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Operations research in courier delivery service

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ABSTRACT

This research paper gives an overview of the problems faced by the courier delivery services, like Vehicle routing problem and cost minimization, and the various operations research techniques that have been applied to solve these problems. We have studied past research papers and collected some of the most efficient Operations Research techniques like the Recursive DBSCAN, CVRPPAD and travelling salesman problems. All these techniques and their applications have been discussed in detail in the paper. All the techniques have their own advantages and limitations, which also, have been mentioned in this paper.

Keywords—Operations Research

1. INTRODUCTION

The courier service industry has seen the growth of about 200 million USD and it is predicted to grow more in the coming years. The growth of this industry is led primarily by the domestic e commerce in India and significant demand from the small and medium business to business segments. Now a day's even small companies provide a home delivery service. It has become a compulsion if the business wishes to survive the immense competition. Every consumer looks for comfort. The spending patterns of the consumers have changed significantly as they prefer paying that extra amount if they are being offered the benefit of home delivery service. According to the survey, "Indian Express Industry-2018: A multi-modal play in building the ecosystem" it is seen that with the rise of the new age businesses and Small to medium enterprises, (SME) and economy on the path of revival, there has been a considerable focus on improving India's logistics performance. It also indicated that the industry grew at 15% growth rate over the past five years and is estimated to be worth Rs. 22,000 crore in the previous year. The study shows that it is because of the e retail businesses that the courier industry is growing rapidly. Statistics show that over 1.3 million shipments take place every day from this industry. It contributed Rs. 5,000 crore in the year 2018.

1.1 Latest trends in the courier delivery

1.1.1 Crowd sourcing: Crowd sourcing is when an organization outsources a particular job or activity to the open public or to a large peer group. This job or activity was earlier performed by the employees of the organization itself. One of the most important conditions for crowd sourcing is a large network of potential people who are enthusiastic about the work allotted to them. Now in the case of courier companies, they are considering the possibility of using public to get the parcels delivered in return for a reward or payment. A few advantages of crowd sourcing included improved costs i.e. less cost incurred by the organisation, increased speed of delivery, flexibility of delivery of packages and diversity. However, it might get difficult to organize the public and the product quality may suffer.

1.1.2 Delivery Drone: This refers to delivering packages through an unmanned aerial vehicle (UAV). E.g.- Amazon Prime Air delivers packages 5lbs in 30 minutes or less. This type of technology is more environmental friendly which is the need of the hour. However, it is economically not feasible. It may not be suitable for small organizations. Also, people may not trust drone since it operates without human monitoring. Also, these days almost all the courier delivering services are using improved connectivity through smart phone applications, GPS tracking, etc.

1.1.3 Package tracking: Package tracking refers to shipping containers or parcels to one place to another at different points of time by sorting, warehousing, and delivering the package. The tracking of packages is done generally in 3 ways: Reporting the arrival and departure time of the package. Vehicle tracking system- it enables the person to locate the vehicle which is carrying his/her package. Tracking through internet, mobile applications, GPS.

1.2 Overview

The courier industry in India has come a long way from its origin in modern form in the 1980s and thereafter. The industry has grown in size and reach. A significant number of players have scaled up their operations to match the contemporary, world-class professional environment. The industry has invested in information technology systems and set up good processes and proprietary systems capable of handling large volumes. In the current scenario, companies are interconnected much more with their customers and mainly use transportation as method for their business. These days there is high competition among logistics companies. This is mainly due to high expectations of customers on quality of service which includes on time delivery in short notice. Couriers are mainly used to deliver mails, parcels, etc. Couriers differentiate themselves from other mail services by features like security, signature, fast delivery, etc. Couriers are also costlier than other mail services. The core on which a courier company works is logistics. Any firm will try to manage effective transport at lesser cost. With an annual growth rate of 25%, the Indian parcel courier market is estimated to be in the tune of 4000 crores. It's been a phenomenal growth, before the Industrial era, messages were hand-delivered using runners, trained pigeons, riders on horseback, etc. The rise of E-commerce has imposed this disruption among **Parcel Delivery Service** providers, and in retrospect, it is widening the gap among big and small players in the market. Which is why staying ahead of the curve is rather essential today. Seventy-seven percent of retailers in Asia and North America are considering increasing their investment in delivery tech over the next two years. So, what are the various trends that could prevail?

