folan, P., Browne, J., and Jagdev, H. (2007), Performance: Its meaning and content for today's business research. Computers in Industry, 58, 605–620.
- Fortuin, L. (1988), Performance indicators—Why where and how? European Journal of Operational Research, 34, 1–9.
- Gunasekaran, A., Patel, C. and Tirtiroglu, E. (2001), Performance measures and metrics in a supply chain environment. International Journal of Operations and Production Management, 21 (1/2), 71-87.
- Hagelaar, G.J.L.F. and Van der Vorst, J.G.A.J. (2002), Environmental supply chain management: using life cycle assessment to structure supply chains. International Food and Agribusiness Management Review, 4, 399-412.
- Ho, L.A. (2008), ''What affects organizational performance? The linking of learning and knowledge management''. Industrial Management + Data Systems, 108(9), 1234–1254.
- Jharkharia, S. and Shankar, R. (2005), IT enablement of supply chains: understanding the barriers. Journal of Enterprise Information Management, 18(1), 11-27.
- Johnson, H.T. and Kaplan, R.S. (1987), Relevance lost: The rise and fall of management accounting. Harvard Business School Press, Boston, MA.
- Jones, C. (1998), Moving beyond ERP: making the missing link. Logistics Focus, 6 (7), 2–7.
- Kaplan R.S., & Norton D.P., (1993), Putting the Balanced Scorecard to Work. Harvard Business Review
- Kaplan R.S. and Norton D.P. (1992), The Balanced Scorecard - Measures That Drive Performance. Harvard Business Review, 70.
- Kaplan, R. and Norton, D. (1996), Using the balanced scorecard as a strategic management system. Harvard Business Review, 74(1), 75–85.
- Kaplan, R. and Norton, D. (2001), The Balanced Scorecard. PWN, Warsaw.
- Kaplan, R.S. and Norton, D.P. (1992), The balanced scorecard: measures that drive performance. Harvard Business Review, 70, 71-79.

- Kaplan, R.S. and Norton, D.P. (1993), Putting the balanced scorecard to work. Harvard Business Review, 71 (September–October), 134–147.
- Kaplan, R.S. and Norton, P.D. (1992), The balanced scoreboard measures that drives performance. Harvard Business Review, 70 (1), 71–79.
- Kennerley M. and Neely A. D. (2000), "Performance Measurement Frameworks – A Review", Proceedings, 2nd International Conference on Performance Measurement, Cambridge, UK.
- Kordupleski, R.E., Rust, R.T., and Zahorik, A.J. (1993), Why improving quality doesn't improve quality (or whatever happened to marketing?). California Management Review 35 (3), 82–95.
- Korpela, J., Kylaheiko, K., Lehmuswaara, A., et al. (2002), An analytic approach to production capacity allocation and supply chain design. International Journal of Production Economics, 78 (2 Special Iss.), 187-195.
- Kuei, C., Madu, C.N., Lin, C., and Chow, W.S. (2002), Developing Supply chain strategies based on the survey of supply chain Quality and technology management. The International Journal of Quality & Reliability Management, 19 (7), 889–901.
- Lai, K.H., Ngai, E.W.T. and Cheng, T.C.E. (2002), Measures for evaluating supply chain performance in transport logistics. Transportation Research. Part E Logistics and Transportation Review, 38 (6), 439-456.
- Lambert, D.M. and Cooper, M.C. (2000), Issues in supply chain management. Industrial Marketing Management, 29 (1), 65-83.
- Lapide, L. (2000), What about measuring supply chain performance? ASCET, 2.
- Lebas, M. (1995), Performance measurement and performance management. International Journal of Production Economics, 41 (1–3), 23–25.
- Lee D.M. (1999), Structured decision making with Interpretive Structural Modeling (ISM). Sorach, Canada.
- Lee, H. L., & Billington, C. (1992), Managing supply chain inventory: Pitfalls and opportunities. Sloan Management of Review, Spring, 65–73.
- Lee, H.L. & Billington, C., (1992), Supply chain management: pitfalls and opportunities. Sloan Management Review, 33, 65-73.
- Lee, H.L., and Billington, C. (1992), Managing supply chain inventory: Pitfalls and opportunities. Sloan Management Review, 33 (3), 65–73.
- Levy, D. L. (1997), Lean production in an international supply chain. Sloan Management Review, Winter, 94–102.

