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Optimization in logistics for supply chain management of an automobile industry using Fuzzy DEMATEL matrix method

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Abstract: Industrial engineers always want to implement optimization techniques in all activities performed in an organization, which is only possible by synchronizing multiple activities of each department, and combining it in a way, which is optimized as per efficiency, effectiveness, productivity and profit are concerned. Organization plant managers and logistics providers have long been dissatisfied with extensive waiting times and severe on-site traffic congestion. This research paper highlights activities of logistics management in this organization which covers activities like determination of supply chain driver affecting logistics and supply chain management of an organization, analysis of current vehicles freights which particularly involves number of freights per day, checking how effectively collection plan needs are fulfilled by current vehicles running, implementation of new techniques to improve present working system, scheduled such that the total weighted tardiness is minimized, initiation of practices which organization has to do for withstanding sustainability in logistics management, estimation of cost saving from implementation of new techniques and checking feasibility of conducting these activities repetitively in long run.

Keywords: DEMATEL, supply chain management, logistics management, turn around timing.

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1. Introduction

The supply chain includes not only the manufacturer and suppliers, but also transporters, warehouses, retailers, and even customers themselves (Chopra & Meindl, 2013). Logistics management are mostly concerned with dispatching material outside the plant and receiving of materials inside the plant at optimum cost, least traffic congestion of vehicles coming in the plant, involving least time to complete all tasks in addition to maintain Just In Time inventory management strategy and having effectiveness in production system. The success or failure of supply chain management depends upon a suitable Supply chain management (S.C.M.) system and appropriate drivers selection. This mass production automobile firm apply collaborative commerce by establishing 450 strategic suppliers and involve them in the early stages of product research and development. Supply chain drivers consist of following drivers: Suppliers, Manufacturers, transporters, retailers, warehouses and customers. This Mass production organization has 450 suppliers and has to deal with about 500 vehicles coming inside the plant premises daily for the logistics of required materials. Organization members have developed a system to deal with 500 vehicles daily for meeting needs of production. A trip sheet which is the necessary document for any successful logistics delivery is designed which include parameters like: Barcode, Gate Entry Number, Supplier address, window timing, Trip sheet Number, Trip sheet date, Vehicle Number, Transporter, Name of Transporter, Vehicle Type, Driver Name, Driver No, Valid Driving License, PUC Status, Vehicle Load Type, Plant, List of parts with invoices attached to it and Value of material with tax. If supplied quantity is higher or lesser than demanded then entry to this vehicle inside the plant is not given because of this critical material required under different department like Manufacturing, Assembly and store shop has to enter through critical vehicle.

This critical vehicle entry causes organization an extra cost in logistics and degrade level of efficiency and effectiveness as desired by organization. If all things goes accurately according to organization planning then the dock is allotted to logistics vehicle. The Major challenges faced during unloading of materials at dockyard are: there are clusters of material coming from vendors. 75% of materials are following principles of containerization (carrying material in containers), Palletization (carrying materials on pallets), Trolley while 25% of vendors are supplying materials in loose. Problems of loose materials are as follows: comparatively it consume more time in unloading activities as workforce need to place individual material onto the pallet then by help of forklift they place material wherever they want but forklift cannot be used directly to uplift material in one go for this reason workforce is extended onto dock which consist of carrying loose material so to compensate time, organization invest workforce which enhances cost of labor. Turnaround time (T.A.T.) is probably the most important key performance indicator in any logistics operation, as stated in Bolstorff (2007). The other challenges which affect performance are number of dock leveler active working or not, space capacity of vehicles, dock management system, availability of workforce at the time of unloading, synchronizing all activities all together and have a working model to deal situations with variable production.

The logistics performance of companies and the impact it has on supply chain efficiency and responsiveness has captured the attention of scholars worldwide and the research on the topic has proliferated. Michael Tracey, (1998), says that firms that do not develop and optimize their logistics efficiency will find themselves competing handicapped. He argues that logistics strategy should not be considered as a supplement to manufacturing strategy but it must be regarded as an important component of overall business strategy. Though most of the firms hold the belief that logistics provides a competitive advantage, but very few empirical studies have been done to establish how it creates value for the customer (Novack, Rinehart & Langley, 1994). Taking out the cost of the logistics network and simultaneously maintaining or improving agreed levels of service is examined by (John Gattorna, 1992). He argues that firms that look at aspects of quality vis-à-vis logistics and follow an optimization model, have acquired the means to ascertain strategic and tactical shifts in the direction of improved logistics performance. It can be a good solution to optimize the distribution routes (Hua et al., 2014).

