ICMIEE-PI-140419

ANALYSIS OF SUPPLY CHAIN EFFICIENCY AND SUGGESTIONS FOR IMPROVEMENT, A CASE STUDY

[1]*Md. Rezaul Karim, AKM Sarower Kabir, Md. Aslam Khan, Md. Minul Ehsan And S.K.Biswas*[2]
[1] Graduates of Department of Mechanical and Production Engineering, Ahsanullah University of Science & Technology, (AUST), Dhaka, Bangladesh
[2] Professor, MPE (Mechanical & Production Engineering) Dept., AUST, Dhaka, Bangladesh

ABSTRACT
The supply chain is the connected series of activities, in relation to any production or service organization, which is concerned with planning, coordinating and controlling of materials, parts and finished goods from supplier to customer. Supply chain efficiencies have been the central theme of focus in any organization in designing and implementing supply networks. In this paper, we tried to improve the efficiency of supply chain of a local furniture industry, on the basis of highest moving and lowest moving product. A number of key findings were found, like the deficiency in the logistics system, which in our opinion played an important role in supply chain analysis. Study was made by PARETO analysis, time study and demand forecasting. We found the relationship between productivity and other measures of performances by analyzing Pareto chart with other methods. Experimental verification of efficiency in terms of logistic, demand forecasting and time study were also made. Finally we came to the conclusion that the companies that manage the supply chain as a single entity and ensure the appropriate use of tools and techniques in order to meet the need of the market, will not be left behind in the fight for survival. We think the findings will be helpful to the management of the company.

Keywords: Supply Chain Management, Logistics, Pareto Analysis, Time study, Forecasting

1. Introduction[1][3],[12] and [13]

Considering the importance of supply chain in an industry, we decided to apply our theoretical knowledge of supply chain to practical problems. As a part of the case study we selected RFL Furniture Ltd at Rupganj, Narayanganj. We decided to analyze the supply chain of the RFL furniture by using various related tools with a view to solving, prioritizing problems regarding supply chain distribution centers, evaluating supply chain efficiency etc. Our main objectives were: studying and analyzing the existing supply chain scenario of 'Regal furniture (RFL) Limited' and suggesting optimum solution in terms of efficiency, conducting a time study for most moving item of RFL (Regal) furniture so that standard time of producing the items can be identified. We also tried to create a relationship between customer demand and production planning by calculating demand forecasting.

2. Problem analysis [1], [2], [3] and [11]

In the following major areas, we gave relatively more attention to analyze the supply chain of RFL furniture in particular and we especially found some problems in the following areas after initial checking and verification. Major problem areas as found by us were as follows:

- Logistics
- Storage
- Production
- Maintenance
- Customers' satisfaction

By analyzing the Pareto chart, we have observed that most significant problems have been created by logistics area which leads us to scrutinize the efficiency in terms of average logistics index. Through this analysis we suggested an improvement of efficiency. Next area was customers' voice. Customers have been complaining of not getting their product in time due to varieties of different issues which encouraged us to conduct a time study for the most moving item of RFL furniture to have a look at the difference between the standard time and total cycle time.

2.1 Calculation of Supply Chain Efficiency [10], [6] and [1]

Index for measuring supply chain efficiency is given in reference [10] and may be expressed by:

$$Al_i = PE_i\,(1-SCC_i) \qquad \ldots\ldots\ldots\ldots.. \qquad (1)$$

Where,
Al_i = Average logistics Index
PE_i = Performance external Index
SCC_i = Supply chain cost Index
SCC_i = Total SCC/Net Sales.

