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Application of Operations Research in Supply Chain Management of FMCG Industry

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Abstract:- It is essential for FMCG companies to manage their supply chain by reducing costs and at the same time maintaining quality of their products. In this paper we have tried to explore ways in which we can make a small aspect of supply chain a little more efficient, and sustainable in the process. The first technique looks at how to optimize the delivery of products to minimize costs. This includes finding out number of units to be transported so that demand as well as supply is satisfied. The second technique analyses the product mix that should exist within a truck to maximize weight constraints and reduce number of delivery times. The third technique used is the vehicle routing method, to account for efficient logistics taking into consideration time and cost constraints.

Keywords:- *Supply Chain Management, FMCG, Transportation Problem, Linear Programming, Vehicle Routing, Sustainability.*

I. INTRODUCTION

"Liquidity constraints and lower farm incomes will likely affect revenues at India's leading consumer companies." Economic Times (Sagar Malviya, Sanam Mirchandani, 2019)s. The FMCG is facing a huge slowdown in the past 4 quarters due to the reducing consumption in the rural market. The consumers are shifting Towards cheaper and local daily essential goods in the urban and the rural market. The statistic shows that the revenue earned has fallen from 16.5% in the July-September in 2018 to a 2 year low of 10% in the June quarter this year. Even the FMCG index in BSE has dropped by 7.4% in 2019. All of the above facts are indicating to economic slowdown in the near future for the FMCG sector in India.

Fast Moving Consumer Goods (FMCG) are commonly named as consumer packaged goods. Items in this category include all types of consumables other than groceries/pulses. The FMCG products are normally used up within a short amount of time.it ranges between a couple of days to a year. Therefore they are quickly substituted when they are not available. Due to this large quantity of goods are sold which gives a high profit margin despite the low profit margins of FMCG goods. Therefore , using operations research tactics on supply chain management on FMCG goods is important as they will make sure that the products are profitable while also ensuring that the products are available at the right place at the right time.

For example linear programming models can be used to reduce the production, distribution and the inventory costs while maximising profits. Here we are also going to assume perishability of products is also an important factor to be considered while optimizing the problem. This is because the retailers will expect to have a certain amount of shelf life left when they receive the product. Therefore, the only a part of the shelf life can be used up during the supply chain process. Also another reason is because if shelf life is not considered then some of the goods may exceed shelf life period causing the company extra disposal costs. Due to this some of the demand will not be utilised. This will cause loss of missed sales.

II. OVERVIEW OF THE INDUSTRY

Most authors have emphasised on the broad scope of *supply chain* as a systems in the value chain far beyond just the traditional production-to-customer concept. Supply chain management covers the processes of demand management, manufacturing planning and scheduling, inventory management, order processing and fulfilment, warehousing, transportation, distribution management, import/export management, product development, promotions planning, and customer service. (Gupta, Managing Supply Chain in Indian FMCG Sector , 2002). A customer-focused definition is given by Hines (2004:p76): "Supply chain strategies require a total systems view of the links in the chain that work together efficiently to create customer satisfaction at the end point of delivery to the consumer. As a consequence, costs must be lowered throughout the chain by driving out unnecessary expenses, movements, and handling. The main focus is turned to efficiency and added value, or the end-user's perception of value. Efficiency must be increased, and bottlenecks removed. The measurement of performance focuses on total system efficiency and the equitable monetary reward distribution to those within the supply chain. The supply chain system must be responsive to customer requirements."

