

Reengineering of Logistics Value Chain of a Petroleum Products Marketing Company – Formulation of a Performance Measurement System

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Abstract

A petroleum product marketing company faces many an upheaval in its journey towards attaining excellence. It is more pronounced for a long-established nationalized company, when its pricing remains governed; while it continues to face the challenges from private players with Green field Refineries & modern approach to Supply Chain. In this context, at some point or the other, it has to look towards its logistics value chain and reengineer the same. This paper dwells formulation of Performance measurement tool for the value chain of a petroleum marketing company, with the ultimate purpose of using it to reengineer the value chain.

Keywords

Logistics, Petroleum, Value Chain, Reengineering

1. Introduction

Subsequent upon nationalization of the Oil Industry in India, the Public Sector units (PSU) have been the crowning glory in the Indian business environment. With the deregulation in 1999, PSUs successfully faced stiff competition from private players. Despite a changing scenario and continuous government interventions on pricing and subsidies, PSUs have succeeded on their capabilities maintained their current status as elite Undertakings. With Crude prices fluctuating with a peak of \$135 per barrel to a low of \$45, there have been uncertainties. With no clear road map for linking retail pricing to crude Prices, PSUs have been passing through a difficult stage. At this juncture, it may be of interest to reengineer the logistics value chain of a petroleum company.

Companies need to be competitive to survive. Today, it is not companies that are competing but the supply chains are. A company's performance is based on its supply chain performance - the entire chain's ability to meet end-customer needs through product availability and responsive on-time delivery. Supply chain performance crosses both functional lines and company boundaries. To achieve the goal, performance measures, or "metrics", are needed for assessments and eventual improvements. They must show not only how well one is serving its customers (service metrics) but also how well one is handling its business (speed, assets, inventory and financial metrics).

This paper attempts to analyze the existing value chain of a petroleum products marketing company, explore the different available frameworks for performance measurement of a supply chain and formulate a performance measurement tool to be used for reengineering the logistics value chain of a petroleum products marketing company. The scope of the study was limited to Indian context with primary emphasis on the logistics value chain of the product marketing area of a Fortune 500 global ranking Indian Petroleum product marketing company, which is one of the India's largest PSU with a turn over of nearly 62 Billion \$, with nearly 48 % market share. Like all other PSUs, this company also faced challenges from several fronts, including entry of private players, reduced marketing margins etcetera.

2. Sustaining the Competitive Advantage

Porter (1998) [6] defines Competitive Advantage as a position that a firm occupies in its competitive landscape. Competitive advantage, sustainable or not, exists when a company makes economic rents, i.e., their earnings exceed their costs (including cost of capital). He further defines Sustained Competitive Advantage thus, “A firm possesses a Sustainable Competitive Advantage, when it has value-creating processes and positions that cannot be duplicated or imitated by other firms that lead to the production of normal rents”. Wiggins & Timothy (2005) [8] explain that in today’s global market place, sustaining a competitive position is of paramount importance and periods of sustained competitive advantage have grown shorter over time. Firms have started to leverage their logistics capabilities as a source of competitive advantage as per Zhao (2001) [9] and further described that Competitive advantage may be gained from two main sources: assets and the capabilities that enable assets to be deployed advantageously. Wiggins & Timothy (2005) [8] describe Capabilities as complex bundles of skills and accumulated knowledge, exercised through organizational processes, which enable firms to coordinate activities and make use of their assets. Brewer (2001) [3] links managing logistics to competitive advantage and firms need to position themselves strategically based on their unique, valuable and unmatched resources & capabilities. Mohanty (2007) [5] advocates for gaining competitive advantage, a firm must promote value to its customers by performing activities more efficiently than its competitors or in a unique way that creates greater buyer value. The review of literature suggests a host of logistics capabilities: Customer focus capabilities, Supply-Management Capabilities, Integration Capabilities, Measurement Capabilities, Information Exchange Capabilities and Logistics Learning Capabilities.