Contact Adresses: tel. : +88-01817-746070, +88-01838-261758
E-mail: skbaust@yahoo.com, skbiswas.mpe@aust.edu, skbcuet@yahoo.com

Some costs related to supply chain have been stated below which were collected from the RFL officials at the plant site:

Supply Chain Costs [7] include,

Manufacturing cost = BDT 6800 per single unit

(The basis for this was: Sales of wardrobe in BDT)

In the following calculations, basis was considered as selling of 50 units of wardrobe per month with average cost of BDT5000/ unit:

Administration Cost = 4% of sales
= 4% of (50×5000)
= BDT 10000

Warehouse Cost = 8% of sales
= 8% of (50×5000)
= BDT 20000

Distribution Cost = 4% of sales
= 4% of (50×5000)
= BDT 10000

Capital Cost = 14.5% of sales
= 14.5% of (50×5000)
= BDT 36250

Ordering Cost = 6% of sales
= 6% of (50×5000)
= BDT 15000

Therefore ***total*** Supply Chain Cost for 50 numbers of item becomes = 10000+20000+10000+36250+15000
= BDT 91250

Therefore we get: $SCC_i = 91250/(50\times5000) = 0.365$

Therefore, Al_i becomes $= PE_i\,(1\text{-}SCC_i)$ ………… (1)
$= 0.48(1\text{-}0.365) = 0.3048$

Where, $PE_i = DP_i \times LT_i \times CS_i$ ……….. (2)

Where,

DP_i = Delivery Precision Index

CS_i = Customer Satisfaction Index

LT_i = Lead Time index

Therefore PE_i becomes $= DP_i \times LT_i \times CS_i$ ……… (3)
$= 0.8 \times 3 \times (8/40) = 0.48$

The basis of the values considered in the above equation was as follows:

DP_i has was taken as 0.8 because we found out from the customer that 80 delivery out of 100 reached on time, so

$DP_i = 80/100 = 0.8$

LT_i was considered as 3 days: by consulting with the authorities of the RFL about the lead time, and

CS_i value was considered by conducting a survey; we asked different questions related to their satisfaction. 8 out of 40 customer gave positive feedback about the products, so CS_i index was taken as (8/40) = 0.2

Therefore as per calculation shown in (1) above existing Supply chain efficiency becomes 30.48 %, which can be considered low compared to standard efficiency in an industry. The authors think that the company might get benefit if this can be improved.

Thus our suggestions for improving the efficiency have been mentioned in discussion & in conclusion.

2.2 Time study of wardrobe [11], [14] and [12]

Time study was done on Auto panel saw, Sliding Saw, straight edging machine, CNC machine and boring machine for making different parts of making wardrobe. We conducted time study for all of the mentioned machines. Sample calculations have been shown for only two machines

<u>Auto Panel saw:</u>

Time taken in each machine for making the related part of a wardrobe was mentioned. Calculation was done following the basic theory of normal time and standard time calculation:

Normal time = Total operating Time × performance rating
= 37.5 hour × 0.70
= 1575 minutes

We calculated allowance factor like that mentioned in the following [11]. And actual time was found by observing time using stop watch.

- Allowance Factor = Unavoidable delay + avoidable delay + machine allowance
= 70+25+70
= 165 minutes which is approximately 7.5 % of actual operating time.

So, Allowance Factor becomes = 7.5% = 7.5/100 = 0.075

And thus the Standard time becomes =

Normal Time × 1/(1-Allowance factor)
= 1575× (1/1-0.075)
= 17032.70 minutes
= 28.37 hours (Approx.)

**** Consulting with the management level officials of RFL Ltd. and by observing the workers while producing the product performance rating has been taken as 70%*

<u>b) For sliding saw:</u>

Like that in (a) for (b) Sliding Saw similar type of calculations were mentioned below:

- Normal time = Total operating Time × performance rating
= 1374.6×0.70
= 962.22 minutes

- Allowance Factor = unavoidable delay + avoidable delay + machine allowance
  = 51+23+5
  = 79 minutes which is approximately 5.7 % of operating time

  So, Allowance Factor in this case becomes = 5.7 % = 5.7/100 = 0.057

- Therefore, standard Time for (b) becomes =

  Normal Time × (1/1-%Allowance factor)
  = 962.22×(1/1-0.057)
  = 1020.38 minutes
  = 17 hours (approx.)

Similarly primary data was also taken for straight edging machine, CNC machine and boring machine.