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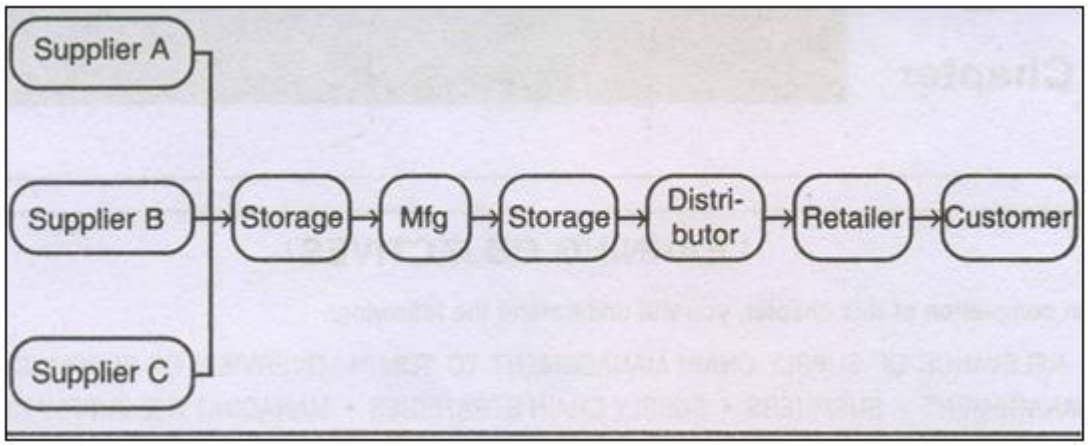

Fig 1:- Supply Chain for a Manufacturing Organization (Supply Chain Management) by Welingkar

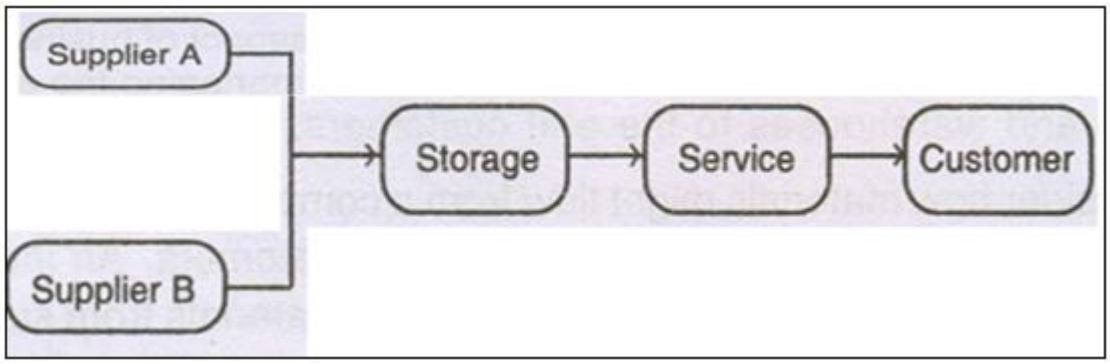

Fig 2:- Supply Chain for a Service Organization (Supply Chain Management) by Welingkar

➢ *Fast-moving consumer goods (FMCG)*

Sector is the 4th largest sector in the Indian economy with Household and Personal Care accounting for 50 per cent of FMCG sales in India. Growing awareness, easier access and changing lifestyles have been the key growth drivers for the sector. The urban segment (accounts for a revenue share of around 55 per cent) is the largest contributor to the overall revenue generated by the FMCG sector in India.

Rural consumption has increased, led by a combination of increasing incomes and higher aspiration levels; there is an increased demand for branded products in rural India. The rural FMCG market in India is expected to grow to US$ 220 billion by 2025 from US$ 23.6 billion in FY18. In FY18, FMCG's rural segment contributed an estimated 10 per cent of the total income and it is forecasted to contribute 15-16 per cent in FY 19. FMCG sector is forecasted to grow at 12-13 per cent between April–June 2019.

On the other hand, with the share of unorganised market in the FMCG sector falling, the organised sector growth is expected to rise with increased level of brand consciousness, also augmented by the growth in modern retail.

Another major factor propelling the demand for food services in India is the growing youth population, primarily in the country's urban regions. India has a large base of young consumers who form the majority of the workforce and, due to time constraints, barely get time for cooking. (IBEF, 2019)

Thus Supply Chain management using quantitative methods is about optimizing the millions of decisions that need to be made by the company every day, computers play a central role in this undertaking. SCM at present is about taking digitalization one step further.

To some extent, Quantitative Supply Chain was born out of those mistakes: instead of pretending that the system somehow knows the business better that its own management, the focus needs to place on executing the insights generated by the management, but with a higher degree of reliability, clarity and agility. Software technology done right is a capable enabler, but, considering the present capabilities of software, removing people entirely from the solution isn't a realistic option. (Lokad.com, n.d.)