3. The Existing Value Chain of the Petroleum Products Marketing Company

Prior to the deregulation in 2002, the effective supply chain of the selected petroleum product company was the simply “Supply-Push” methodology. However, the deregulation brought in severe competition in the marketing sector. Coupled with sub-optimal revenue arising out of under recoveries in SKO & LPG and high customer demands, the company had redefined its supply chain to “Demand-Pull” philosophy, with Corporate Profitability in focus. The earlier & the revised supply chain can be described as follows:

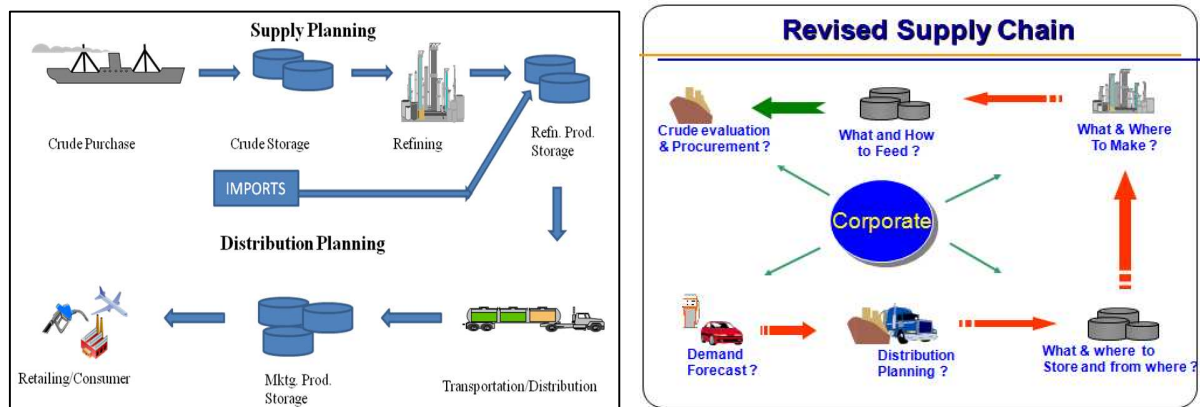


Figure 1: Earlier & Revised Supply Chain

4. Formulating a Suitable Tool for Performance Measurement

Logistics measurement has many measures and measurement approaches from which to choose. The academic literature and trade press suggest several prospective frameworks and models suggested by Brewer and Speh (2000) [2], Beamon (1999) [1], Bravo Model adopted by Donselaar (1998) [4] and Supply Chain Operations Reference Models by Supply Chain Council. Many have been adapted and implemented in organizations. It is for an organization to choose which framework is best suited for it.

For this petroleum product marketing company, the framework chosen applies Analytical Hierarchical Process (AHP), in combination with Balanced Score Card (BSC). This technique is earlier explored in the works of Brewer and Speh (2000) [2] and Varma, Wadhwa and Deshmukh (2007) [7]. The technique focuses on the real business process, reflects the operation status of the supply chain.

BSC takes care of financial and non-financial measures. It enables management reports to focus on measures specifically selected to represent the organizations strategy. AHP provides a framework to cope with multiple criteria situations involving intuitive, rational, quantitative and qualitative aspects. General methods, which are used to evaluate supply chains, cannot be used in the case of this company. It requires judgment and only experts in this field can provide the same. To convert these judgments into quantifiable numbers, AHP provides a perfect solution. In addition to quantification of subjective data, hierarchical representation of a system can be used to describe how changes in priority at upper levels affect the priority of criteria in lower levels. The BSC discussed earlier describes only four perspectives. However within each perspective, a set of criteria can be listed. For example, customer perspective can be measured in terms of Product Purity, Responsiveness to customer and so on. These smaller constituents can be used to make pair-wise comparison judgments to express relative strength or intensity of impact of the elements in the hierarchy.

With all these in the background, the methodology has been developed for the Primary Distribution of the Supply Chain of the petroleum company. In this regard, the product destination is a depot or a Secondary Storage point (SSP). Hence the customer for this supply chain is a SSP. The objectives of this technique are a. Identify criteria which are important for the evaluation of a supply chain; b. Validate the importance of criteria to be used for measuring supply chain performance which has been identified through study; c. Formulate an AHP framework applied to the BSC for evaluating the performance of the petroleum supply chain, based on the above criteria; d. Determine the relative weights of the different perspectives, viz, customer, financial, internal business process and innovation and learning, and also the weights of criteria under each of the perspectives.