Total Operating Time for 5 machines as mentioned above for making ***one wardrobe*** was =

37.5+22.91+16.25+21.5+8+24.16 = 130.3 hour = 5.43 days
And thus standard time becomes= 28.37+17+13.39 +15.92 +7.96 +18.38 = 101.02 hour = 4.2 days

The Company uses 120 units to make a lot.
Therefore, total delay time for lot of 120 units becomes (Operating time - Standard time)
= (5.43 – 4.2)days/lot
= 0.23 days/lot
= 0.010 day/unit
= 0.246 hours / unit
= 14.76 min/unit
Pl check the above calculation for delay/unit or per lot?

Our suggestions for improvement have been mentioned in discussion & conclusion separately.

2.3 Forecasting for the sales of wardrobe [12], [3]

With a view to improve supply chain responsiveness, the gap between demand and supply needs to be reduced, by ensuring availability of the product at optimum cost, customer satisfaction can be increased. We have applied weighted moving average method and exponential smoothing method to find out forecasted sales value of wardrobe.

(a) By weighted Moving average method

Calculation for moving average method has been given as follows:

Table 2.3 (a) for weighted moving average method

Month	Actual Sales	Forecasted value
May	9	Forecast could not be found as data for April was not known
June	25	9×0.33+9×0.67=9
July	33	9×0.33+25×0.67=19.72
August	Not known	25×0.33+33×0.67=30.36

Considering weights as:
Latest month’s weight= 0.67
Other month’s weight=0.33

So, using above method we found forecast for July = 19.72 and that for august = 30.36. It may be mentioned that Actual sales value from RFL for April and August could not be obtained. Hence Forecasted value of May too could not be calculated.

Mean absolute deviation (MAD) has been calculated by the following relation:
MAD = summation of respective absolute values of (actual –forecasted value) / Total no. of observations

b) By Exponential Smoothing Method

Exponential smoothing method=
New forecast F_t = previous month’s forecast+ smoothing constant (Actual forecast-previous forecast)

The objective is to obtain the most accurate forecast no matter the technique used:

As we know, for industrial purpose smoothing constant α in the range of 0.2-0.7 is generally used. In the following table 2.3 (b) we have considered only three values of smoothing constant α = 0.2, 0.3 and 0.5. We found out that the value of α for which MAD is minimum is by using an alpha of 0.50. Although we ended up with the lowest MAD by using the only three values of constant = α, forecasts might be more reliable using other values of alpha and also considering other related variables.

But for this particular case of forecast of RFL α = 0.5 should be used by the RFL authorities.

Table 2.3 (b) for exponential smoothing method

Month	Actual sales	α = 0.2	α = 0.3	α = 0.5
		Forecasted sales		
May	9	9	9	9
June	25	9	9	9
July	33	26.06	26.58	27.64
August	Not known	33.53	33.79	34.32
Mean Absolute Deviation		7.65	7.47	7.12

For α = 0.5 MAD is minimum

Example of sample calculation:

(i) Forecast for July for smoothing constant α = 0.2
25+ 0.2(25-19.72) = 26.06

(ii) Example for MAD calculation for α = 0.3:
[(9-9) + (25-9) + (33-26.58)] / 3 = 7.47

(c) Exponential smoothing trend adjustment method

T_t = (1-β) × previous month's trend + β × (Present Forecast value- Previous Forecast value)
Adjusted forecast with trend = Forecast without trend + T_t.

β = 0.4 was used in this paper to reduce the impact of the trend error occurring between the actual value and forecast value as this value is usually considered as equal to 0.4 by many organizations and related authors.

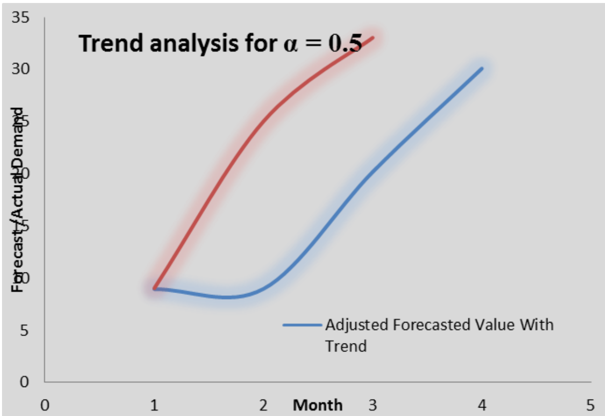
The following Tables 2.3 (c) and 2.3 (d) show the calculation results only and the related graph. Sample calculation has not been shown as it is similar to that shown earlier for exponential smoothing method.