2. Literature review

Supply Chain Management may be defined as the management of upstream and downstream associations with vendors and customers to provide better customer value at least cost to the supply chain. Dubey, R., & Samar Ali, S. (2013).Freight transport activities are crucial in logistics systems planning. The reason is twofold: firstly, they determine the most important part (often between 33% and 66%) of the logistics costs; and secondly, they significantly affect the service level provided to customers. Our concern in this paper is mainly focus on smoothing process flow, elimination of those activities which are not required, logistic and supply chain management of organization, maintaining turn around timing, scheduling window timing and reducing transportation cost simultaneously be ensuring effectiveness and efficiency in management of materials. A short turnaround time is economically advantageous, making the most efficient use of time and materials. (Bowersox, Closs & Cooper, 2002).

An encoded and programmed truck unloader designed which disclosed way for unloading trolleys, boxes and palletized materials from trailers. (US Patent No. US 2016/0001991 A1, 2016). A robot is designed that has instruction to follow a particular transportation path and simultaneously stacking tires by following stacking pattern (US Patent No. US 10, 266,351 B2, 2018). Objective of time management can be achieved by following this patents but it is costly while implementing. This patent helps in identifying space allocation of trolley and their patterns of arrangement (US Patent No. US 10, 059, 537 B2, 2017).

The quantitative conventional methods mostly use either probabilistic techniques or statistics, or both, but they have limitations dealing with the ambiguity and fuzziness in information (Seker & Zavadskas, 2017).The main objectives are to (1) evaluate various routing heuristics versus an optimal routine in a volume-based storage environment, (2) propose several methods of implementing volume-based storage, and (3) examine the interaction of the routing (Petersen & Aase, 2004) and storage policies under different operating conditions of pick list size and demand skewness (Petersen & Schmenner, 1999).

In current organization it has been observed that production has been increased from 55245 (in year 2018-19) to 75052 units (in year 2019-20) and particularly in this year organization face problems in scheduling turn around timing for logistics vehicle, material allocation, managing supply chain, maintaining quality, on time delivery of assembled vehicles, managing vendors, space utilization problems and traffic congestion of logistics vehicle inside premises which are the consequences of not able to fulfill collection plan requirement. Through sales report it has been observed that productivity increased to 35.85% and by cost report it has been calculated that for serving such increase in production, cost of freight increased to 26.5% with these critical vehicle running increases to 15.8%. In this situation concerning to various departments we need to segregate which particular supply chain driver we need to focus on for getting solution of all problems which are majorly affecting the overall supply chain management.

A case study that supports the planning of order picking operations as well as the spinal load on the order picker and the consequent injury risks. Glock, C., Grosse, E., Abedinnia, H. and Emde, S. (2015). This paper is useful in conducting case study of pilot run vehicle and studying arrangement patterns of trolley in better utilizing space utilization of logistics vehicle.

3. Problem identification

Role of transportation is very significant and has direct impact on performance efficiency and effectiveness of logistics activities (Shaik & Kader, 2013).40 to 50 percent of logistics cost and 4 to 10 percent of the product selling price is consumed by transportation driver itself (Santosh Kumar & Shirisha, 2014). To achieve objective of optimization in logistics for supply chain management we have review some patents though they are costly to install in current organization but the important thing come out after reading this patent is they provide an idea of placing different materials in a particular order so as to achieve space utilization and high volume material shipment. Cost associated per freight generated along with inventory carried inside the plant is also taken under consideration Parkan et al. (2009). This paper is useful in identifying suitable supply chain driver and focusing attention on that particular driver can serve our purpose of optimization in SCM.

4. Methodology

For identification of most important Supply Chain Drivers with organization logistics team we have designed a survey and based on DEMATEL Fuzzy Matrix our prior task is to find out which driver affect the most in optimization in logistics and supply chain management of organization. The analysis procedures of Fuzzy DEMATEL method Akyuz, E (2015).

Step 1. Define the evaluation criteria.

For DEMATEL Matrix analysis, we have taken 10 samples and shown value obtained under each criteria with reference to response collected from organization head and team members. These six supply chain driver are denoted in analysis as M: Manufacturer, S: Supplier, T: Transporter, R: Retailer, C: Customer, W: Warehouse as shown in Table 2.

Table 1: Linguistic terms and TFN numbers

Linguistic terms	Corresponding triangular fuzzy numbers (TFNS)
No influence (NO)	(0, 0, 0.25)
Very low influence (VL)	(0, 0.25, 0.5)
Low influence (L)	(0.25, 0.5, 0.75)
High influence (H)	(0.5, 0.75, 1)
Very high influence (VH)	(0.75, 1, 1)

Step 2. Select a group of experts who have knowledge and experience about problem to evaluate the effect between factors using pairwise comparison.

