Abstract
on
“A study of supply chain management system of auto industries in Pune region with reference to passenger car segment.”

Submitted to
Savitribai Phule Pune University
For the degree of
Doctor of Philosophy in Management

By
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XIV
1. Introduction

1.1 An overview of supply chain management
Worldwide organizations are striving to increase their productivity in order to stay competitive in the global market. Supply chain management plays a very crucial role in this competitive environment. The process of supply chain has become complicated and there are uncertainties at every stage in the chain viz Demand Forecasts, stock outs or late deliveries. Nowadays effective supply chain has become an imperative in order to increase customer satisfaction, reduce costs and handling demand supply scenario.

1.2 Historical development of supply chain management

1.3 Meaning and definitions of supply chain management
Supply chain literature is full of various definitions of supply chain. Some authors define SCM in operational terms involving the flow of materials and products, some view it as a management philosophy, and some view it in terms of a management process. Definitions of SCM can be classified into three categories: a management philosophy, implementation of a management philosophy, and a set of management processes.

In brief all the above definitions of Supply Chain Management focuses on its nature, scope and significance of Supply Chain Management directly or indirectly.

1.4 Supply chain/Value chain

1.5 Objectives of supply chain management
Supply chain management is a philosophy that evolved in response to the transformations in the business environment. The goals of managing the supply chain includes (1) To balance customers’ demands with the need for making a profit and attaining growth objectives and (2) To integrate all supply chain activities, processes and organisational entities; increase the rate of flow of products and services; reduce total cost of ownership for the ultimate customer; and decrease the total cycle time of the supply chain.

1.6 Dimensions of supply chain management
Supply chain management comprises coordinating activities across the supply chain. Central to this is converting customer demand into related activities at each level of the supply chain.

1.7 Supply chain Integration
1.8 Future trends in supply chain management

Conclusion

The field of supply chain management is extremely complex because it deals with firms, departments and individuals linked by flows of resources, namely material, information and money.

2. Introduction to Automobile Sector

This chapter highlights an overview of the Automobile Industry in India and Worldwide including its role and trends with reference to pre liberalization and post liberalization period.

2.1 An overview of automobile industry

The automobile as we know which is run on wheel was not invented in a single day by a single inventor. The history of the automobile reflects an evolution that took place worldwide. It is estimated that over 100,000 patents created the modern automobile.

In the last two decades, the automobile industry has experienced major changes, which have come about through the pressure of globalization, the introduction of lean production practices and the development of modularization. These changes have thus affected the relationship between original equipment manufacturer (OEMs) and their suppliers, most particularly those in the first tier, known as automobile component manufacturers (ACMs).

2.5 Present status & significance of Indian automobile industry

On the canvas of the Indian economy, auto industry maintains a high-flying place. Due to its deep forward and rearward linkages with several key segments of the economy, automobile industry has a strong multiplier effect and is capable of being the driver of the economic growth. A sound transportation system plays an essential role in the country's rapid economic and industrial development. The well-developed Indian automobile industry skillfully fulfils this catalytic role by producing a wide variety of vehicles: passenger cars, light, medium and heavy commercial vehicles, multi-utility vehicles such as jeeps, scooters, motorcycles, mopeds, three wheelers, tractors etc.
The automobile industry has been at the forefront of supply chain management. Its supplier networks are large and diverse in terms of size, technical sophistication, and global location. Leading automobile manufacturers have developed extensive networks of suppliers over the last decade. All of these factors make the automobile industry an ideal site for investigation into how effectively a company can manage relationships with suppliers to gain a sustained competitive advantage.

**Future scope for automobile industry**
The automobile is the greatest mechanical engineering achievement of the 20th century. The automobile, airplane, Apollo, air conditioning and other technologies made major contributions to engineering progress and economic and social development in the last 100 years.

3. **The review of literature**
For review of literature, research papers/articles, Ph.D. Theses, websites like SIAM, ACMA and many others and several books were studied. The study revealed the following aspects relating to the automobile supply chain as:

- Automobile supply chain is dynamic and complex.
- Automobile industry plays a crucial role in Indian economy.

