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Optimizing Supply Chain System in Textile Industry

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***Abstract*—Supply chain management is a process of supplying the finished products to the customers through the various stages, starting with procurement of raw materials to delivering the finished product to the customer. The stages in supply chain have been flexible over the years with industries trying increasing their profit by optimizing the process. This project deals with optimizing the supply chain process in a textile industry by comparing the orders given by two industries based in Spain and Netherlands respectively. The current transportation route is studied and then optimal route is given using the software. The results obtained in both the scenarios are used to create an optimized model.**

***Keywords*—Supply Chain; Shakti Textiles; Karur,; Bommasandra; Transportation; Ordering Types,; Operations Research**

I. INTRODUCTION

Supply chain management is the oversight of materials, information, and finances as they move in a process from supplier to consumer. It involves coordinating and integrating these flows both within and among companies. It is said that the ultimate goal of any effective supply chain management system is to make products available when needed.

Fig.1. Stages of Supply Chain

Supply chain management flows can be divided into three main flows:
• The product flow
• The information flow
• The finances flow

The factors which determine the efficiency of logistics are as follows:

- Cost of transportation of products between the partners.
- The time accuracy with which the product is being delivery

II. LITERATURE REVIEW

1. **Journal: A Study on Supply Chain Collaboration in Textile Industry Nov 17 2018.**
   Authors: Dr.Swamynathan.R, Dr.Kannan. V, Dr.Vanathi.R, S.Sasikala.

   The main aim of the study is to identify the factors influencing supply chain collaboration and the reasons for the textile units to implement the supply chain collaboration.

2. **Journal: Supply chain planning: a quantitative comparison between Lean and Info-Sharing models 26 Aug 2018.**
   Authors**:** Matteo Rossini, Alberto Portioli.

   This article compares Lean and Info-Sharing approaches as SCP models, with the aim of allowing a better understanding of pros and cons of each of them and to identify under which condition Info-Sharing is better, and when, on the contrary, Lean is better.

3. **Journal: Indian Textile Industry: Opportunities, Challenges and Suggestions May 04, 2018.**
   Authors**:** Satish Kumar R.

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The paper tries to provide insights into the Indian textile industry. The article attempts to explain the opportunities, challenges and suggestions.

4. **Journal: Supply Chain Management in Textile Sector: A Sequential Process August 2017**
Authors**:** PriyanshuRaparia.

This journal focuses on Supply chain collaboration in apparel industry, Supply chain visibility, Logistical challenges in Textile supply chain such as Weak Points at Manufacturer, Weak Points at Distributor, Weak Points at Retail Store Back Store Weak Points at Sales Office and Evolving Customer needs.

5. **Journal: A Comparative Study of the Supply Chain Key Factors Differentiated By Nearshore Manufacturing 24-27 May 2017.**
Authors: ShahriareMahmood, Hanna Kropsu-Vehkaperä, PekkaKess.

The exclusivity of this research is to examine the significance of nearshore manufacturing and point out the important considerations in different cases. In particular, it has taken into consideration also the complicacy of textile supply chain for selecting the key facto
.

III. PROBLEM DEFINITION

Upon our understanding of supply chain in Shakti textiles, a small scale industry we have come up with following possible problems:

1) There are two types of order from two different customers of Shakti textiles. We have studied the process of functioning for both these order types. It is important that the industry focus on the order type which generate more profit.
2) The transportation of the raw materials and finished goods takes a complex route. It is therefore important to simplify the route with possible adjustments in order to decrease the logistics cost.

The methodology employed for this project is as follows:
1) Explorative Research
2) Data collection and analysis.
3) Model development.