Table 2.3 (c) for exponential smoothing with trend adjustment

Month	Actual	Forecast without trend	Trend	Adjusted Forecast with trend
May	9	9	0	9
June	25	9	0	9
July	33	17	3.2	20.2
August	Could not be known.	25	5.1	30.1

Among all the methods weighted moving average method was found to give optimum result. Because among them MAD is minimum for weighted moving average method.

Table 2.3 (d) : Trend graphs for forecasting adjustment



We compared the results of simple exponential forecasted values with those of trend adjusted forecasted values. But in the above figure the graph for exponential smoothing forecasting method were not shown. In the above figure the red line indicates the actual value.

3. DISCUSSION [4], [5],[8],[9]

In this study data which was taken by ourselves has been named as Primary data in the following discussion and we also used some other data provided by the company, which we call as Secondary data. In terms of data collection, secondary data was taken into consideration for sales which was applied to improve demand planning including suitable forecasting method for high moving (wardrobe) and low moving (show-case) products, smoothing constant and trend analysis, although all sample calculations could not be shown. Time study was done using only the collected primary data by means of that we studied to find out standard time of doing operation of high moving product. Since the production schedule for show-case (low moving) was not available in the plant. Secondary data was used to measure the efficiency; later on the same was applied to determine supply chain efficiency in terms of logistics. Pareto chart, one of the basic tools of TQM has been used to identify the most significant reasons of inefficiencies. We also take into account the second most significant reasons of inefficiencies which was relevant to customers. *Our part findings and possible consequences were mentioned below*:

Current supply chain efficiency in terms of logistics was found as not good, and this resulted in creating dissatisfaction between customers and dealers. That in turn increased overall supply chain cost.

Time study was used to determine deviation between operating time and standard time. The authors think that "Bottle Necks" in product flow processes in different machines and increments of lead time of the product (high moving), was the possible consequence of it.

Demand planning, is needed to be done to ensure actual demand forecast so that the company can satisfy customer demand otherwise profit will be cut-down by losing the customers.

Some additional findings of our work can be listed as bellow:
Due to unorganized in-process inventory, the plant is producing "bottle-necks" i.e., process is temporarily stopped for some time, in various points of product flow in the process. By reducing the amount of in-process inventory "bottle-necks" in flow process can be minimized. Proper arrangements of machine might play a vital role in eliminating bottle neck. Apart from that proper planning of material flow and daily production schedule must be done regularly, Safety measures were also found to be poor. Huge dust yielded at every machine during operation which can be considered as unhygienic for the workers as very few of them use musk and goggles. Aero-sucker might be used which in turn becomes beneficial to use for blowing dust from the production area to the outside bin. After the conversation with the workers, it was also observed that workers were found not to be much motivated to contribute in the productivity. Performance bonus, award system and granting of occasional leave along with other appropriate measures might play a vital role in motivating workers.

4. CONCLUSION [6],[4]and[3]

Supply chain starts from the procurement of raw materials to produce a particular product and ends when that product is purchased by the customer. It is a very large chain which always tries to give best efficiency with perfect responsiveness to the consumer. When we were assigned to analyze the supply chain efficiency of two particular product WAREDROBE and SHOWCASE of RFL furniture we decided to do the work by finding problems in every section of the supply chain, related with those particular products such as procurement process, transportation for procuring items, storage and quality control for both raw materials and finished goods, material handling systems for processing, distribution system for finished goods, transportation facilities for distribution, customer feedback for those products and overall production. We found overall logistics played a vital role for the supply chain efficiency. Current status of supply chain efficiency and how it can be improved has been brought to light through this research work. Dissatisfaction of customer and how it is affecting the product's penetration in the market was also found out through this work. Forecasting of customer demand would be the key for success of RFL furniture in next few years. Small but continuous improvement will be the best solution in the production planning to get the supply chain efficiency. Time study for the high moving optimum item (WAREDROBE) showed how much time should be utilized during the processing of that particular product. Proper utilization of work hour must be ensured by the company to increase the total supply chain efficiency. Safe and healthy work environment will motivate the employees for attaining the company's profitability goal. By following the best way and working hard in that technique is the key to success for the RFL furniture. We feel, if the managing authorities of RFL Company try to introduce the findings as described in this paper, we are sure the company might overcome the difficulties which is being faced now and the company might be benefited in the long run.