**After the extensive literature review, the following gaps were identified:**
- The existing studies have multiple points of views but none of them have offered an integral and specific study on problems/issues/challenges faced by automobile component manufacturers to manage their supply chain.
- None of the studies have focused collectively on all the challenges.
- The area which is concerned with SCM and the topics or concepts referred are very generic to multiple industries.
- No specific attention has been given separately to Supply chain of most organized and advanced automobile industry/sector.
- No research has been done so far on Supply chain management system of automobile industries in Pune region. As Pune is considered as automobile hub where companies like Tata Motors Ltd., Volkswagen India pvt. Ltd., General Motors who are the leaders in car segments are located.

XVII
Therefore the researcher has undertaken to study supply chain management system of automobile industries in Pune region.

4. Research Methodology

Objectives of the research

- To study the scope, concept and importance of supply chain management in automobile industry.
- To understand a perspective of the Indian automobile industry.
- To investigate the present practices in supply chain management of Indian automobile industry.
- To identify the supply chain related challenges and issues which are faced by the automobile industries in Pune region.
- To examine the effectiveness of present supply chain management of automobile industry.

In consistent with the above objectives, the following hypotheses have been formulated.

Hypothesis of the research

H01: Effectiveness of supply chain management depends on timely delivery.
H01: Not H01
H02: Of all the factors lead time is the most important factor in managing the supply chain.
H02: Not H02
H03: Streamline operation processes of SCM is an effect of balanced inventory.
H03: Not H03

Universe and selection of units

Universe

The total number of automobile industries who are the members of MCCIA and ACMA are 282 from Pune region. Pune region includes Pune Industrial belt which consists of
Ranjangaon MIDC, Chakan, Bhosari Industrial Estate and other part of pune city where automobile related industries are integrated.

Sample

The entire universe is considered for the study. However though the researcher has contacted to all there 282 industries, it is found that some of them are non functional, non operative, relocated to other place and some of them were not interested to give the response to the questionnaire. Hence response is received from only 123 industries. Similarly, it is observed during the data editing and coding that out of 123 industries only 95 respondents completed the entire questionnaire and that was useful for the further analysis hence the response rate for this study is 77%.

Primary data and secondary data -

Primary data is collected by survey method is used and for that purpose a questionnaire is prepared. The self administered and semi structured questionnaire by using 5 point likert scale is prepared by the researcher. The researcher has also taken in depth interview for getting first hand information.

Pilot Survey has been conducted by the researcher, after the Pilot study survey, fine tune was given to the questionnaire and then it was sent to the respondents

For this research work, the data from Research Journals, Books, Research publications, yellow pages, and websites were used.

Validity

Face validity and content validity is used in the research.

Data analysis and interpretation

For Data Analysis, firstly Data editing, coding, compilation is done in Excel sheet and then descriptive statistics is used for further analysis. As data is ordinal in nature, Non-parametric test is used for testing of hypothesis
5. Data Analysis & Interpretation

With a view to test the hypothesis regarding the study of supply chain management system of automobile industries, it was necessary to collect primary data and analyse the same. The primary data is collected by triangulation method through Structured survey questionnaire, observations and in depth interview for cross validation. The results were obtained mainly by using the descriptive statistics viz mean, mode, median, standard deviation etc.

The results of the primary data are split into following three groups.
(1) Profile of the responding industries;
(2) The descriptive statistics related to study;
(3) Hypothesis testing

The results of each hypothesis are explained in following paragraph.

Hypothesis 1

Hₐ₁: Effectiveness of supply chain management depends on timely delivery.

Hₐ: Not Hₐ₁

The Kruskal-Wallis test was used to test the hypothesis. Kruskal Wallis test is the analogue to the F-test used in analysis of variance. While analysis of variance tests depend on the assumption that all populations under comparison are normally distributed, the Kruskal-Wallis test places no such restriction on the comparison.