III. RESEARCH OBJECTIVES

1. To understand the overall value generated by the levels of value chain of the product by increasing the efficiency of supply chain using OR techniques.
2. To discuss possible reduction in supply chain costs by working on logistics and truck turnaround time.
3. To elaborate on possible application and knowledge of supply chain management to reach the maximum possible consumer group in the FMCG sector.

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4. To find applications of sustainable methods in supply chain to help FMCG industry work towards a more green model.

IV. RESEARCH METHODOLOGY

We have referred to 12 research papers and 5 articles related to supply chain management in various industries for the purpose of understanding the processes and applied the concepts to write our paper on supply chain in FMCG industry. We have only used secondary data as a means of data collection. The first technique used is transportation problem and formulated the same using references from a research paper. The second technique used is Linear Programming Problem where-in we have formulated the equation to show how to optimize truck utility. And thirdly we have explored vehicle routing problem to minimise time and cost utilisation. We have also written about the future capacity of a sustainable supply chain management system.

V. LITERATURE REVIEW

Supply chain has been a topic of wide discussion and importance ever since the advent of the Industrial revolution. This is simply because of the fact that supply chain has increased its definition by leaps during the past two decades. FMCG is the sector that caters to the biggest demographic pool in the world and thus has been a point of contention for increasing its efficiency and effectiveness to the maximum communities in the world. All FMCG companies follow a point of contention to increase their sales by playing on their reach in deeper markets of India as these are inelastic products, and even a slight change in price could trigger a price war within the big players in the market. Though the consumers could benefit from the same, this would resist the entry and sustainability of smaller players. That is when these companies try to instead tweak their production cost ,i.e., cost incurred in the supply chain process. Transportation cost represents approximately 40 to 50 percent of total logistic costs and 4 to 10 percent of the product selling price for many companies. (P.Shirisha, 2014). Therefore, transportation decisions directly affect the total logistic costs. Transportation being an important component of supply chain competitiveness has also been a major focus area for studies by authors on refining the efficiency using operations research.

One of the constructs to improve supply chain efficiency is to look at truck utilization. (Joris van de Klundert, 2011)explore different models to improve the Less than Truckload (LTL) utilization. The argue that the motive is to increase the vehicle utilization of already scheduled road transportation activities which not just benefits the freight sender by reducing costs but also reduces congestion and pollution for the society at large. These models were established and put into practice with the help of O.R. techniques and finally refined by AI in the modern days.

The possibilities of applying Operations Research (O.R.) techniques in the design of real-world systems are vast. The optimization and design of the supply chain network (SCN) is one of the relevant topics that has directed the attention of many scholars. Sound decisions in this regard, including the proper selection of the facility's location, transportation modes and routes and inventory management policies, can noticeably improve the systems performance. We have relied on secondary data for our paper on the basis of current practices adopted by conglomerates and the upcoming FMCG companies to increase the scope of their supply chain to integrate sustainability as well as cost- effectiveness into the models.

VI. FINDINGS AND ANALYSIS

A. Transportation Problem: (Federal, 2014)

Transportation problem is a type of linear programming problem with the objective of minimizing the cost of distribution of a product from a number of sources say for eg warehouses to the destinations which could be retail outlets. In the case of supply chain problems, transportation problem methods can be used to identify the best possible methods through which we can satisfy demand taking into consideration supply constraints at the minimum cost possible.

To demonstrate how the technique can be used we assume an FMCG company subsidiary ABC Ltd.

The company has 4 plants and 5 retail outlets. The following outlines the transportation problem table.

	1	2	3	4	5	Supply
A	960	720	1080	1200	480	15
B	672	792	864	1080	624	15
C	1008	864	1584	360	552	15
D	1272	792	528	288	864	15
Demand	8	12	10	11	19	

Table 1

- A, B, C, D are the supply centres in the warehouses
- 1, 2, 3, 4, 5 are the retail outlets.
- The cost consists of transporting goods in each truck.
- The transportation cost is assumed to be Rs 12 per mile which consists of maintenance, fuel, personnel and loading on and off.
- This cost is multiplied by the distance between each supply and demand centre and multiplied by 2 to get roundabout cost.

After solving this particular transportation problem, we can arrive at the best possible allocations of truck routes with lowest cost.