IV. SHAKTI TEXTILES

OVERVIEW ON THE INDUSTRY

Shakti Textiles is a small-scale industry which is l ocated in Bommanahalli, Bengaluru. The industry was established on November 17, 2003. They manufacture home furnishing textile products like kitchen towels, curtains, cushions, cushion cover, table cloth etc. It currently operates with a turnover of 100 million INR per annum. In the initial couple of years the industry produced home furnishing textile products which were sold within the country. But later they started exporting their products. Their products were initially sold in United States of America but it didn't last long. Later, they started to export their products in European countries. Currently they export their products mostly to Spain and Netherlands.
The two main customers of Shakti textiles are:

- El Corte Ingles from Spain
- Leen Bakker from Netherlands

V. EL CORTE INGLES – ORDERING TYPE

El Corte Ingles is a Spanish company which imports home furnishing textile products are sell in their showroom. In India, they place their order through one of its agent. The Buying house now has two roles to play. They are:

- They have to circulate the order details other than the cost to all the companies in India. They have to select the industry which would obtain the entire order for El Corte. This selection is based on the cost which the industry is demanding, the quality of the product and the ability to deliver the order on time.
- They have to inspect the entire order after its manufacturing before dispatching it to the Spain.

The industries have to send a sample of the product to the buying house. Based on the quality of this sample and the other parameters, the entire order is given to the industry. The entire flow of information and the products can be understood by the fig.3

Fig.3. Supply Chain stages in El-Corte Ingles

VI. LEEN BAKKER – ORDERING TYPE

Leen Bakker has completely different approach when it comes to placing order of product from Shakti textiles. Leen Bakker contacts an agent and shares all the details necessary. The entire set up can be understood through fig.2.

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Fig.2 Supply Chain stages in Leen Bakker

VII. PROCESS INVOLVED IN MANUFACTURING

There are nine steps in manufacturing a kitchen towel. Shakti textiles doesn't perform all the activities in the manufacturing. The sequence of process is shown in fig.5.1. It procures the raw materials from mills of Karur. The dyeing process takes place in Madiwala, Bengaluru and the printing takes place in Bommasandra, Bengaluru.

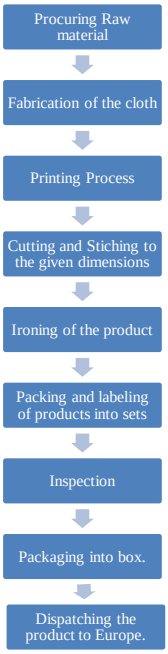

Fig.4 Process involved in Shakti industries

VIII. COMPARING THE TWO ORDER TYPES

El corte and Leen corte have different ways of placing their orders. The cost of producing the same product would obviously be different for these buyers. The main difference is seen as the inclusion of a extra stage in supply chain which is called as buying house. Due to this the cost of transportation increases for El corte. Also, the buying house inspects the products before dispatching it hence the cost of inspection also increases. These two parameters add extra manufacturing cost for El corte. Following which plotted Pareto chart has been plotted using Tableau software for analysis since visualization are easier to understand than plain numbers.

IX. DATA COMPARISON

Table 1. Cost Comparison of various processes between El-Corte and Leen Bakker

PROCESS	EL CORTE – COST (INR)	LEEN BAKKER – COST (INR)
Cloth	18	18
Fabrication	8	8
Printing	6.3	6.3
Finishing Processes	5	5
Packing and labeling	4	4
Inspection	1.25	0.40
Transportation	9	8

X. EL CORTE – PARETO CHART

The data for El corte ordering type is plotted on the Pareto chart which is shown in fig.5

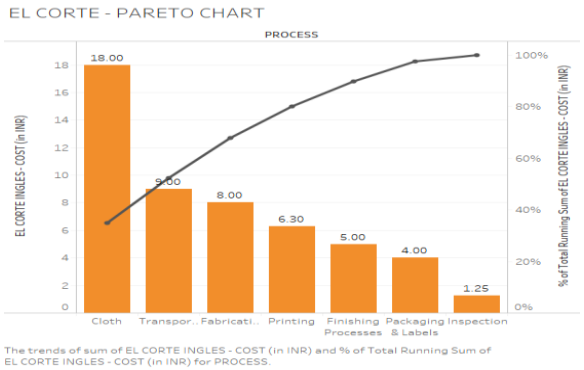

Fig.5 Pareto Analysis chart of El-Corte Ingles ordering type

XI. LEEN BAKKER – PARETO CHART

The data for Leen Bakker ordering type is plotted on the Pareto chart which is shown in fig 6.