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<th>Flexibility of suppliers to deliver right quality</th>
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Test Statistic is

\[ H(Cal) = \frac{12}{n(n+1)} \times \left[ \sum T_i - \frac{n(n+1)}{2} \right] \]
\[ = \frac{12}{3(3+1)} \times \left[ (21^2 + 26^2 + 11^2 + 11^2 + 34^2) / 5 \right] - 3(3+1) \]
\[ = 826.3 \]

Rejection region: at \( df = 3 - 1 = 2 \), reject \( H_0 \) if \( H(Cal) \geq H(Cal) \)

Decision is, \( H_{cal} = 826.3 > H_{tab} = 5.99 \)

From the analysis we can conclude that Effectiveness of supply chain management depends on timely delivery hence \( H_{o1} \) is accepted and \( H_{a1} \) is rejected.

Hypothesis 2

\( H_{o2} \): Of all the factors lead time is the most important factor in managing the supply chain.

\( H_{a2} \): Not \( H_{o2} \)
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Test Statistic is

\[
H_{(Cal)} = \frac{12}{n(n+1)} \times \left[ \sum Ti^2/n \right] - 3(n+1)
\]

\[
= \frac{12}{2(2+1)} \times \left[ (9^2+12^2+5^2+3^2+17^2)/2 \right] - 3(2+1)
\]

\[
= 1091
\]

Rejection region: at df = 2-1 = 1, reject \( H_0 \) if \( H(Tab) \geq H_{(Cal)} \)

Decision is, \( H_{Cal} = 1091 > H_{Tab} = 3.84 \)

The test result shows that lead time is the most important or more influenced factor in managing the supply chain. Hence we accept the null hypothesis and reject the alternate hypothesis.
Hypothesis 3

H₀₃: Streamline operation processes of SCM is an effect of balanced inventory
Hₐ₃: Not H₀₃

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Test Statistic is

\[ H(Cal) = \frac{12}{n(n+1)} \left( \sum T_i^2 / n \right) - 3(n+1) \]
\[ = 12/2(2+1) \left( (4^2+10^2+6^2+9^2+15^2)/2 \right) - 3(2+1) \]
\[ = 441 \]

Rejection region: at df=2-1 =1, reject H₀ if \( H(\text{Tab}) \geq H(Cal) \)

Decision is , \( H_{cal} = 441 > H_{tab} = 3.84 \)

The test result proves that Streamline operation processes of SCM is an effect of balanced inventory the null hypothesis is accepted while the alternate hypothesis is rejected.
6. Findings and Recommendations

Findings

➤ Trust between automobile industries and their supplier-It is found that the trust between automobile industries and their suppliers is a significant challenge.

➤ Delivery of the right quality material- 51% respondents said that they are facing the problem of delivery of right quality material from their suppliers and it affects the regular flow of production directly or indirectly.

➤ Availability of on time delivery-Data reveals that majority of the respondents, are facing the problem of getting the delivery of material in time from their suppliers which hampers their scheduling.

➤ Challenge of Material Availability-Material availability is a major challenge in managing the supply chain.

➤ Material Lead Time-Lead time is too long or too lengthy and it affects the regular flow of production.

➤ Price /Cost of the Material-A Burning issue in the supply chain. Due to global slowdown of economy, prices of material has rapidly increased and affected on the automobile sector to the large extent.

➤ Flexibility in the supply chain-51 percent respondents are facing this challenge. They said that their suppliers are not able to supply if there is sudden increase or decrease in demand, most of them need advance orders from these industries. Reliability on only one customer or few customers was also observed as a big problem.

➤ Financial stability-From the data, it reveals that financial stability of suppliers is a challenge in managing the supply chain.

➤ Capacity limitation-59 percent respondents said that they are suffering due to capacity limitation at the supplier's side. Overall it is observed that the capacity limitation is a bottleneck in supply chain.

➤ Transportation related issues such as congestion, weather conditions, and heavy traffic-65 percent respondents opined that transportation related issues such as congestion, road delays, heavy traffic etc. need to tackle efficiently and effectively for smoothening the supply chain.
Heavy Tolls: It is observed that half of the respondents said that they suffer from heavy tolls imposed on them during the transit.

Government rules and regulations: Changes in government’s rules & regulation are beyond the control of both the parties involved in the supply chain.

Taxes and Levis: Researcher found that 94 respondents has problem of Taxes. Every year the tax structure revised by the government for different items affects the business.

