

Performance Evaluation of Supply Chain and Logistics Management System using Balanced Score Card for Efficiency Enhancement in Indian Automotive Industries

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Abstract

Objective: In universal spirited environment, automotive industries are desired to perform efficiently to meet the maximum percentage of demand by minimum cost. The objective of this article is to create a balance scorecard model for the evaluation of reliability and performance of automotive manufacturing industries to evaluate their supply and demand chain system. **Method/Analysis:** Using this new idea, the performance of industries should be assessed regarding their supply and demand chain system with the major four criteria like design and development, manufacturing point, financial requirement and consumer's point of view. The main four features of the industries are policies and firm coordination, design and execution, effectiveness of shipment and information technology usagetotally covers by the new designed balanced scorecard with twenty five evaluation points. **Findings:** Abroad survey was carried out in Indian automotive manufacturing industries with well structured questionnaires to collect the necessary data. **Application/Improvements:** The comparison between multinational, public limited, private limited and small scale organizations were carried out to measure the performance variation of their supply and demand chain system. Based on the correlation of above four features, a structural equation model was designed to improve the supply and demand chain management system for automotive manufacturing industries and found that the α coefficient was above 0.80 hence, the balanced score card was reliable.

Keywords: Evaluation, Efficiency, PSPP Software, Reliability, SCM, Score Card

1. Introduction

Supply Chain Management (SCM) and Logistics Management (LM) make sure that manufacturing goods reach customers at the right quality in right time with right quantity through the necessary channel. SCM contracts with meeting the required demand using material supply while LM guaranteed the progress

of the goods from the point of supply to the demand. The aim of any supply chain and logistics management resolutions is to assure that a manufactured item arrive the end customer at the minimum possible cost¹⁻². Many ongoing research projects in supply chain and logistics management are in progress for the past few decades to attain this objective but more often than not in a conventional supply chain network setup, where the

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network split ends at a physical retail shop. The start of e-commerce has changed the way of supply chain and logistics management decisions were made. The day is not far off when the majority of the material retail shops would be forced to lock due to their lack of ability to contend in cost with the e-commerce canal. Even though there is high revenue making through online sales, there is still more work wants to be carried out to minimize the cost of the product. The assessment of the performance of supply chain and logistics management steps over individual business limits, thus it is essential to provide entire deliberation to function circumstances within the whole supply chain system which basically increases the complexity. Supply chain and logistics performance management evaluation became as a significant division of supply and demand chain management which concerned the awareness of various national and international research scholars. This article analyzes the performance variation measurement of supply chain and logistics management with a structured balanced scorecard model. Enormous scholarly research articles were published in the area of supply chain and logistics management already. From this a standard review of key survey articles across various aspects of supply and demand chain with logistics management to facilitate the reader with a preliminary tip for continue the research. A SCM policy defines the business model for operating a supply chain to place an organization in the competitive market. Every manufacturing goods have its own supply chain strategy and the aim is to makes sure that the increase of income with decrease of cost^{3,4}. Among the members in a supply chain and logistics management collaboration is a significant role to make sure that there is a faultless supply of manufacturing goods and information⁵. Lack of team work leads to bullwhip result, which is very much unwanted in a supply and demand chain management system⁶. An agile based supply chain model was created to integrate and increase the clarity among the stakeholders in the supply chain and logistics management to eradicate the mediators and to meet out the market demand⁷⁻⁹. A SCM model was developed for procuring iron ore and coke from various resources with manufacturing and delivery of steel goods were examined to develop the productivity of a steel making plant in Iran¹⁰. A SCM model was developed to present the essential of quality in a medium scale foundry industry over various delay conditions, rejection rates and different other factors and also examined the relationship

among the supply and demand chain practices¹¹. A model was developed to evaluate the environmental performance of the supply chain and logistics were analysed in a case study industry and explained the ability to yardstick the first tiers suppliers and goods of an industry. It was also acted as a decision support tool to describe the various measures to be taken for developing the environmental performance of the supply chain in international level^{12,13}. A case-based reasoning system was created to support for assigning the appropriate weights by means of the balanced scorecard design. For an efficient case recovery, a genetic algorithm was engaged for facilitating all weighting altitudes by balanced scorecard and for deciding the most suitable three level characteristic weights¹⁴. The review on the field of supply chain and logistics performance management particularly in the field of automotive industry was carried out and offers a new idea related to the automotive supply chain and logistics management. The article presents detailed suggestions for Performance Management System (PMS) of automobile manufacturing industries and also performance indicators to monitor the supply and logistics management¹⁵⁻¹⁷.