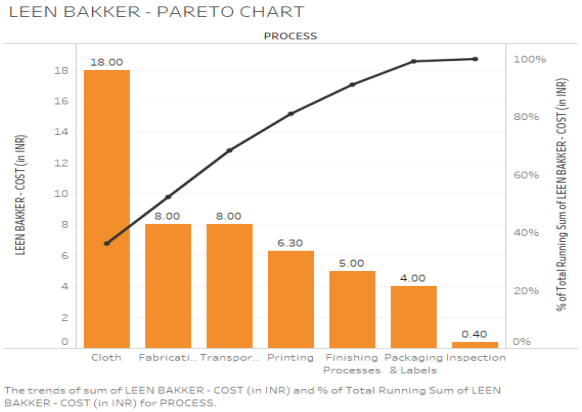

Fig.6. Pareto Analysis chart of Leen Bakker ordering type

XII. TRANSPORTATION ROUTE

PRESENT TRANSPORTATION ROUTE

The series of the raw material flow can be understood from the following flow diagram represented in fig.2.

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Table 2. Distance between Source and Destination in KM

SOURCE TO DESTINATION	DISTANCE (KM)
Shakti Textiles to Karur	284
Shakti Textiles to Madiwala	06
Shakti Textiles to Bommasandra	12
Shakti Textiles to Tuticorin	585

The distance travelled = 284 + 06 + 06 + 12 + 12 + 585 = **905 kilometers**

Shakti textiles uses the service of Jai Hanuman Tempo for the transportation process all throughout. The cost charged by Jai Hanuman Tempo service is 25 rupees per kilometer.

Gross distance travelled = 2 x Net distance travelled (i.e. Actual distance travelled)

The total cost of transportation = (gross distance travelled) x (cost per kilometer)

= 2 x 905x 25

= 45250 rupees

XIII. OPTIMIZED TRANSPORTATION ROUTE

The two basic conditions to be followed while solving a traveling salesman problem is:

- The salesman has to travel all the cities only once.
- The starting and the finishing city/point of the travel should be the same.
- LINGO has been used to verify the answer obtained in manual method.

MANUAL METHOD

The first point should be Karur since it is from this place that the raw materials are procured. So, the remaining process can takes place only if the raw materials are procured.

The four places where the truck has to travel are:
Karur(K) – to procure raw materials.
Madiwala(M) – for dyeing process.
Bommasandra(B) – for printing process.
Shakti textiles(ST) – for other operational processes.

PROBLEM

Table 3. Problem matrix

	K	M	B	ST
K	-	290	272	284
M	290	-	18	6
B	272	18	-	12
ST	284	6	12	-

ASSIGNMENT

Table 4 Assigning optimal route

	K	M	B	ST
K	-	18	**0**	6
M	24	-	12	**0**
B	**0**	6	-	0
ST	18	**0**	6	-

From the above assignment, we get an incomplete route as KARUR → BOMMASANDRA → KARUR.

RE-ASSIGNING

Table 5. Re-assigning optimal route

	K	M	B	ST
K	-	18	**0**	6
M	24	-	12	**0**
B	0	**6**	-	0
ST	**18**	0	6	-

From the above re-assignment, we get an optimum route, which is:

KARUR→ BOMMASANDRA → MADIWALA → SHAKTI TEXTILES → KARUR.

XIV. USING LINGO SOFTWARE

LINGO is a comprehensive tool designed to make building and solving Linear, Nonlinear (convex & non-convex/Global), Quadratic, Quadratically Constrained, Second Order Cone, Semi-Definite, Stochastic and Integer optimization models faster, easier and more efficient.