Demand forecasting: It is found that 67 percent respondents have a problem due to rigid market forecasting and changes in demand affects the functioning of business.

Output based on customer forecasts to plan: It is observed that 65 percent respondents said that they face this as a challenge because of variations in demand from customers, which resulted in faulty planning.

Cycle Times: In respect of cycle times, 58 percent respondents said that lengthy cycle times affects the operational process.

Inventory levels: It is observed that 61 percent respondents said that inventory or stock plays vital role in managing the supply chain, if there is increase in inventory levels, it directly affects the working capital management and if inventory level decreases it affects the regular flow of production.

Shortage of a key material: 50 percent respondents have the problem due to shortage of key material in managing the supply chain.

Outdated Technology: 56 percent respondents said that outdated technology affects the smooth functioning of supply chain and they need to always cope with new technology to satisfy the end users.

Cost of replacing outdated technology: In line with the above mentioned attribute it is observed that cost required to replace the outdated technology is very high hence it shows that there is a need to tackle this issue.

Integrating technology with suppliers and customers: 52 percent respondents said that there must be integration of new technology to meet the customer’s expectation to cope up with advanced and updated technology.

Labour problem-availability of skills: During the survey it is found that non availability of skilled labour force is a critical issue which needs to be handled effectively and efficiently to improve supply chain management system.

XXV
➤ Capacity limitations due to customer order fluctuations: It is observed that 65 percent respondents rated this attribute as a major challenge which creates bullwhip effect and there is a need to be handle order fluctuations carefully in managing the demand and supply.

➤ Capacity limitations due to capital funding: 57 percent respondents face problem due to non-availability of capital. Majority of them has given higher rating hence it clarifies that working capital management plays crucial role in the supply chain.

➤ Cancellation of orders: The business badly affected due to cancellation of orders hence this issue need to tackle for smooth functioning of the business.

➤ Difficulties in meeting quality requirements: It is also found that quality needs to be monitored at every stage of manufacturing beginning from purchasing till the distribution of the product to the customers as 52 percent respondents has given highest rating to this attribute.

➤ Pressure by Original equipment manufacturers to reduce prices: 61 percent respondents face severe problem due to pressure by Original equipment manufacturers to reduce prices of the components hence this is a challenge for automobile supply chain.

➤ Expectations of customers to comply with new technology are too high: It is found that, 46 percent respondents said that meeting customers requirement is really a difficult task in terms of quality and cost and they presume this attribute as a challenge.

➤ Use of RFID technology: Data depicts that the suppliers do not use RFID technology which is very essential for automobile industries as many components are required for assembly line.

➤ MRP implementation at Supplier’s end: 51 percent respondents said that MRP implementation is not done effectively at their supplier’s plant. If proper attention is not paid then this is a major challenge faced by automobile industries to the large extent.

➤ Use of Information System Tool such as ERP: 47 percent respondents said that their suppliers are not implementing the ERP system. In order to compete in the global market it is the need of hour to implement ERP/SAP.

➤ Supplier’s Ability to JIT Purchasing/Delivery: As observed, 55 percent respondents said that JIT technique is not applied in most of the industries for several reasons such as rework, eliminate waste, surprisingly people are reluctant to adopt this technique in their
organization because of initial cost of implementation and rigorous training involved in its implementation.

➢ Poor communication between the parties involved in the supply chain: Majority of respondents opined that poor communication is a major hurdle in managing the supply chain and there is a need for improvement in the same for sustainable competitive advantage.

➢ Suppliers do not have ISO accreditation: It is found that suppliers of 54 percent respondents don’t have ISO accreditation. ISO/TS 16949:2009 is generally required for automobile suppliers to maintain integrity and build quality of the end product.

➢ Road delays: 45 percent respondents said that their supply get disturbed due to in transit delays, and increased waiting time. This delay can be occurring because of congestion or problem in Prohibition of downtown circulation and there is a need to reduce the same downtown circulation.

➢ Whether there is need for Supply Chain Risk Management: 47 percent respondents opined that troubleshooting of the complaints is not done from supplier’s end and there is a need for supply chain risk management for best quality and efficiency.