Step 3. Define the fuzzy linguistic scale for dealing with the vagueness of human assessments, the linguistic variable "influence" is used with a five-level scale containing the following scale items in the group decision-making proposed by Li, R.J(1995).

Step 4. Obtain an initial direct relation matrix with pair wise comparison.

Table 2: Initial direct relation matrix

	M	S	T	W	R	C
M	0	3	3	3	3	4
S	4	0	4	3	4	4
T	3	4	0	4	3	4
W	2	2	3	0	3	2
R	2	2	3	3	0	4
C	3	3	4	0	4	0

Step 5. Obtain the normalized fuzzy direct-relation matrix (N) using equation given below. In this value of parameter λ= (1/18.8) which is defined as the highest sum of all variables in rows and columns wise.

$$N = \lambda . X \qquad (1)$$

Table 3: Overall Fuzzy Direct Relationship Matrix(X)

							∑R
	0	2.8	3	2.7	2.9	3.7	**15.1**
	4	0	4	3	4	3.8	**18.8**
	3.1	3.9	0	3.9	3.1	3.8	**17.8**
	2	2.2	3	0	2.9	2.1	**12.2**
	2	2.1	3	3	0	3.6	**13.7**
	3	3	3.8	0	3.9	0	**13.7**
∑C	**14.1**	**14**	**16.8**	**12.6**	**16.8**	**17**	**18.8**

∑C: sum of all variables in each column

∑R: sum of all variable in each row

Table 4: Normalized fuzzy direct relation matrix (N)

0	0.148	0.159	0.143	0.154	0.196
0.212	0	0.212	0.159	0.212	0.202
0.164	0.207	0	0.207	0.164	0.202
0.106	0.117	0.159	0	0.154	0.111
0.106	0.111	0.159	0.159	0	0.191
0.159	0.159	0.202	0	0.207	0

Step 6. Compute the total-relation matrix T using equation.

$$T = N(1 - N)^{-1} \tag{2}$$

Step 7. Determine row (Ri) and column (Cj) sums for each row i and column j from the T matrix.

Table 5: Total Relation matrix (T)

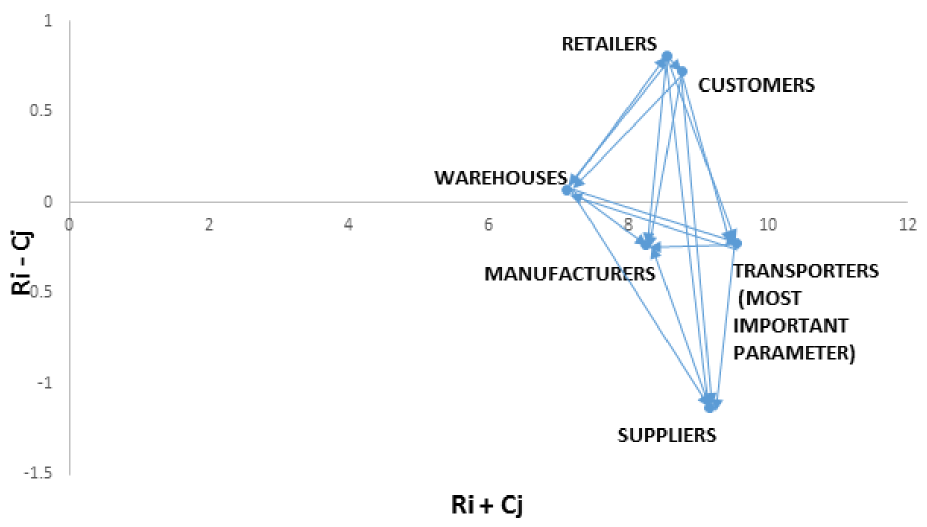
0.555	0.685	0.783	0.620	0.781	0.822	**4.245**
0.849	0.673	0.958	0.741	0.959	0.965	**5.144**
0.782	0.812	0.745	0.746	0.888	0.924	**5.144**
0.557	0.566	0.673	0.417	0.670	0.647	**4.896**
0.601	0.607	0.726	0.588	0.590	0.758	**3.529**
0.666	0.666	0.781	0.490	0.787	0.629	**3.869**
4.010	**4.010**	**4.666**	**3.600**	**4.674**	**4.744**	**4.019**