A green supply chain performance measurement structure was described by an intra-organizational joint decision making approach. Green balanced scorecard was used within the collaborative decision making approach using a fuzzy Analytic Network Process (ANP) to support in getting at a reliable, precise and timely data supply across overall cross functional areas of a business. The executed approach helps the industry to recognize additional requirements of the collaborative data across the supply chain and logistics information about consumers and current markets. In general, the above approach helped managers in deciding if the suppliers' performances meet the manufacturing industry and environment principles with efficient human resource¹⁸⁻²¹. Additionally for make sure the PMS is in line along with the manufacturing industries policy will improve policy achievement by lower level management and therefore leads to increase the policy attainment^{22,23}. The recent development in automotive supply chain and logistics additional accentuate the constraint for rethinking the logistics of PMS^{24,25}. A balanced scorecard strategy map was proposed to investigate the types of linkages through which supply chain and logistics management practices collision with financial and non-financial performance, and also to achieve the industry policy goal. The final results exposed that there are several strategic

roots that link the supply chain and logistics management practices and also other in substantial possessions related to financial performance²⁶⁻²⁸. From the above literature, an attempt was made to create a technical and consistent modal to evaluate the performance of supply chain based on the existing scenario. A novel idea of an effectual evaluation tool of balanced scorecard was used for self evaluation of supply and demand chain performance in automotive industries in Chennai, Tamil Nadu.

2. Methodology

Balanced score card is a management tool along with information which offers a new idea to estimate the performance of manufacturing industries by four aspects broadly, which have prominence and mutual collision with design and development, manufacturing point, financial requirement and consumer's point of view. The main objective is to balance among a series of signs such as balance among short period and long period goals, financial and non financial signs, delayed and leading signs, internal and external performance. Attention management must be transferred to understand planned targets from short period goals and transfer to carry out realtime analysis of causes from feedback reflection on results. The structure of balanced scorecard design principles are shown in Figure 1.

3. Data Collection and Analysis

As per the characteristics of SCM and the benefit of balanced score card, researchers and managers who took part in the Japanese logistics system society were designed a new assessment scorecard after ten rounds of deliberations for performance of logistics and supply chain. After that, Tokyo institute of technology organized a professional seminar where many research scholars from various countries were discussed and enhanced the score

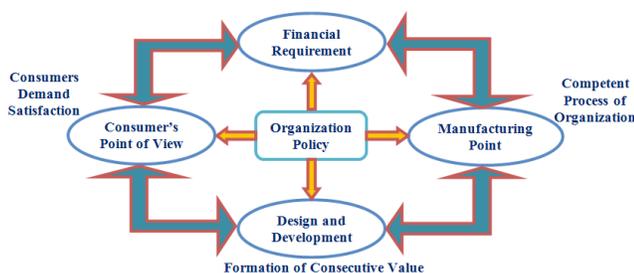


Figure 1. Principle design of balanced score card.

card. The improved score card involved the four aspects like policies and firm coordination, design and execution, effectiveness of shipment and information technology. Policies and firm coordination was measured with five to seven input signs and the score card contains twenty five input parameters. In addition with score card data, the final questionnaire also covers basic information about industries. The guidelines of performance score card for logistics and supply chain management are as follows.

3.1 Policies and Firm Coordination

The parameters considered for this guidelines are significant degree of logistics and supply chain management in industry policies, description of supplier contract items and degree of information sharing, characterization of customer contract items and degree of information sharing, essential degree on customer satisfaction and worker training and appraisal system.