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B. Linear Programming Problem: (Chikhalkar) (Banik, 2011)

In our research paper we have used Linear Programming Model to decide what product mix to put on a truck to either minimize weight, volume or floor position. In our research we have decided the objective function to be minimization of weight however it could be either of the other two as well.

In this study we pick a particular customer who has enough demand or orders to formulate the linear programming problem. In our case we have assumed the customer to have order 5 shipments in a period of one month.

To create the linear programming problem we define the objective function along with the constraints. More weight is allocated to the initial shipments and then decreased as the shipments increase. This is called decreasing-weighted average objective function. This is done to maximize the weight progressively.

➢ *Objective Function :*

5(Truck 5 Xi* Weight) + 4(Truck 4 Xi* Weight) + 3(Truck 3 Xi* Weight) + 2*(Truck 2 Xi* Weight) + 1*(Truck 1 Xi * Weight)

Xi are SKU decision variables and Xi is binary with 1 representing that a SKU has been selected for a shipment, or 0 representing that that SKU has not been selected for a shipment.

Subject to constraints :
Weight : $\sum Wi * Xi \leq 50000$ say
Volume : $\sum Vi * Xi \leq 5000$ say
Floor Position : $\sum F * Xi \leq 30$ say

Using this objective subject to these constraints we can find out the optimal number of trucks by maximizing weight which could eventually result in a decrease of number of trucks required and hence cost of transportation.

C. Vehicle Routing Problem (Shukla, 2017)

This technique is used to find out the optimal route that can be used taking into consideration time and cost minimization. Under vehicle routing problem there arises three kinds of problems.

- The first problem is to vehicles to customers, where either multiple vehicles need to be delivered to a customer, multiple destinations, where one customer needs to be served more than once etc.
- The second kind of problem arises when we need to create sequences in cases where trucks need to deliver to customers as well as pick up goods from certain places. This means finding out the ways in which trucks can get to the assigned destinations keeping constraints such as order of delivery in mind.
- The third kind of problem deals with time constraints with respect to the customer.

The three ways in which we can help solve the problems are,

➢ *Vehicle Flow Formulation* : Integer Variables are used to find the solution.
➢ *Commodity Flow Formulations* : Additional Integer Variables are used to take into consideration flow of commodities.
➢ *Set Partitioning Problem* : Developing the Set Partition Formulation In the SPP formulation each of the columns represent a (feasible) route, and each of the rows represent a customer. So aij = 1 if customer i is included into route j. For each subset of customers Sj the cost cj is determined by solving a Transportation Problem over the customers.

VII. SUSTAINABILITY IN SUPPLY CHAIN MODELS

Supply chain is the first link of the manufacturing industry to its output and hence provides the possibilities to gain a factorial-fold gains from incorporating sustainable practices at this stage of the value chain.

As and how supply chain management (SCM) added to its scope of definition, different policies and means have been taken into consideration for increasing competence of the SCM activities. The emergence of *lean Supply Chain* brought in the established concept of efficient utilization, where cost reduction, flexibility and process improvement were targeted through the minimization of different types of wastes in the system. After a few years, *agility* was introduced as a competency with the aim of developing an Supply Chain with a high ability to respond to the market changes.

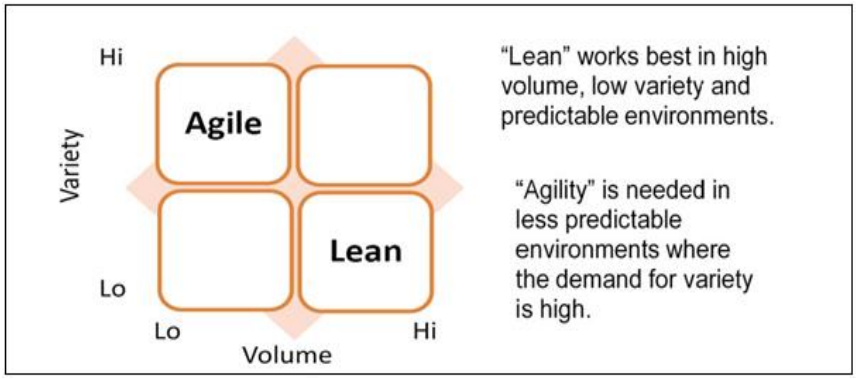

Fig 3

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These models have been put in place with a significant success rate ranging from providing both economic and environmental aid. Since the Paris Peace Agreement, climate change and global warming has become the major concerns of international society leading to a surge in scientific and technological solutions for various business aspects. The 'green' concept has evolved rapidly to reduce pollution and the negative environmental impacts of Supply Chain activities. Supply chain efficiency have proved benefits for profitability and is soon going to be the differentiating factor for both the service and manufacturing sector which could make or break a sustained growth trajectory.