➢ Continuous Improvement (5S/ KANBAN implementation): As KANBAN is one effective tool for Keeping eye on inventory levels, it is suggested that organization should focus on this system as well as 5 S for reduction of waste.

**Strategic planning**

48% industries believe that they need to improve their strategic SCM planning. Only one fourth of these companies seem to be satisfied with their strategic planning while 15% claim that they have just started to implement some sort of strategic planning for SCM. An interesting finding is the fact that 10% stated that they find strategic planning not appropriate. This study also found that the majority of industries do not have a clear logistics plan, and 67 of them, do not have a separate logistics department.

**Supplier and customer relationships in managing the supply chain**

In respect of suppliers, 49 companies (52%) said their partnerships as satisfactory, while 36 companies (38%) believe that partnership needs improvement. In respect of customers the situation is nearly reversed. Only 34 companies (36%) are satisfied with their
partnerships with their customers while 46 companies (48%) state that it needs improvement.

**Role of Information systems in managing the supply chain**

The researcher has observed that the role of information system is very essential and crucial for the effective supply chain. Warehouse Management System (WMS), Material Requirement Planning (MRP) and Bar Coding are the most popular IT solutions. On the other extreme, theory of constraints (TOC) and Radio Frequency Identification (RFID) is not used in these industries. Concerning future implementation, Customer Relationship Management (CRM) proved as the most desired IT solution, followed by e-Commerce and e-Business applications.

**Findings from in depth interview**

Deficiencies in the local supplier base were identified. These deficiencies relate to the Suppliers lack of technology, global supply capability and cost competitiveness.

For implementing the Web EDI Portal process it is found that

- More time is required for IBD at buyer’s end
- Improper allocation of material in the warehouse and in the assembly line
- Double bar coding system increases repetitive paper work
- Their exists communication gap between despondent of logistics department and suppliers
- Tendency of many suppliers to over commit themselves in terms of what they can deliver.

**Recommendations**

1. **Role of trust in supplier relationship**-

   It is argued that building partnership trust is at the heart of managing risk and a prerequisite in supply chain. Lack of trust is one of the major factors that contribute to supply chain risks. It is recommended that automobile industries must build the trustworthy relationship for the sustainable development and growth.
2. **Delivery of the right quality material**
   As material is a lifeblood for organization, it is recommended that the parties involved in the business must focus on delivery of right quality material.

3. **Availability of on time delivery**
   The importance of raw materials is obvious to those stakeholders that operate upstream extracting, refining, and processing material into products. Materials are not simply a bundle of characteristics that translate into product performance. Instead, on the operational side, materials establish a class of appropriate production technologies and, by extension, possible product forms and architecture. By addressing this issue in the research, the researcher has found that availability of on time delivery is a challenge. To overcome this challenge the researcher has recommended following points-
   - **Outcomes**-Types of changes can be observed in supply chains as a result of limited materials availability.
   - **Mechanisms**-Supply chain causes to face limited raw materials availability.
   - **Metrics**-Supply chain decision-makers screening for materials availability.

4. **Pressure by OEM to reduce price**
   It is recommended that close working relationship between all stakeholder's need to be developed on mutual trust and negotiations. This can also help in forecasting of future needs of all of them.

5. **Price of materials**
   It is recommended that procurement department of these originations focus on opportunities to negotiate prices. In this regard, it is suggested that buyers be trained to improve their negotiation skills and to focus their skills on investigating and estimating costs more accurately. This will help them to ensure that the buyer is equipped to obtain the best possible prices to its employer.

6. **Cancellation of orders**
   The another significant challenge is that the cancellation of orders with mean 3.125 which has resulted in the holding of excessive inventory. To overcome this issue, it is recommended that industries reduce the selling price of their excessive stock to their original equipment customers, and in some instances, the aftermarket, in order to
generate cash flow. These industries could offer stock clearance specials to eliminate the accumulation of slow-moving stock.

7. **Financial stability of suppliers**

The financial stability of a supplier (ACM) is vital to an OEM as well as for the future sustainability of this supplier. The insolvency of a supplier clearly impacts on the production of motor vehicles till an alternate supplier is found. In turn, the financial stability of a supplier is important to the ACM because the insolvency of a supplier has an impact on the supply of materials.