3.2 Design and execution

Optimizing logistics policy system resources based on data flow infrastructure, market orientation comprehension and accuracy of demand prediction, precision and SCM planning adjustment, exactness and visibility of inventory control and tracking and also consistency and visibility of working procedure are the different parameters for design and execution.

3.3 Effectiveness of shipment

For this constraint total logistics costs, inventory turnover rate and cycle period, environmental protection awareness, Just-in-time, consumers in advance and reprinted efficiency, delivery effects and quality and visibility of supply chain inventory and identify the ability of opportunity costs are the major roles.

3.4 Information Technology

Usage of barcode/automatic cognition and data capture, electronic data interchange and computer in operation and decisions are the major criteria in the case of information technology.

For all kinds of business environment it is mandatory that, current management ideas give more concentration to the consumer orientation and satisfaction. Additionally financial data is an important role to estimate externality of business system. Efficiency of supply chain and logistics measure supply chain performance from

external customers and output. Outstanding financial performance and customer satisfaction are entrenched in the business process of industries. To some extent, the degree of business process quality determines financial performance in industries and customer satisfaction. Design and execution aptitude reflects the internal business process of organizations and are the determinative conditions for industries to obtain high efficiency in supply chain and logistics. In advanced information technology suitable applications are greatly improved the sharing degree of information in industries and member firms of supply chains, promote the efficiency of logistics and capital flow, develop the coordinating ability of the entire supply chain and resource integration and improve the supply chain performance levels. The applied ability of information technology reflects the applied level in the supply chain management process. Policies and firm coordination provides the most important internal enterprise environment for management activities of logistics and supply chain. The coordination skill in policies and firm coordination reflects the degree of enterprise emphasis and the support foundation on employee training, logistics and supply chain management.

The score card applies Likert scale of bipolar scaling method is applied in the industries in 5 point scale to evaluate an index. The high scores indicate that the industries have the better performance on the index. Through common discussions of experts and relative staff in enterprise circles, the performance level represented by index scores is defined and explained. Based on the important degree of supply chain and logistics management in enterprise policies the following observations were made.

- Top management has no definite strategy or policy about logistics and supply chain management. There is no specialized department for taking charge of logistics and SCM reformation.
- There is a responsible department for logistics reformation, but the activity area is limited to only internal departments. High level leadership people not participated for taking logistics policy.
- Under the instruction of high level leadership, there is a specialized organization for taking charge of logistics and supply chain management, but its influences don't permeate in the whole company.

- Under the support of definite enterprise policies and the charge of high level leaders, reformation of logistics management is promoted constantly.
- There is a clear enterprise policy covering logistics and supply chain management under the leadership of the general manager, there is a system covering the entire enterprise to enhance the logistics adaptation to environmental changes.

In the year of 2015, collected members of survey team from various education and manufacturing areas are assigned to survey the industrial organizations within India. The survey was mainly integrated with two types such as according to relevant data, business directories and organizations with cooperative relations with the study, a questionnaire was e-mailed and an informal discussion was conducted in industries to fill up the questionnaire face to face. A total of 300 questionnaires were sent and 270 questionnaires were taken back, including 210 questionnaires and 78% of recovery. The proportion of effective samples was 65%. By auditing the complete and effective organizations in the questionnaire, these organizations were referred to as sample organizations. The feedback results for the sample organizations with the percentage of feedback were given in Table 1. Similarly the characterization of sample organizations with the percentage of sample size for the appropriate parameters was summarized in Table 2.

Table 1. Feedback result of sample industries

Locations	No. of Feedbacks	% of Feedbacks
Ambatur	35	16.70
Maraimalainagar	29	13.81
Sriperumputhur	35	16.70
Thirumazhisai	32	15.24
Ennur	19	09.05
Semparamakkam	13	06.19
Guindy	12	05.75
Thuraiyakkam	5	02.40
Tamparam	2	00.95
Siruseri	2	00.95
Villivakkam	3	01.43
Padi	2	00.95
Ranipet	2	00.95
Vellore	9	04.29
Coimbatore	10	04.76