LINGO provides a completely integrated package that includes a powerful language for expressing optimization models, a full featured environment for building and editing problems, and a set of fast built-in solvers. The recently released LINGO 18.0 includes a number of significant enhancements and new features. .

Key Benefits of LINGO

- Easy Model Expression
- Convenient Data Options
- Powerful Solvers.

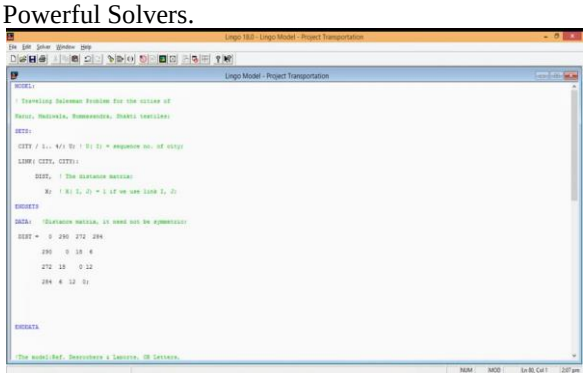

Fig.7 Program on LINGO – 1

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SOLUTION OBTAINED

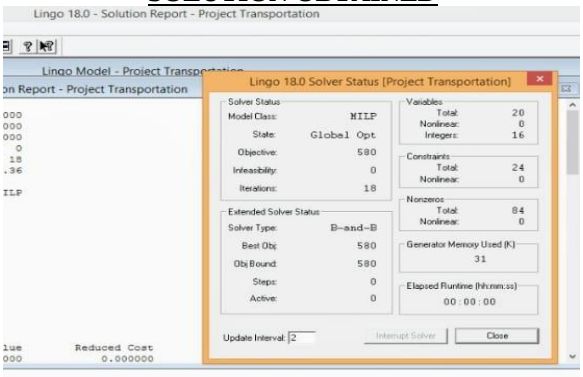

Fig 8. Solution on LINGO - 1

From the software, we got the optimum solution as: **KARUR à BOMMASANDRA à MADIWALA à SHAKTI TEXTILES à KARUR.**

This is the same route which we got by solving the problem by manual method.

1.1. INSIGHTS ON THE SOLUTION OBTAINED

There are few important inferences which are drawn from the solution obtained. They are as follows:

1. From the above route, we can observe that the truck first goes to Bommasandra and then to Madiwala. But, by the sequential process of manufacturing the raw material should first be dyed in Madiwala and then printing should take place in Bommasandra. Hence the optimal route would now change as,

KARUR à **MADIWALA** à **BOMMASANDRA** à **SHAKTI TEXTILES** à **KARUR.**

2. Secondly, if the dyeing process takes place in Karur itself from where the raw materials are bought, then dying of cloth in Madiwala can be skipped. Then, the new optimal route would be,

KARUR à **BOMMASANDRA** à **SHAKTI TEXTILES** à **KARUR.**

However this would change the dynamics of the industry for sometime but then this would only prove to be profitable for the entire industry on a long run.

3. The third important insight to be noticed is that in the current scenario the staff of the Shakti textiles inspects the raw material after dyeing and printing process. But, this would not be possible in the current new optimal route. The industry can thus sign a bond with dyeing and printing industry that they would have to be paid for any damage in the raw materials. They can also assign couple of trustworthy employees to regularly go and check the raw material condition as and when the raw materials arrive for dyeing and printing in their respective industries.

4. The next and very important insight which we have overseen all this while is that the starting and closing points of the travel should be the same. But, in this case of manufacturing Kitchen towel, the starting point is Karur from where raw materials have been procured and the finishing point is Tuticorin sea port which is also known as Thoothukudi sea port. However we assumed that the finishing point is Karur in the travelling salesman problem. However, it so happens that the route to Thoothukudi sea port from Bengaluru is via Karur. So we can assume that the truck loaded with the finished good halts at Karur and finishes one complete loop as conditioned by the travelling salesman problem. Thus we can say that there are one complete loop and then there is one way route from Karur to Thoothukudi sea port. The fig.8 shows the route from Bengaluru to Thoothukudi via Karur.