1) Growth of B2C2) Same Day Delivery3) The Rise of AI

1.3 Research Objective

- To understand the working of the courier industry by evaluating Operations in the steps involved.
- To provide a solution for proper utilization of time and cost in courier service industry.
- To see the real-life application of what we learn in lectures such as travelling salesman problems, vehicle routing problems and linear programming.

1.4 Research Methodology

We have done secondary research to collect the data which includes:

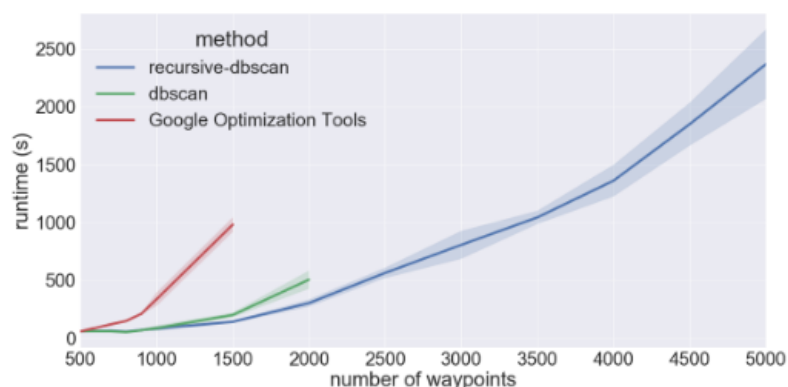
- Previously published research papers
- Articles
- Blogs
- Newspapers

2. LITERATURE REVIEW

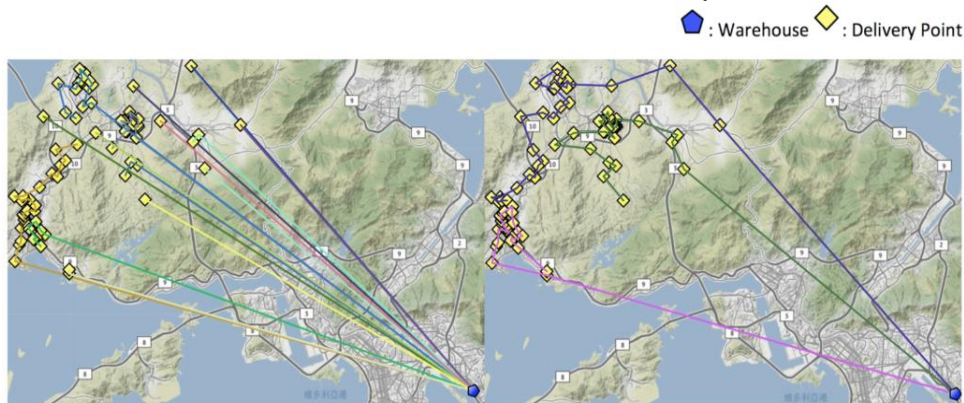
2.1 GOGO VAN Article: (KamilBujel, 2018)Initially, the operations team at GOGO VAN used to manually sort orders and create route maps every morning at the start of the day. It took one person approximately 1 hour to create route maps for about 100 orders. As the no. of orders increased, the time is taken per worker and the no. of workers, increased. This was adding to the cost of the company as well as decreasing its efficiency. This proved that there was an immediate need for automation in this department.

The company had its goals clear. It wanted to deliver on time, keep buffer times for drivers, save fuel, minimise the idle time for drivers and fully automate the process. With passage of time and a good amount of research, it realised that it was facing the common problem of Vehicle Routing Problem. It started tapping into research papers looking for solutions but they didn't want to use the ongoing operations research techniques. They wanted something more efficient and something of their own. Hence they first approached Google Optimization Tools.