NOMENCLATURE

SCC	Supply Chain Cost
MRR	Material Receiving Report
LC	Letter Of Credit
DET	Double End Trimmed
JIT	Just In Time
CRM	Customer Relationship Management
CPL	Certified Professional Logistician
PLM	Product Life-Cycle Management
MRP	Material Requirement Planning
ERP	Enterprise Resource Planning
$\mathbf{SCC_i}$	Supply Chain Cost Index
$\mathbf{PE_i}$	Performance External Index
$\mathbf{AL_i}$	Average Logistic Index
CNC	Computer Numerical Control
ISO	International Standards Organizations
PR	Purchase Requisition / performance rating
$\mathbf{CS_i}$	Customer Satisfaction Index
$\mathbf{LT_i}$	Lead Time index

ACKNOWLEDGEMENT:
The authors gratefully acknowledge the contributions, suggestions, advices by RFL authorities during the study. The authors are also grateful to the AUST authorities for giving permission to work in RFL relating to final year thesis work of students.

REFERENCES

[1] Ayers, J. B. (2001). Handbook of Supply chain management, St. Lucie Press, USA, Florida.

[2] Ballou, R. H. (2004). Business logistics / Supply chain management: planning, organizing, and controlling the Supply chain (5 ed.). Pearson Prentice Hall, Upper Saddle River, N.J.

[3] Beamon, B. M. (1999). Measuring Supply chain performance. International Journal of Operations & Production Management, Vol. 19, No. 3, pp. 275-292.

[4] Bowersox, D. J. & Closs, D. J. (1996). Logistical Management – The Integrated Supply Chain Process, McGraw-Hill Companies Inc, New York.

[5] Chandra, C. and Kumar, S. (2000). Supply chain management in theory and practice: a passing fad or a fundamental change. Industrial Management Data Systems,No. 100, pp. 100-113.

[6] Chen J. (1997). Achieving maximum Supply chain efficiency. IIE Solutions, Vol. 29, pp. 30-35.

[7] Christopher, M. (1998). Logistics and Supply Chain Management: Strategies for Reducing Costs and Improving Services (2nd ed.). Pitman, London

[8] Christopher, M. & Gattorna, J. (2005). Supply chain cost management and value-based pricing. Industrial Marketing Management, Vol 34. 2, pp. 115-121

[9] Christopher, M. & Towill, D. (2000). Supply Chain migration from lean and functional to agile and customised, Supply Chain Management: An international Journal, Vol. 5, No. 4, pp. 206-213. Collin, J (2003). Selecting the right Supply Chain for a Customer in project business. Diss. Tekniska högskolan Helsingfors. Helsingfors.

[10] Annelie Pettersson Measurements of efficiency in a Supply chain, Division of Industrial logistics, Luleå University of Technology

[11] Cooper, M. C. and L. M. Ellram (1993). Characteristics of Supply Chain Management and the Implications for Purchasing and Logistics Strategy. The International Journal of Logistics Management. Vol. 4, pp.13-24. Cooper, M.C., Lambert, D.M. & Pagh, J.D. (1997). Supply chain management: more than a new name for logistics. International Journal of Logistics Management,Vol. 8. No.1, pp.1-14.

[12] Production and operation management by J. Heizer & B. Render, Pearson Publication.

[13] Rezaul Karim, Sarower Kabir, Aslam Khan, Mainul Ehsan, " Analysis of Supply Chain Efficiency of RFL Furniture limited and provide recommendations for improvement", B.Sc. Eng. thesis submitted to the MPE Dept, AUST, in 2014.

[14] Motion and Time study by Barns