- Li W.L., Humphreys P., Chan L.Y., and Kumaraswamy M. (2003), Predicting purchasing performance: the role of supplier development programs. J Mater Process Technol, 138(1–3):243–249.
- Li, D., and O' Brien, C. (1999), Integrated decision modelling of supply chain efficiency. International Journal of Production Economics, 59 (1/3), 147-157.
- Lisiecka, K. (2002), The Balanced Scorecard. Quality Problems, 6, 4.
- Lohman, F.A.B. (1999), The effectiveness of management information. Ph.D. Thesis, Delft University.
- Mandal, A. and Deshmukh, S.G. (1993), Vendor selection using interpretive structural modeling (ISM). Int J Oper Prod Manage 14(6), 52–59.
- Mapes, J., New, C., and Szwejczewski, M. (1997), Performance trade-offs in manufacturing plants. International Journal of Operations & Production Management 17 (10), 1020–1033
- Marciniak, E. (2002), The usage of The Balanced Scorecard in the quality management according to requirements in ISO 9001:2000 standard. Quality Problems, 8 ,8.
- Marr, B. and Schiuma, G. (2003), Business performance measurement— past, present and future. Management Decision, 41 (8), 680–687.
- Martinsons, M., Davison, R., and Tse, D. (1998), The balanced scorecard: a foundation for the strategic management of information systems.
- Maskell, B.H. (1991), Performance Measurement for World Class Manufacturing., Productivity Press, Inc., Portland, OR.
- Medori, D. and Steeple, D. (2000), A framework for auditing and enhancing performance measurement systems. International Journal of Operations & Production Management, 20 (5) 520–533.
- Meyer and Marshall, W. (2002), Finding performance: The new discipline of management. In Business Performance Measurement: Theory and Practice. edited by Andrew Neely. Cambridge University Press.
- Michalska, J. (2005), The usage of The Balanced Scorecard for the estimation of the enterprise's effectiveness. Journal of Materials Processing Technology, 751–758.
- Moberg, C.R., Cutler, B.D., Gross, A., and Speh, T.W. (2002), Identifying antecedents of information exchange within supply chains. International Journal of Physical Distribution & Logistics Management, 32 (9), 755–770.
- Murphy, G.B., Trailer, J.W., and Hill, R.C. (1996), Measuring performance in entrepreneurship research. Journal of Business Research, 36 (1), 15-23.

- Nanni, A.J., Dixon, J.R., and Vollmann, T.E. (1992), Integrated performance measurement: Management accounting to support the new manufacturing realities. Journal of Management Accounting Research, 4, 1–19.
- Neely, A. (1999), The performance measurement revolution: why now and what next?. International Journal of Operations and Production Management, 19 (2) , 205–228.
- Neely, A.D., Gregory, M., and Platts, K. (1995), Performance measurement system design. International Journal of Operations & Production Management,15 (4), 80–116.
- Noble, D. (1997), Purchasing and supplier management as a future competitive edge. Logistics Focus 5 (5), 23–27.
- Pandey V.C., Suresh G., and Ravi S. (2005), An Interpretive Structural Modeling of enabler variables for integration in supply chain management, Productivity 46(1), 93–108.
- Persson, F. and Olhager, J. (2002), Performance simulation of supply chain designs. International Journal of Production Economics, 77, 231-245.
- Phelan, P. (1993), The Ontology of Performance: Representation without Reproduction, Unmarked: The Politics of Performance, Routledge, London/ New York, 146–166.
- Power, D.J., Sohal, A., and Rahman, S.U. (2001), Critical success factors in agile supply chain management: an empirical study. International Journal of Physical Distribution and Logistics Management, 31 (4), 247–265.
- Kumar, P., Shankar R., and Yadav S.S. (2008), Modeling the enablers of agile manufacturing system. Proceedings of GLOGIFT 08**,** Stevens Institute of Technology **,** Hoboken, NJ, 262-273.
- Kumar, P., Shankar , R., and Yadav S.S. (2008), Flexibility in global supply chain: modeling the enablers. Journal of Modelling in Management ,Vol. 3, No. 3, 277-297.
- Qureshi, M. N., Kumar, D., and Kumar, P. (2007), Modeling the logistics outsourcing relationship variables to enhance shippers' productivity and competitiveness in logistical supply chain. International Journal of Productivity and Performance Management, 56, (8), 689-714.
- Rajesh K.S., Suresh K.G., and Deshmukh S.G. (2007), Interpretive structural modeling of factors for improving competitiveness of SMEs. Int J Prod Qual Manage, 2(4):423–440.
- Ravi, V. and Shankar, R. (2005), Analysis of interactions among the barriers of reverse logistics. Technological Forecasting and Social Change, 72, 1011-29.
- Rigby D.K. (2001), Management Tools and Techniques: A Survey. California Management Review, 43 (2).