The following numbers elaborate that to cut their emissions in line with the Paris target while increasing sales at the projected rate of 5.3 percent a year, FMCG companies would have to lower their carbon intensity—the amount of greenhouse gas emitted per unit of output—by more than 90 percent between 2015 and 2050. (Swartz, n.d.)

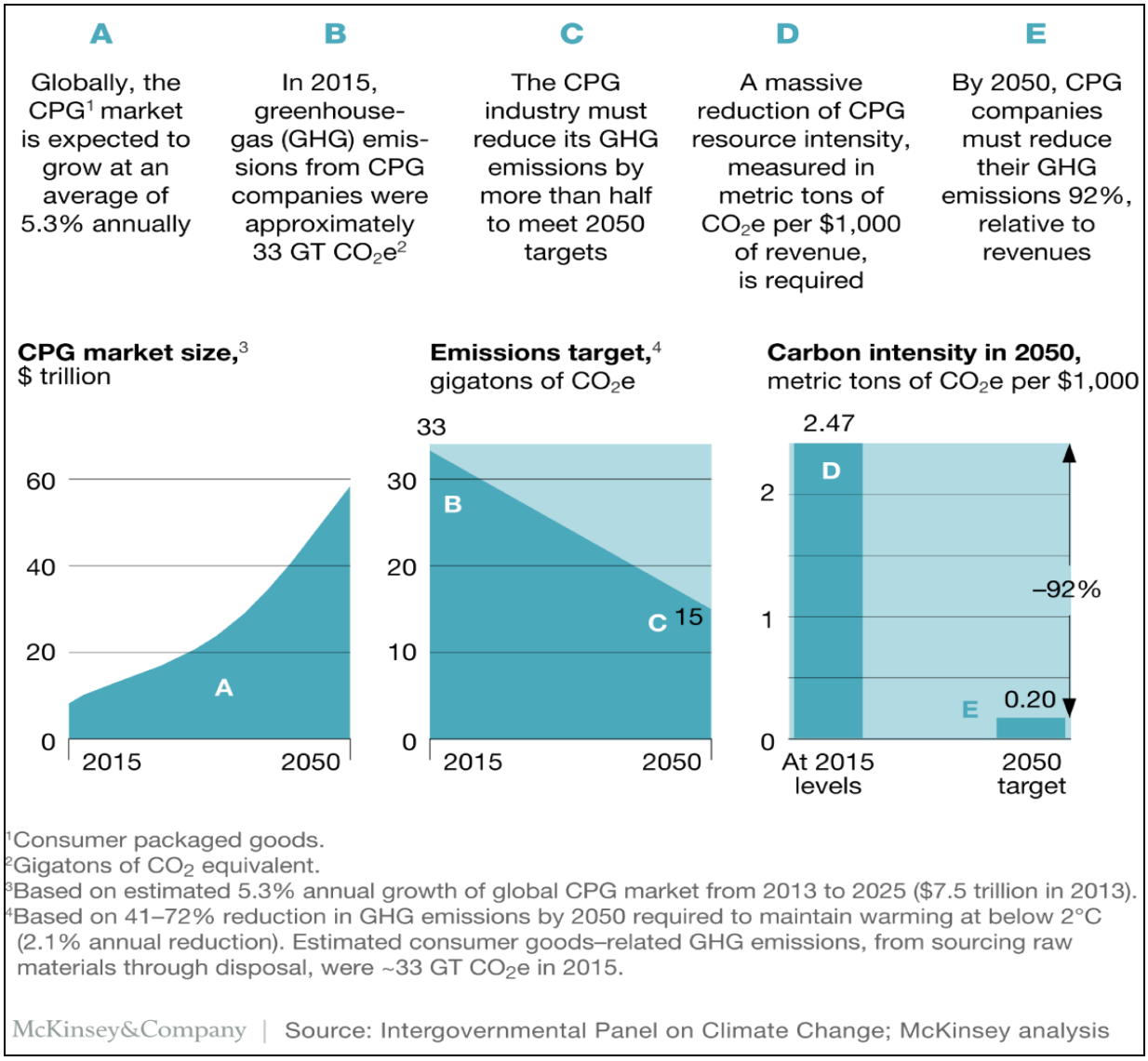

Fig 4

VIII. CHALLENGES

➢ *Shelf Life*

Not all FMCG products have a good shelf life. A lot of these products need to from producer to retailer to customer within a couple of days. This makes the linear programming and the transportation problems more complicated as it adds a time constraint to it as well. The business owners now have to bring into consideration that for how long can the product stay in their own shelfs and also that how long will the product last at the customers shelf. However this can be solved using the vehicular routing model.

For example- A grocery store owner figures out that buying a particular product having a shelf life for 5 days from seller A is more efficient than buying it from seller B. He also finds out that seller A takes 3-4 days to get the product from the manufacturer/farmer whereas Seller B takes only 2-3 days. The grocery store owner might prefer

seller B as the product might expire even before he could sell or it might expire after one day after the customer buys the product.

- *New Technology*

Operations research was made easier by developing advanced computer and machines. It made easier for business owners to find the best routes and ways to transport the products. Technology has grown even more and instead of helping the growth of complimenting operations research, it's working towards substituting operations research.

Automated truck loading system, a method companies are working on where the trucks will be docked to the machines at the factory. These machines will put the products directly into the truck according to the orders. This is expected to work by 2025 and will completely nullify the use of OR in this particular scenario.

IX. LIMITATIONS

- Inadequate time to research well enough about the supply chain pertaining specifically to FMCG products.