8. **Material lead times and procurement lead time**

It is recommended that Automobile industries should work with their suppliers to reduce lead times. Two factors need to be considered when analysing lead times: (1) the time it takes to manufacture the item; and (2) the time it takes to transport the item from supplier to these industries. It is also recommended that automobile industries could also proactively analyse final customer demand patterns to match their supplier’s production levels with the ultimate customer or OEM’s demand. ACMs could also review their order systems to ensure that they are efficient and that their requirements are being reordered at the most appropriate time.

A real-time information system such as Collaborative Resource Planning (CRP) between industries, their customers and their suppliers would alleviate both lead time and inventory problems.

9. **High cost of replacing outdated technology**

In order to assist these industries to replace their outdated technology and equipment, it is recommended that government should provide assistance in the form of loan at low rate of interest. This would help them to be more effective, improve the supply to the local market and perhaps even help to obtain additional sales volumes in other countries, on the basis of being more cost competitive, that is, greater volume allowing for reduced prices because these industries fixed overhead is spread over a larger production volumes. By doing this, industries have a competitive advantage from a flexibility perspective as their operations are more labour intensive than capital intensive (automated). They will therefore able to produce lower or higher volumes compared to
other countries where production is oriented towards long, fixed, automated, high production runs.

10. Labour problems – availability of skill
Automobile industries require high quality technical skill, which is also a challenge in managing the supply chain. However, ironically there is a lack of certain specialist skills with some industries which are struggling to source the right skills. In the automotive component industry, the scarce skills include tool making, fitting and turning and welding.

It is recommended that further research be undertaken to investigate at operational level, whether these industries have increased their focus on training and developing their employees.

11. Capacity limitations due to order fluctuations
It is recommended that automobile industries should improve and enhance their demand management systems to make them more effective. In such situation, demand management can be used to estimate, control, smooth and coordinate and balance the demand and supply of a business’ products and services.

After the in depth interview with personnel of Volkswagen India(P) Ltd, it is recommended that the company must provide training to their local suppliers for effective implementation of Web EDI system, which has various advantages such as

1. It speeds up the transfer of business documents.
2. It eliminates paperwork.
3. It reduces administrative phone calls with customers.
4. It reduces manual data entry errors.
5. Potential errors are captured faster.
6. It allows different computer systems to share data regardless of operating systems.
7. It reduces document processing time.
8. It provides accurate data for customer service.

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9. It increases the chance of Preferred Vendor Status
10. Extensive data edits insure that data sent to trading partners meets their requirements

**Conclusion**

This study is classified as both descriptive and exploratory. Through the literature research, it is established that various automobile industries face supply chain challenges. These challenges are mainly as a direct result of rapid developments in supply chain management, technological advancements, globalisation, intensified global competition. The second stage of the research study consisted of a survey, using the structured questionnaires. The identified supply chain challenges were tested and ranked by the responding industries. The findings indicated that the responding industries had been keeping a close eye on both their customers and suppliers.

To conclude, it is significant to mention here that based on the analysis, the findings imply that almost all industries involved in the study are facing the same challenges in managing their supply chain. In addition to the above, it is noted that the respondents have rated highest grading to almost 38 different attributes. It is evident from this study that the automobile industries need to benchmark their activities and improve upon them to improve effectiveness of implementation of SCM in their organizations.

In conclusion, Automobile industries could alleviate most of the problem areas in their supply chain environment through better co-operation with other supply chain partners, skilling their workers and investing in new technology. The latter would require government assistance. It is therefore recommended that the parties involved in supply chain must embrace the supply chain management philosophy to its fullest extent and take into account the impact of decisions on the other parties.

**Limitations of the study and the way forward for future research**

- Not all the automobile industries in Pune Region were included because they are geographically dispersed. Geographical scope of the study restricted to Pune Region only.
• Although a large number of supply chain challenges were investigated, it was not possible to identify all supply chain difficulties. In addition, it should be noted that all problems in the automobile industry cannot be linked solely to supply chain management.

• The researcher has studied all aspects from the supplier’s point of view as it is a B-to-B research.

• Time is the limitation for the study.

References (Selected)

XXXIII