They successfully created the first algorithm, but the problem they faced was very high runtime and RAM usage. This wasn't acceptable. They then tried the DBSCAN method. It was better than GOT but it also had its downside. Each cluster of orders had to be of the same radius. This meant that a cluster of 1 km in some area could have 1000 orders whereas a cluster of same 1 km radius in some other area could have only 3 orders. That is when the company decided to use the Recursive – DBSCAN approach. It turned out that this method greatly outperformed Google Optimization Tools method and that same time it did not even take much from the runtimes of DBSCAN.



It also proved that Recursive DBSCAN worked much better than DBSCAN. Below, on the left-hand side, we have a map showing an assignment found using normal DBSCAN algorithm. We can see that many of the drivers only deliver one order — as these orders are the only ones in their batches. On the right-hand side we see that the recursive method handles this issue quite well, by using different radii for different regions, it manages to find a solution that delivers all orders only using 3 vehicles! This is a perfect visualization of how the Recursive DBSCAN method is better for our use case and why we chose to use it.



3. VEHICLE ROUTING PROBLEM (TRAVELLING SALESMAN PROBLEM)

The vehicle routing problem seeks to service a number of consumers with a fleet of vehicles having constraints such as less time or limited fuel. This system has been formulated by Dantzig and Ramser. VRP is an important problem in the fields of transportation, distribution, and logistics. Effective management of logistics incurs less transportation cost which can be done through vehicle routing problems. All the courier problem comes under Vehicle Routing Problem Delivery and Pickup (VRPDP). [M.R. Thansekhar and N. Balaji (Eds.): ICIET'14] Goal: To create routes for various vehicles located at various places to minimize time taken, distance travelled and costs incurred. Vehicle Routing problems have various components such as depots, customers, vehicles and the routes

Few Variations in Vehicle Routing Problem (VRP):

- VRP with both pickup and delivery
- VRP with LIFO (last in first out)
- VRP with a time window
- Capacitated VRP
- Multiple trip VRP

Problem Formulation:

$$\text{MINIMIZATION } Z = \sum_{v=1}^V \sum_{i=0}^N \sum_{j=0}^N D_{ij} X_{ijv} \quad (1)$$

Subject to:

$$\sum_{v=1}^V \sum_{i=0}^N X_{ijv} = 1 \text{ for all } j = 1 \dots N \quad (2)$$

$$\sum_{i=0}^N X_{ivj} - \sum_{i=0}^N X_{ivj} = 0 \text{ for all } j = 0 \dots N, v = 1 \dots N \quad (3)$$

$$\sum_{i=0}^N P_{iv} X_{ijv} \leq C_v \text{ for all } j = 1 \dots N \quad (4)$$

$$\sum_{v=1}^V \sum_{i=0}^M \sum_{j=0}^N D_{ij} X_{ijv} \leq MTL \quad (5)$$

Where,

T= Time

X_{ij}= if j is supplied after I by vehicle

V= set of vehicles

D_{ij}= distance travelled

N= No. of possible scenario considered

(I,j) i,j ∈ N

Equation 1: Total travel cost of the routes is minimized

Equation 2: Each customer should be visited only once by a vehicle

Equation 3: Route continuity

Equation 4: Quantity of pickup load at the customer point should not exceed the vehicle capacity

Equation 5: Maximum tour length constraint

[Alisha Fernandes, Aksh Tulsyan, Ankit Nisar, Anisha Rawat, Aditya Kumar, 2017]

4. IMPROVEMENTS IN THE QUALITY OF COURIER SERVICES

There are various ways of solving Vehicle routing problems such as manually, using Pre-set Solvers and using specially designed route Optimization software. These softwares can solve problems within seconds. This shows how far technology has come. Even with the advances of dynamic routing, there are certain challenges that remain, for example, the driver, damage to vehicle, etc. "At least until we get autonomous vehicles, we'll be relying on drivers to adhere to the policies that we've set," said Kavanagh of WEX. Vehicle Routing Problem aims to provide a combined approach for both reductions in the service distance travelled and also the number of vehicles employed for the task. [M.R. Thansekhar and N. Balaji (Eds.): ICIET'14]