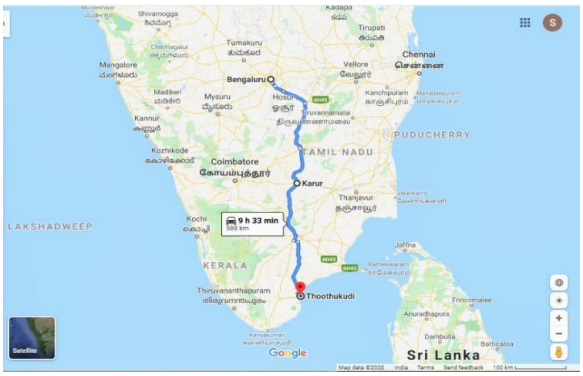

Fig.8 Route to Thoothukudi from Bengaluru via Karur

RESULTS AND ANALYSIS

1. The total cost for producing one unit of Kitchen towel cost is 51.55 INR for El corte ordering type and 49.7 INR for Leen Bakker ordering type. This comparison is done by developing Pareto chart using Tableau software. The increase in cost of manufacturing for El corte is because of the increase in the cost for inspection and transportation . This is because of the presence of an extra supply chain stage called as Buying house. Thus, with the increase in a supply chain stage, the cost of manufacturing increases.

2. The transportation route employed currently in Shakti textiles is very inefficient and thus reduces the profitability. The distance travelled throughout the completion of the order is **1810 kilometers**. It currently costs **45200 INR** for transportation in one complete order.

We have developed, using LINGO software a new optimal route which is as follows,

KARUR à **BOMMASANDRA** à **SHAKTI TEXTILES** à **KARUR.**

For this route, the total gross distance travelled is **1600 kilometers** and for this distance the cost of transportation would be **40000 INR.**

CONCLUSION

1. Supply chain is the core for any manufacturing sector. It is therefore one of the most important function which has to be efficient.

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2. Shakti textiles is a small scale industry which manufactures home furnishing products and exports it to countries of Europe. On understanding the entire process in which it function to manufacture a kitchen towel, we found two areas where some improvements could have been done.

3. Firstly, there were two ways in which Shakti textiles were getting the order. One of them included an extra stage in the supply chain. So, we suggest that the industry tries to get orders directly from the customer and through some buying house.

4. Secondly, the industry operates in a very basic transportation route which could be optimized. We determined an optimum route both manually and using LINGO software. There was reduction in the new transportation cost when compared to old transportation cost.

5. Intangible benefits are often given more priority when compared to tangible benefits. By the use of new transportation route, the industry not just reduces the transportation cost but also speeds up the process. The time to complete the order is reduced and the stress level of the employees is also reduced.

6. The best model which Shakti textiles could adopt is receiving orders through Leen Bakker ordering type and using the new optimal route as shown in earlier section.

FUTURE SCOPE

- Currently, due to the COVID 19 pandemic, they entire business is shut down. The only thing which is still functional is Supply chain. Though, this is only for the essential items. The exports of the apparel industry in India reduced by 91% in April, 2020. This is a serious concern as situations similar to this might arise in future too.

- The first approach would be maintaining a safety stock inventory of raw material which is being procured from the neighbouring state. This ensures that the industry can function if the inter-state transportation is stopped.

- Situations like these would be difficult and would impact the revenue of the industry. So, the industry should be flexible and would be open to manufacture products which would be appropriate in those situations. These products can be face masks, hand gloves etc. It should be noted that it would be futile to manufacture something which completely new to them.

- It is also necessary for the industry to keep in constant touch with its buyers since the difficult situations would subside one day. They would not like carry a burden of losing their customers.

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