- Romero, C. and Rehman, T. (2003), Multiple criteria analysis for agricultural decisions. Elsevier, Amsterdam.
- Rummler, G.A., and Brache, A.P. (2000), Growing the Organization's Effectiveness. PWN, Warsaw.
- Sandstrom, J. and Toivanen, J. (2001), The problem of managing product development engineers: Can the balanced scorecard be an answer?
- Schroeder, R.G., John, C.A., and Scudder, G.D. (1986), White collar productivity measurement. Management Decision, 24 (5), 3–7.
- Shepetuk, A.J. (1991), Is product development process a tortoise or a hare? Management Review 80 (3), 25–27.
- Shulver M., Lawrie G., and Andersen H. (2000), "A process for developing strategically relevant measures of intellectual capital", Proceedings, 2nd International Conference on Performance Measurement, Cambridge, UK
- Slack, N., Chambers, S., Harland, C., Harrison, A., and Johnston, R. (1995), Operations Management. London: Pitman Publishing.
- Smith, P., and Goddard, M. (2002), Performance management and operational research: a marriage made in heaven? Journal of the Operational Research Society, 53 (3), 247–255.
- Spekman, R.E., Kamauff Jr., J.W., and Myhr, N. (1998), An empirical investigation into supply chain management: a perspective on partnerships. Supply Chain Management, 3 (2), 53–67.
- Stalk, G., Evans, P., and Schulman, L.E. (1992), Competing on capabilities: the new rules of corporate strategy. Harvard Business Review 70 (2), 57–69.
- Stephens, S. (2000), The supply chain council operations reference (SCOR) model: integrating process, performance measurements, technology and best practice. Logistics Spectrum (Jul-Sep), 16-18. [http://www.findarticles.com/p/articles/mi_qa3766/is_200007/ai_n8909126]
- Stewart, G. (1995), Supply chain performance benchmarking study reveals keys to supply chain excellence. Logistics Information Management, 8(2), 38–44.
- Supply-Chain Council, (2004), SCOR. Available: [http://www.supply-chain.org/index.ww]
- Takeuchi, H., and Quelch, J.A. (1983), Quality is more than making a good product. Harvard Business Review 61 (4), 139–145.
- Talluri, S. and Baker, R.C. (2002), A multi-phase mathematical programming approach for effective supply chain design. European Journal of Operational Research, 141 (3), 544-558.

- Talluri, S., Baker, R.C. and Sarkis, J. (1999), A framework for designing efficient value chain networks. International Journal of Production Economics, 62 (1/2), 133-144.
- Tan, K.C., Kannan, V.R., and Handfield, R.B. (1998), Supply chain management: supplier performance and firm performance. International Journal of Purchasing and Materials Management 34 (3), 2–9.
- Tan, K.C., Kannan, V.R., Handfield, R.B., and Ghosh, S. (1999), Supply chain management: an empirical study of its impact on performance. International Journal of Operations and Production Management 19 (10), 1034–1052.
- Thomas, J. (1999), Why your supply chain doesn't work. Logistics Management and Distribution Report, 38 (6), 42–44.
- Thonemann, U.W. and Bradley, J.R. (2002), The effect of product variety on supply-chain performance. European Journal of Operational Research, 143 (3), 548-569.
- Tohidi, H., Jafari, A., and Afshar, A. (2010), Using balanced scorecard in educational organizations. Procedia Social and Behavioral Sciences 2, 5544–5548
- Kuo , T.C., Ma , H.Y., Huang ,S.H., Hu, A.H. and Huang, C.S. (2009), Barrier analysis for product service system using interpretive structural model. Springer-Verlag London Limited. Int J Adv Manuf Technol 49:407–417.
- Van der Vorst, J.G.A.J. (2000), Effective food supply chains: generating, modelling and evaluating supply chain scenarios. Proefschrift Wageningen [http://www.library.wur.nl/wda/dissertations/dis2841.pdf]
- Van Hoek, R.I. (1998), Measuring the unmeasurable-measuring and improving performance in the supply chain. Supply Chain Management, 3 (4), 187–192.
- Wang, N. (2003), Measuring transaction costs: an incomplete survey. Ronald Coase Institute, Chicago. Ronald Coase Institute Working Papers no. 2. [http://coase.org/workingpapers/wp-2.pdf]
- Waters, C.D. and Waters, D. (2007), Global Logistics: New Directions in Supply Chain Management. Kogan Page.
- Wholey, J. (1996), Formative and summative evaluation: related issues in performance measurement. Evaluation Practice, 17 (2), 145–149.
- Wines, L. (1996), High order strategy for manufacturing. The Journal of Business Strategy 17 (4), 32–33.
- Zhu, J. (2003), Quantitative models for performance evaluation and benchmarking: data envelopment analysis with spreadsheets and DEA Excel solver. Kluwer, Dordrecht. International Series in Operations Research & Management Science, 51.
- http://www.amigolog.com/ConsultancyCRM.phtml

- http://www.marutisuzuki.com