Table 6: Showing prominence and relation factor

	RI	CI	Pi	Ei
Manufacturer	4.010	4.245	8.255	-0.235
Suppliers	4.010	5.144	9.154	-1.133
Transporters	4.662	4.896	9.563	-0.230
Warehouses	3.600	3.529	7.129	0.070
Retailers	4.674	3.869	8.543	0.805
Customers	4.744	4.019	8.764	0.724

Step 8. The causal diagram is built with the horizontal axis (Ri + Cj = Pi) and the vertical axis (Ri - Cj = Ei). The horizontal axis "Prominence" refers the importance degree of the factor, whereas the vertical axis "Relation" shows the extent of the influence. If the (Ri - Cj) axis is positive, the factor is in the cause group. Otherwise, if the (Ri - Cj) axis is negative, the factor is in the effect group. Causal diagrams can convert complex relationships of factors into an easy to understand structural model, providing awareness for problem solving.

Figure 1: Causal Diagram

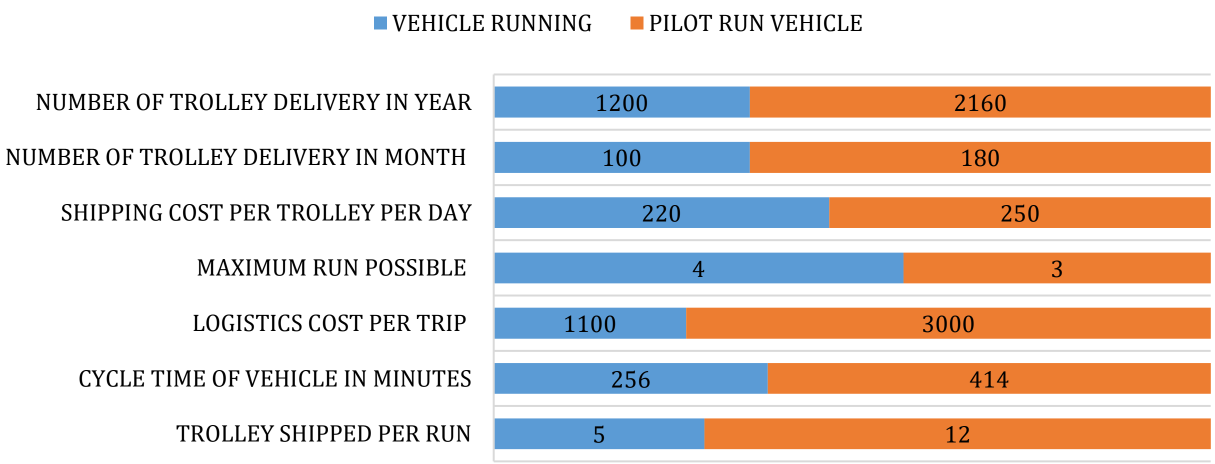


5. Results and discussion

FUZZY DEMATEL MATRIX identified "TRANSPORTER" to be the most influencing Supply Chain Management drivers by analysis and Causal Diagram. Case study of vehicle shows that our problem of high traffic congestion, optimization in efficiency, effectiveness and overall management is solved by concerning our study towards transporter end for this organization. The Summary chart shows that number of trolley deliver in a year increase to 80% and cost incurred in implementation of pilot run vehicle and in achieving of target only through pilot run vehicle is 13.63% which saves 12.87% of transportation cost also with delivering material in high quantity with safety. So Pilot run is beneficial in case of higher production while in case of lower production, vehicle running currently is feasible.

To emphasis on all parameter of transporter, Pilot run case study is conducted to analyze all logistics activities and comparing it with vehicle of dimension (17.5ft*6.75ft*7ft) which is currently running between vendor and plant premises for fulfilling objective of logistics. This vehicle carry 75% palletized material and 25% loose material. Also for minimizing number of freights and delivering maximum resources in every go our team decided to initiate a Pilot run vehicle of dimension (32ft*8.5ft*10ft) for 15 days. Changes done in transporter end is we have adopted a container as pilot run vehicle which has volume capacity of 3.28 times more than vehicle currently running and all materials are shipped with implementation of Pallatization to 100%.