Table 2. Characterization of sample organizations

Parameter	Characteristics of Organization	Sample Size	% of Sample Size
Industry Owned	Multinational Companies	9	16.67
	Public Limited Companies	10	18.52
	Private Limited Companies	15	27.78
	Small Scale Industries	20	37.03
No. of Employees	1-50	25	11.36
	51-100	30	13.63
	101-250	20	09.10
	251-500	20	09.10
	501-1000	50	22.71
	Above 1000	75	34.10
Total Sales	0-10	25	16.34
	11-25	55	35.95
	26-50	22	14.38
	51-100	11	07.18
	101-250	8	05.23
	251-500	7	04.58
	Above 500	25	16.34

4. Results and Discussion

4.1 Reliability and Strength

Reliability and strength are two main signs of questionnaire quality. Reliability refers to the reliability standard between measuring data and conclusions either measuring tools can measure item degree stably in terms of stability and consistency or not. Strength means the results measured by the questionnaire reach the expected targets. The higher strength is the more measured results will display real features of measured objects. Based on the different emphasis, generally strength can be divided into three types such as content, relevance and structure strength. Because of content and relevance strength can be tested by relevant experts during the design stage of questionnaires, structure strength of the questionnaire is also generally tested.

Cronbach α coefficient test is the most common reliability test. In general if α coefficient is above 0.90 the reliability of the questionnaire is excellent. If it is above 0.80 the reliability is acceptable and if it is above 0.70 the questionnaire should be modified greatly. But the

reliability value is below 0.70 the questionnaire should be redesigned. Based on survey data, the PSPP software was used to conduct reliability analysis of four evaluative perspectives of policies and firm coordination, design and execution, effectiveness of shipment and information technology for supply chain performance score card. The result reveals that then reliability analysis of policies and firm coordination, design and execution, effectiveness of shipment and information technology are 0.80, 0.82, 0.83 and 0.82 respectively and the α coefficient was above 0.80 in all parameters which indicating that the design of score card for analyzing the supply chain performance was reliable.

Structure strength demonstrates the isomorphism degree between actual results and expected evaluation, which representing that the structure of actual evaluation model can be regarded as the replacement of expected evaluation content on the structure to a great extent. While evaluating the structure strength, confirmatory factor analysis was selected. Based on the data collected through survey, confirmatory industry analysis of structure for supply chain and logistics performance score card was carried out using Lisrel software and the results are shown in Figure 2. It was found that the Root Mean Square Error of Approximation (RMSEA) was smaller than 0.05 and the values of Normed Fit Index (NFI), Non-Normed Fit Index (NNFI) and Comparative Fit Index (CFI) were above 0.90, which representing that the model fitting was positive and the mentioned structure model could be accepted.

4.2 Comparison of Supply Chain and Logistics Performance

The Indian economy is still in the changing phase from government planned economy to market economy. The improvement and open up policy in India launches important multinational capital. Multinational companies have already become an important part in Indian economy and account for 45% of Indian exports and 55% of Indian imports. With the economic reform of India, private industries have also been developed rapidly. In 2004, employees of private industries totaled 11.7 million people and this increased to 18.1 million people in 2010, so it is necessary to study the difference among public limited, multinational and private industries in supply chain and logistics management. The average performance of every kind of enterprise in policies and firm coordination, design and execution, effectiveness of shipment