To develop the model, the choice of factors determining supply chain performance under the four perspectives of BSC has been validated using opinion from subject matter experts (SMEs). Responses of a total of 28 SMEs were collected. Not only the SMEs were limited to the company, only those people were considered as respondents, who had sufficient understanding of the petroleum supply chain. Most respondents had an experience of at least 15 years or more in the petroleum industry.

a. In order to identify the criteria which are important for the evaluation of a supply chain various journals and literature were studied, after which the following have been identified & grouped under the four BSC perspectives.
Customer Perspective: *Product Quality, Product Service Level, Customer Satisfaction, Responsiveness, Market reach*

Financial Perspective: *Adherence to Budget, Transportation Costs, Operating Costs, Inventory, Cost Savings*

Internal Business Perspective: *Timeliness, Waster Reduction, Accuracy, Utilization of Resources, Shipment Visibility*

Innovation & Learning Perspective: *Automation, Learning and Growth, Suggestions Implemented*

b. The effectiveness of the supply chain can be measured by how well an organization achieves these strategic objectives and they have been treated as the criteria for measuring supply chain performance. In order to further revalidate the criteria so chosen, industry experts were asked to rate the importance of the criteria in the questionnaire on a Likert scale of 4. The scale of 4 was purposely used to avoid tendency of respondents to choose the middle value. The experts were also given the choice of suggesting any additional criteria, which they thought would be important in the evaluation of the petroleum supply chain, which they thought would be important in the petroleum supply chain. However, no particular additional criteria came out strongly from the responses obtained from experts. The summary of the criteria is given below. The criteria chosen were assessed for importance on a Likert scale of 4. The mean scores and also the values of median, mode and SD for the criteria are given in Fig 12. The lowest average score achieved by a criterion was 2.75 out of 4, which is substantial enough to keep the criteria under consideration. Values of median and mode are either 3 or 4, which validate the importance of the chosen criteria.

c. The criteria for determining petroleum supply chain performance have been derived from the strategic objectives that petroleum companies must have. The questionnaire contained pair-wise comparisons between the criteria at two different hierarchy levels of the AHP. Respondents were asked to make pair-wise comparisons based on what they felt was important for evaluating a supply and for its better performance; based on the extensive experience they had in the industry. The *pair-wise comparisons were done on a scale of 1-5*. It would be virtually impossible for a respondent to find a value of relative importance in between these two values. Hence, it was felt that a five-point scale would be adequate to reflect the opinion of industry experts realistically. These pair-wise comparisons were later used to determine the weights of the criteria. Please refer Appendices I and III for the questionnaires.