Figure 2: Summary chart



	TROLLEY SHIPPED PER RUN	CYCLE TIME OF VEHICLE IN MINUTES	LOGISTICS COST PER TRIP	MAXIMUM RUN POSSIBLE	SHIPPING COST PER TROLLEY PER DAY	NUMBER OF TROLLEY DELIVERY IN MONTH	NUMBER OF TROLLEY DELIVERY IN YEAR
VEHICLE RUNNING	5	256	1100	4	220	100	1200
PILOT RUN VEHICLE	12	414	3000	3	250	180	2160

6. Conclusion

Transporter has the most important criteria among all criteria's because it has maximum relationship with other criteria's and highest causal value. Warehouse, retailers and customer falls under cause group as it is having positive value in (Ei) indicate that these three criteria influence other criteria. Manufacturer, suppliers and transporters falls under effect group which indicates that these three criteria's are influence by other criteria's with influence order of Suppliers, manufacturer and transporter. DEMATEL Matrix result conclude that our problem of cost reduction and optimization of efficiency and effectiveness of an automotive organization can be solved by thinking only at Transporter end with fixing all other drivers to be constant.

Case study perform after identifying the most important Supply chain driver through Fuzzy DEMATEL Matrix shows increment of number of trolley delivery in a year by 80%. Also in case of variable production organization team can change logistics vehicle dimension to accommodate production. DEMATEL Matrix gives mathematical solution and Case study provides feasibility of solving an organization problem in a practical manner.

Citation information

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References

Akyuz, E., & Celik, E. (2015). A fuzzy DEMATEL method to evaluate critical operational hazards during gas freeing process in crude oil tankers. *Journal of Loss Prevention in the Process Industries*, *38*, 243-253.

Bolstorff, P. (2007). *Supply Chain Excellence*. AMACOM.

Bowersox, D. J., Closs, D. J., & Cooper, M. B. (2002). *Supply chain logistics management*. Boston, Mass.: McGraw-Hill.

Chopra, S. (2013). Understanding the supply chain. *Transportation Research Part E: Logistics and Transportation Review*, page 1.

Dubey, R., & Samar Ali, S. (2013). An exploratory study on logistics competency and firm performance. *International Journal of Logistics Systems and Management*, *14*(2), 179-199.

Gattorna, J. L. (1992). Logistics networks: achieving quantum improvements in cost/service equations. *International Journal of Physical Distribution & Logistics Management*, 22(6), 31.

Glock, C. H., Grosse, E. H., Neumann, W. P., & Sgarbossa, F. (2017). *Human factors in industrial and logistic system design*. Darmstadt Technical University, Department of Business Administration, Economics and Law, Institute for Business Studies (BWL).

Grosse, E. H., & Glock, C. H. (2015). The effect of worker learning on manual order picking processes. *International Journal of Production Economics*, *170*, 882-890.

Hua, Z. C., Xin, H., & Wei, Z. (2014). Logistics distribution routing optimization algorithm. In *Applied Mechanics and Materials* (Vol. 513, pp. 1740-1743). Trans Tech Publications Ltd.

Kumar, G. S., & Shirisha, P. (2014). Transportation the key player in logistics management. *Journal of business management & social sciences research*, *3*(1), 14-20.

Li, R. J. (1999). Fuzzy method in group decision making. *Computers & Mathematics with Applications*, *38*(1), 91-101.

Lin, R. J. (2013). Using fuzzy DEMATEL to evaluate the green supply chain management practices. *Journal of Cleaner Production*, *40*, 32-39.

Mentes, A., Akyildiz, H., & Helvacioglu, I. (2014). A grey based dematel technıque for rısk assessment of cargo shıps. In *Proceedings of the 7th International Conference on Model Transformation ICMT*.

Parkan, C., & Dubey, R. (2009). Recent developments in the practice of supply chain management and logistics In India. *Portuguese Journal of Management Studies, 14*(1), 71-88.

Petersen, C. G., & Aase, G. (2004). A comparison of picking, storage, and routing policies in manual order picking. *International Journal of Production Economics*, *92*(1), 11-19.

Roodbergen, K. J., & Vis, I. F. (2009). A survey of literature on automated storage and retrieval systems. *European journal of operational research*, *194*(2), 343-362.

Shaik, M. N., & Abdul-Kader, W. (2013). Transportation in reverse logistics enterprise: A comprehensive performance measurement methodology. *Production Planning & Control*, *24*(6), 495-510.

Tracey, M. (1998). The importance of logistics efficiency to customer service and firm performance. *The International Journal of Logistics Management*, *9*(2), 65-81.

Tsai, S. B., Chien, M. F., Xue, Y., Li, L., Jiang, X., Chen, Q., ... & Wang, L. (2015). Using the fuzzy DEMATEL to determine environmental performance: a case of printed circuit board industry in Taiwan. *PloS one*, *10*(6), e0129153. https://doi.org/10.1371/journal.pone.0129153.

(US Patent No. US 2016/0001991 A1, 2016).

(US Patent No. US 10, 266, 351 B2, 2018).

(US Patent No. US 10, 059, 537 B2, 2017).