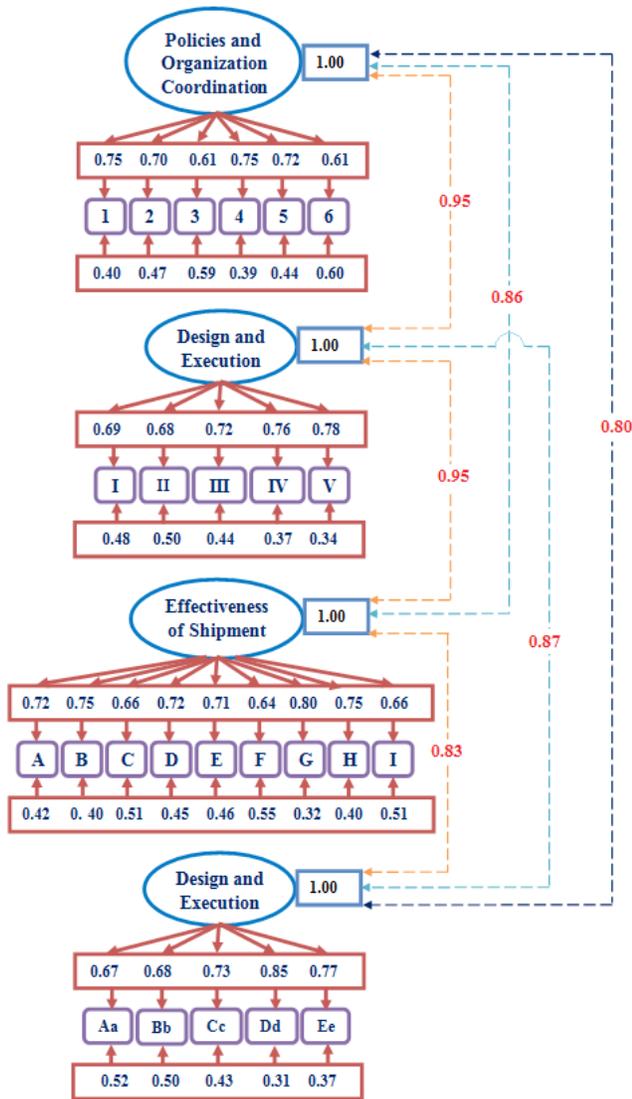


Figure 2. Result of confirmatory factor analysis after standardization.

and applications of information technology is shown in Figure 3. It can be observed that in terms of average performance, multinational companies are superior to public limited, private limited and small scale companies in all the four aspects on the score card. It can also found that public limited companies are superior to private limited companies and small scale industries in policies, design and execution and applications of information technology but superiority of public limited companies in logistics efficiency is not clear. In nonstrict significance, the contributions of public limited companies in policies and firm coordination, design and execution, effectiveness of shipment and applications of information technology are

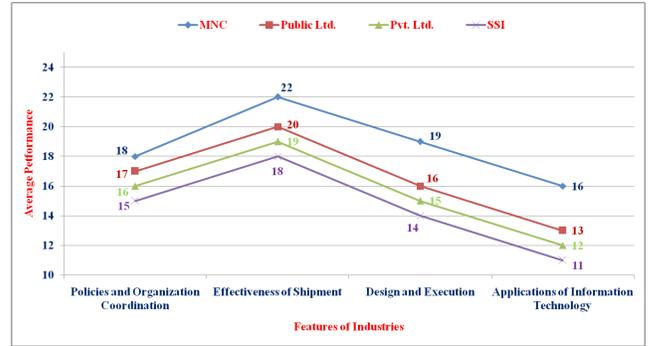


Figure 3. The comparison of supply chain and logistics performance.

inferior to contributions of private limited companies and small scale industries to logistics efficiency.

4.3 Existing Structural Model

Supply chain and logistics efficiency measure the performance of logistics and supply chain in firms from the characteristics of external outputs by the above mentioned design of score card and these outputs are rooted in enterprise business process. In score record, design and execution as well as applications of information technology in industries are the main signs to measure the performance of supply chain and logistics. These business processes involved in logistics and supply chains management exist in an industry or to be carried out in an industry, but are not impacted by company policies and culture. Also confirmatory factor analysis shows that there is a strong correlation between design and execution and applications of information technology. To sum up, the structural model between policies and firm coordination, design and execution, effectiveness of shipment and applications of information technology can be established and shown in Figure 4. The model is developed by giving the input in Lisrel software. The collected data are verified to acquire analysis results. The standard solutions before and after the index of structural equation model are given in Table 3.

The model proposed in this article meets the index requirements hence this model is acceptable. The results show that there is no direct relation between design and execution and applications of information technology, so the acting connection between these parameters is removed. The confirmatory factor analysis among the design and execution and applications of information technology shows a stronger relation, because they

closely depend on the same factor of policies and firm coordination. The proposed model obtained by structural equation for supply chain and logistics analysis is shown in Figure 5. The applications of information technology have a significant influence on effectiveness of shipment. However, influences of design and execution on effectiveness of shipment are stronger, while design and execution and applications of information technology are closely related to policies and firm coordination.