- Lack of technical knowledge on how to simulate real life situations to give a more holistic perspective into the working of the supply chain.
- Limited access to related research papers and journals and other such resources to deepen our knowledge of the entire system.

X. CONCLUSION

This research paper attempts at finding out the most obvious problems and summarizing how it could be solved. It shows that trucks are not fully optimized according to their weight, volume and floor capacity and companies could look into optimizing either one of them or in combination to optimize the delivery and reduce costs. It also looks into problems of finding best possible routes and sequence of routes to satisfy not only the order but also the time constraints.

REFERENCES

[1]. Gupta, B. S. (2020, January). Retrieved from https://www.researchgate.net/publication/287813236_Supply_Chain_Management_in_Indian_FMCG_Sector
[2]. Gupta, B. S. (2002, January). Retrieved from Managing Supply Chain in Indian FMCG Sector : https://www.researchgate.net/publication/287813236_Supply_Chain_Management_in_Indian_FMCG_Sector
[3]. IBEF. (2019, August). Retrieved from https://www.ibef.org/industry/fmcg.aspx
[4]. Lokad.com. (n.d.). Retrieved from https://www.lokad.com/introduction-to-quantitative-supply-chainv
[5]. Sagar Malviya, Sanam Mirchandani. (2019, september 19). The Economic Times. Retrieved from The Economic Times: https://economictimes.indiatimes.com/industry/cons-products/fmcg/worst-fmcg-show-likely-in-15-years-credit-suisse/articleshow/71193810.cms?from=mdr
[6]. Supply Chain Management . (n.d.). Welingkar.
[7]. P.Shirisha, G. K. (2014).
[8]. Chikhalkar, R. (n.d.). Analyse and design an Efficient Logistics System.
[9]. Banik, J. (2011). Modeling Order Guidelines to Improve Truck Utilization. Massachusetts Institute of Technology.
[10]. Federal, A. I. (2014). Supply Chain Management Optimization Problem.
[11]. Shukla, H. (2017). Application of Operations Research in Logistics and Warehouse Optimization.
[12]. Joris van de Klundert, B. O. (2011).
[13]. Swartz, A.-T. B. (n.d.). McKinsey.com. Retrieved from https://www.mckinsey.com/business-functions/sustainability/our-insights/starting-at-the-source-sustainability-in-supply-chains