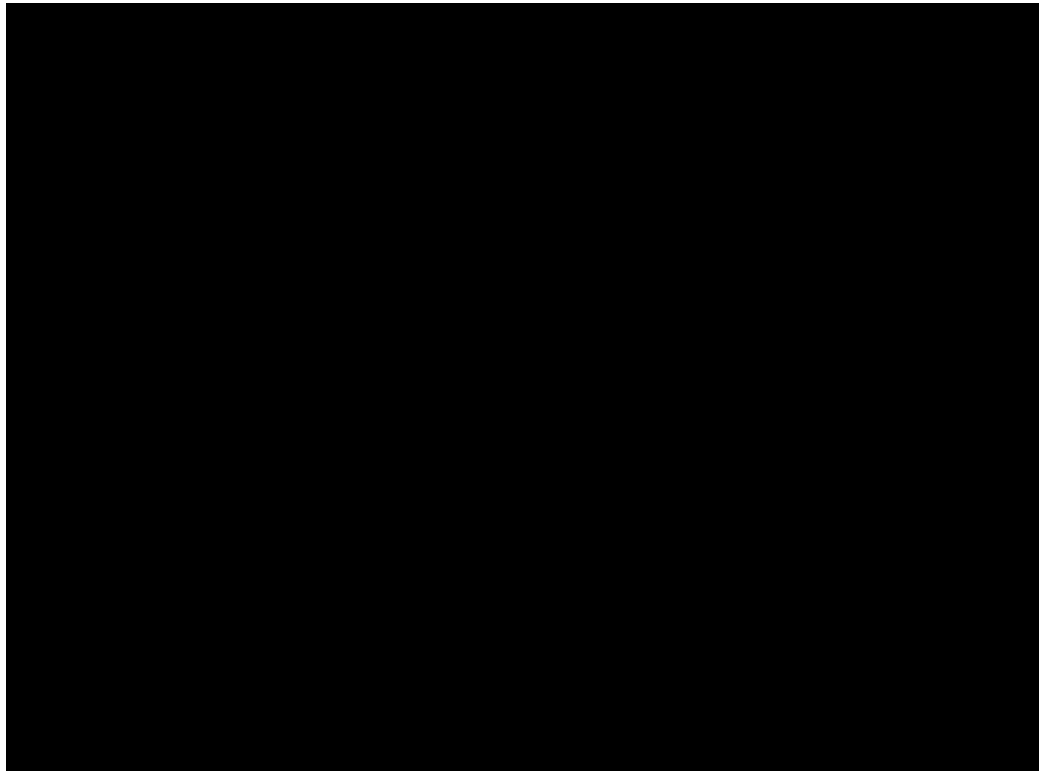


Figure 4: Tabulation of Scores measuring relevance of criteria in petroleum supply chain performance

BSC Perspective					
Pairwise Comparison Matrix					
	Customer	Financial	Internal Business	Innovation & Learning	
Customer	1.000	3.000	1.000	3.000	
Financial	0.333	1.000	0.333	0.333	
Internal Business	1.000	3.000	1.000	1.000	
Innovation & Learning	0.333	3.000	1.000	1.000	
<i>Sum</i>	2.67	10.00	3.33	5.33	

CUSTOMER PERSPECTIVES					
Pairwise Comparison Matrix					
	Product Quality	Product Service	Customer Satisfaction	Responsiveness	Market Reach
Product Quality	1.000	3.000	0.250	0.333	2.000
Product Service Level	0.333	1.000	1.000	0.333	1.000
Customer Satisfaction	4.000	1.000	1.000	3.000	3.000
Responsiveness	3.000	3.000	0.333	1.000	1.000
Market Reach	0.500	1.000	0.333	1.000	1.000
<i>Sum</i>	8.83	9.00	2.92	5.67	8.00

INTERNAL BUSINESS PERSPECTIVES						
Pairwise Comparison Matrix						
	Timeliness	Waste Reduction	Accuracy	Resources	Shipment Visibility	Systems
Timeliness	1.000	3.000	1.000	1.000	1.000	1.000
Waste Reduction	0.333	1.000	0.333	0.333	1.000	1.000
Accuracy	1.000	3.000	1.000	2.000	0.500	1.000
Utilization of Resources	1.000	3.000	0.500	1.000	3.000	2.000
Shipment Visibility	1.000	1.000	2.000	0.333	1.000	1.000
Systems	1.000	1.000	1.000	0.500	1.000	1.000
<i>Sum</i>	5.333	12.000	5.833	5.167	7.500	7.000

FINANCIAL PERSPECTIVES					
Pairwise Comparison Matrix					
	Adherence to Budget	Transportation Cost	Operating Costs	Inventory	Cost Savings
Adherence to Budget	1.000	1.000	1.000	0.500	2.000
Transportation Cost	1.000	1.000	3.000	0.333	0.500
Operating Costs	1.000	0.333	1.000	0.333	0.500
Inventory	2.000	3.000	3.000	1.000	3.000
Cost Savings	0.500	2.000	2.000	0.333	1.000
<i>Sum</i>	5.500	7.333	10.000	2.500	7.000

INNOVATION & LEARNING PERSPECTIVES			
Pairwise Comparison Matrix			
	Automation	Learning & Growth	Suggestions
Automation	1.000	2.000	1.000
Learning & Growth	0.500	1.000	0.500
Suggestions Implemented	1.000	2.000	1.000
<i>Sum</i>	2.50	5.00	2.50

Figure 5: Example of a Response for Level 1 and Level 2 criteria

Response for BSC Perspectives

In order to arrive at a single figure for pair-wise comparisons from the responses obtained from various SMEs, the *geometric mean* of the responses by SMEs was taken.

The weights of four perspectives of BSC at the first level of hierarchy and the weights of the criteria under each perspective at the second level were determined using AHP. The relative weights of the four perspectives found by this method are shown in Figure 8. The result of the model is that Customer Perspective is the most important followed by Internal Business, Financial and Innovation and Learning (in descending order of importance). Within each Perspective the following were the results.