Though effectiveness of shipment is one of the important indexes for customers and shareholders, excellent logistics performance cannot be separated from high quality design and execution, development and utilization of advanced applications of information technology. All of these should be the concern of management in supply chain and logistics management. Moreover, it is also necessary to establish a longterm cooperative relationship between consumers and suppliers and provide effective training for workers.

5. Conclusions

The proposed structural equation model was developed based on the design idea of balanced score card to evaluate the supply chain and logistics performance. The model was designed from the characteristics of design and development, manufacturing point, financial requirement and consumer’s point of view. From the above analysis and observed results the following conclusions were made.

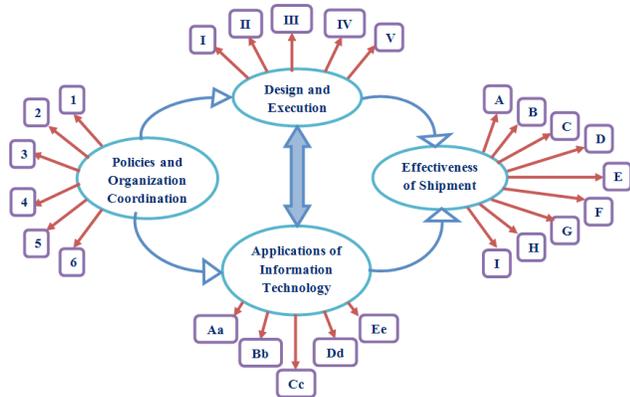


Figure 4. Existing structural model under four characteristics.

Table 3. Results of fitting index before and after structural equation model

Fitting Index	Fitting Results (before)	Fitting Results (after)
X ² (203)	291.54	300.27
RMSEA	0.045	0.047
NFI	0.932	0.92
NNFI	0.954	0.92
CFI	0.954	0.92

- The performance level of supply chain and logistics were evaluated using policies and firm coordination, design and execution, effectiveness of shipment and applications of information technology. Based on the analysis, we developed a supply chain performance evaluation score card with 25 measuring indexes.
- A largescale industry survey was conducted using the designed score card within India to obtain 210 effective questionnaires. The reliability and strength of this score card was analysed using the score card. From the results it was found that the value of α coefficient was above 0.80, which indicates that the design of score card for analyzing the supply chain performance was reliable.
- From the comparative analysis it was found that the performance of supplychains and logistics among these industries, multinational companies exceeds public limited companies and private limited companies in four aspects of the score card, while public limited companies are superior to the private limited companies and small scale industries.
- Besides, we developed a structural model for the above four aspects and evaluated the supply chain and logistics performance and the results were obtained. From the results it was concluded that it is essential to establish a long term cooperative relationship among customers and suppliers and provide effective training for workers.

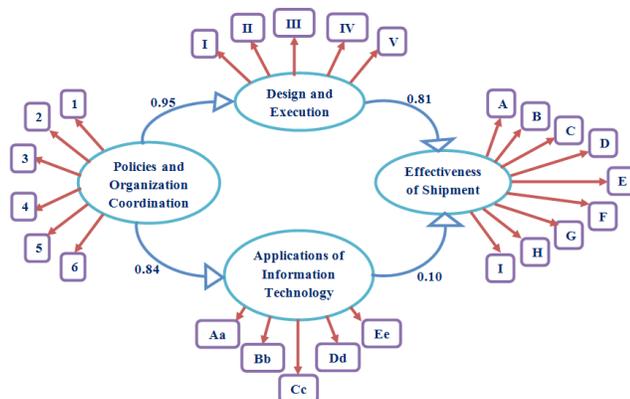


Figure 5. Proposed structural equation model for analysis under four characteristics.

The research may be viable to extend through similar aspects related to performance evaluation of supply chain and logistics with suitable methods.

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