Final AHP Matrix													
BSC Perspectives													
Pairwise Comparison Matrix					Computation of Priority Vector								
	Customer	Financial	Internal Business	Innovation & Learning	Customer	Financial	Internal Business	Innovation & Learning	Weights				
Customer	1.000	1.458	1.224	1.480	0.315	0.324	0.316	0.301	0.314				
Financial	0.686	1.000	0.950	1.017	0.216	0.223	0.245	0.207	0.223				
Internal Business	0.817	1.053	1.000	1.426	0.257	0.234	0.258	0.290	0.260				
Innovation & Learning	0.676	0.983	0.701	1.000	0.213	0.219	0.181	0.203	0.204				
Sum	3.10	4.49	3.88	4.92	1.00	1.00	1.00	1.00	1.00				
Pairwise Comparison Matrix					Computation of Priority Vector								
	Product Quality	Product Service	Customer Satisfaction	Responsiveness	Market Reach	Product Quality	Product Service	Customer Satisfaction	Responsive ness	Market Reach	Weights		
Product Quality	1.000	1.872	1.186	1.504	1.368	0.265	0.343	0.257	0.272	0.198	0.267		
Product Service Level	0.534	1.000	1.021	1.084	1.452	0.142	0.183	0.221	0.196	0.210	0.190		
Customer Satisfaction	0.843	0.979	1.000	1.276	1.598	0.223	0.179	0.217	0.230	0.232	0.216		
Responsiveness	0.665	0.922	0.784	1.000	1.483	0.176	0.169	0.170	0.181	0.215	0.182		
Market Reach	0.731	0.689	0.626	0.674	1.000	0.194	0.126	0.136	0.122	0.145	0.144		
Sum	3.77	5.46	4.62	5.54	6.90	1.00	1.00	1.00	1.00	1.00	1.00		
Pairwise Comparison Matrix					Computation of Priority Vector								
	Adherence to Budget	Transportation Cost	Operating Costs	Inventory	Cost Savings	Adherence to Budget	Transportation Cost	Operating Costs	Inventory	Cost Savings	Weights		
Adherence to Budget	1.000	0.771	0.608	0.688	0.675	0.145	0.174	0.119	0.138	0.149	0.145		
Transportation Cost	1.297	1.000	1.216	1.423	0.888	0.189	0.226	0.239	0.286	0.196	0.227		
Operating Costs	1.644	0.822	1.000	1.021	0.775	0.239	0.186	0.196	0.205	0.171	0.200		
Inventory	1.453	0.703	0.980	1.000	1.194	0.211	0.159	0.192	0.201	0.263	0.205		
Cost Savings	1.483	1.127	1.291	0.838	1.000	0.216	0.255	0.253	0.169	0.221	0.223		
Sum	6.876	4.423	5.095	4.970	4.530	1.000	1.000	1.000	1.000	1.000	1.000		
Pairwise Comparison Matrix					Computation of Priority Vector								
	Timeliness	Waste Reduction	Accuracy	Utilization of Resources	Shipment Visibility	Systems	Timeliness	Waste Reduction	Accuracy	Utilization of Resources	Shipment Visibility	Systems	Weights
Timeliness	1.000	2.329	1.638	1.538	1.785	1.731	0.261	0.290	0.275	0.282	0.223	0.232	0.261
Waste Reduction	0.429	1.000	0.706	0.725	1.025	1.088	0.112	0.125	0.119	0.133	0.128	0.146	0.127
Accuracy	0.611	1.416	1.000	0.969	1.337	1.209	0.160	0.177	0.168	0.177	0.167	0.162	0.169
Utilization of Resources	0.650	1.380	1.032	1.000	1.752	1.511	0.170	0.172	0.173	0.183	0.219	0.203	0.187
Shipment Visibility	0.560	0.976	0.748	0.571	1.000	0.919	0.146	0.122	0.126	0.104	0.125	0.123	0.124
Systems	0.578	0.919	0.827	0.662	1.088	1.000	0.151	0.115	0.139	0.121	0.136	0.134	0.133
Sum	3.828	8.019	5.951	5.465	7.988	7.458	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Pairwise Comparison Matrix				Computation of Priority Vector									
	Automation	Learning & Growth	Suggestions Implemented	Automation	Learning & Growth	Suggestions	Weights						
Automation	1.000	1.040	1.357	0.371	0.376	0.363	0.370						
Learning & Growth	0.962	1.000	1.379	0.356	0.362	0.369	0.362						
Suggestions Implemented	0.737	0.725	1.000	0.273	0.262	0.268	0.268						
Sum	2.70	2.77	3.74	1.00	1.00	1.00	1.00						

Figure 6: Final AHP matrices after taking geometric mean and final weightage calculation



Figure 7: Table of Relative weights of four perspectives (first level of hierarchy)

5. Summary and Future Scope

This study is with an ultimate aim of reengineering the logistics value chain of a petroleum products marketing company. The study threw up very interesting results with Customer Perspective being the most vital, even for a public sector petroleum company. Scope of the current study was limited to a Petroleum PSUs in India. However, the methodology can be very well extended to other petroleum marketing companies and can also be used for benchmarking the perspectives.

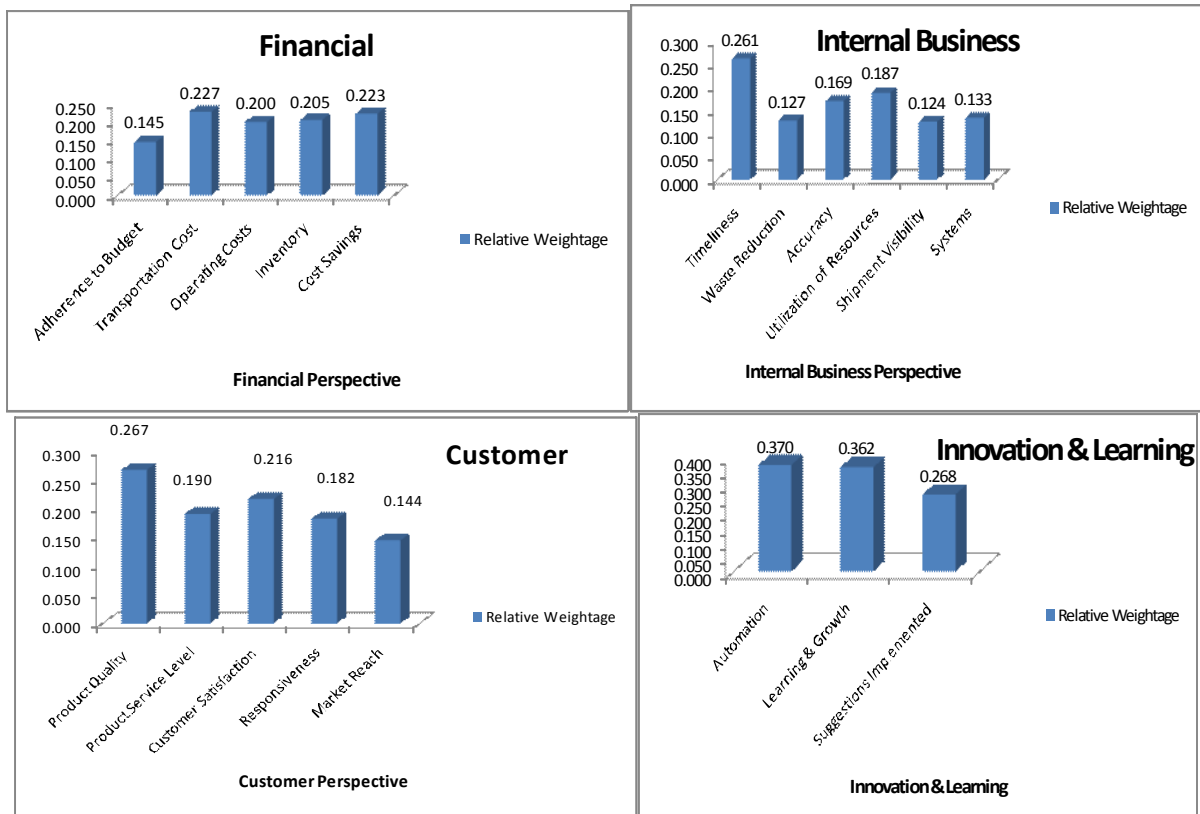


Figure 8: Graphical Representation of Relative Weightages of All Perspective

Acknowledgement

The authors would like to thank Ms Aarthi Muralidhar & Mr. Rajat Baweja, management summer trainees, who not only participated in the formulation, but also carried out the entire survey through questionnaire and assisted in analysis of the data.

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