Courier Delivery systems require good planning and perfect allocation in order to ensure no wastage of time and attain efficiency as well as optimality. Logistics is an integral part of any enterprise. It involves the flow of raw material and products but customers also want the delivery of the product at the right place and at the right time. The logistics process at the stage of design must take into account the quality standards. For the correct product to be delivered, operations in the production sectors shall be implemented. Kaizen, Lean Six Sigma or Total quality/management (TQM). However these quality standards are not always possible to implement in individual companies. Thus referring to well known quality methods the parameters that can be used regardless of implementation:

- Right product
- Right quantity
- Right condition
- Right place
- Right time
- Right consumer
- Right Price

The significant functions of most of the courier services are similar. The main objectives are based on the logistics process of the organization. It shall be done in such a way that the shipment gets delivered to the assigned destination. In reality it means that neither the sender nor the receiver has to move from their permanent address to receive the goods.

When playing the role of a sender, they shall expect:

- Delivery to a particular person
- Delivery before the indicated time
- Return of the confirmed documents

The basis of the operation of the courier companies is the night shuttle services. Every day these cars or airplanes go to the central sorting office. In the sorting office there is Trans-shipment of goods and then transport moves in opposite direction. In a distribution center, the connections are express. The task of these centers is to sort the shipments and send them to the assigned destination. The distribution center functioning is scheduled and synchronized. On the conveyer belt the parcel from the DC is scanned and the information goes to the data warehouse. This is how the customer may sometimes obtain information about where the product is in the process of delivery. The shipments then reach the local terminal and the sorting and division into the regional courier services take place. The last stage is the door-to-door delivery to the customer.

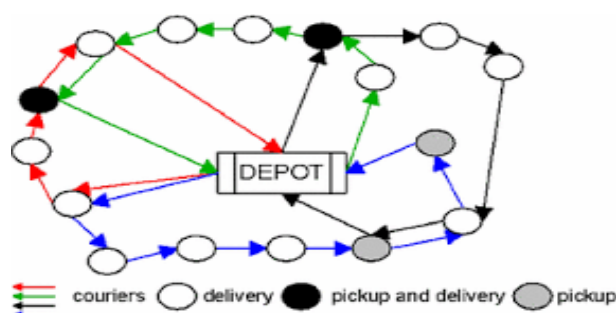
4.1 Development of the courier industry

For this industry the most important quality parameters are:

- On time delivery (within the specified time)
- Effectiveness of the delivery (correct place)
- Loss ratio (Damaged shipments that are returned)

5. VEHICLE ROUTING PROBLEM IN COURIER SERVICES

In the last 12 years, due to the rapid development of Information Technologies, online services and an increase in usage of mobile phones has resulted in tremendous growth of E-Commerce. This has contributed a lot in emergence of a number of postal and courier service operators. Rising competition among courier service operators has contributed to development of new types of services such as mail-tracking systems, parcel lockers, etc. Although these services are effective, there are many problems regarding the optimum utilization of cost and time. These problems can be solved by finding the optimal solution in terms of cost and time for both delivery and collection of courier items to/from end customers. The proposed model proposes an original hybrid approach, which gives a far greater modelling flexibility and efficiency. Various forms of VRPs occur in the field of product distribution/shipments. Solving these problems within acceptable time and optimum costs have become a key issue in modern distribution. In its basic form, a VRP is defined as a problem that answers the question “What is the optimal set of routes for a set of vehicles/fleet/transportation modes to travel in order to deliver to a given set of customers?” This is a combinatorial integer optimization problem which generalises the well-known Travelling Salesman Problem (TSP). The VRP objective is generally to minimize route costs. Objective functions could vary with particular variants and applications. Several VRP variants exist such as VRP with pickup and delivery, capacitated VRP, VRP with backhauls, VRP with backhauls and time windows, etc. The most often used methods and approaches for solving VRPs can be divided into exact approaches, heuristics, constructive methods, two-phase algorithms, and metaheuristics. Pawel Sitek in his research paper has proposed a capacitated VRP with pickup and alternate delivery as Couriers are universal in that they can serve any delivery point and do pickups and deliveries. The differences are introducing various delivery point types, accounting for the capacity of one delivery point type (parcel lockers) and using alternative delivery points. These three differences make the formulation of CVRPPAD different from existing variants. The delivery network for CVRPPAD is:



The CVRPPAD has unique features that distinguish it from other variants of the VRPs. Due to the Binary Linear Program, mathematical programming (MP) provides a natural environment for its implementation. A number of solvers are available, both commercial and free of charge, which uses MP methods such as simplex, branch and bound, branch and price, etc. These methods are exact methods, which, taking into account a binary character of decision variables and characteristics of VRPs, renders them inefficient especially in the case of real data instances of larger sizes. The most important characteristics include taking into account the capacity of delivery points and alternative locations. The proposed model of the CVRPPAD combines the features of many different variants of VRP such as delivery and pick-ups, vehicle capacity, different type of vehicles and so on to deliver on the current limitations in the courier services market. This model and method of its solution can be widely implemented in information management systems of postal item distribution. For this purpose, a universal information structure is advisable in the form of sets of facts that are easily integrated with the databases.

6. LIMITATIONS

- As the data is based on secondary research, so it may not be accurate and may limit the scope of analysis.
- Difficulty in finding the data as many of the research sites was blocked and on some sites data was not enough to analyse.
- Difficulty in finding practical problems to explain each type of Operations Research techniques used in the research paper.
- Not having great experience in this field, we may have compromised the scope and depth of discussion.

7. CONCLUSION

Courier Services may look simple from the outside but they have a very complicated process happening within. In the preceding paragraphs we briefly trace information on the Courier Delivery Services sector and in the process elaborate on various techniques of Operations Research and their applications in the above mentioned sector. Operations Research provides tools and techniques for thinking, analysing and solving, which leads to taking decisions in a structured and focused way towards optimality and efficiency. Operations research methods such as Recursive DBSCAN, Google Optimization Table, Travelling Salesman Problem, Binary Linear Programming, and Vehicle Routing Problem are used in the Courier Delivering Services sector. Before concluding it will be most appropriate to quote Staffort Beer the famous OR Scientist: *"We call that work operational (with a large O) because it is based in the world of genuine activity, the places where things actually happen. All good sciences, as distinguished from all mysticism is found in empiricism."*

8. REFERENCES

- [1] Bujel, K. (2018, July 25). Improving Operations with Route Optimization. Retrieved from www.towardsdatascience.com:https://towardsdatascience.com/improving-operations-with-route-optimization-4b8a3701ca39
- [2] Buzoianu, G. (2016, September 28). Logistics and courier services, carrier and courier driver. Retrieved from www.eurosender.com:https://www.eurosender.com/blog/en/logistics-and-courier-services/
- [3] Ibrahim, A., and Abdulaziz, R. (2019, March). CAPACITATED VEHICLE ROUTING PROBLEM. *International Journal of Research*, 7(3), 310-327. doi:10.5281/zenodo.2636820
- [4] Kumar, S. (2018, February). A study on the use of logistics management by courier services in india. *international journal of engineering sciences and research technology*, 7(2), 136-140.
- [5] Ordonez, F., Dessouky, M., and Wang, C. (2012). *A New Approach for Routing Courier Delivery Services with Urgent Demand*. California: Metrans Tansrportation Center.
- [6] Sitek, P., and Wikarek, J. (2019, February). Capacitated vehicle routing problem with pick-up and alternative delivery (CVRPPAD): model and implementation using a hybrid approach. *Annals of Operations Research*, 273(1-2), 257-277.
- [7] Fernandes, A., and Tulsyan, A. (2017). Use of Operations Research in Courier Delivery Services. *International Journal of New Technology and Research (IJNTR)*, 3 (10), 22-26.
- [8] Holliday, C. (2011). FedEx Inofrms. Retrieved from www.informs.org:https://www.informs.org/Impact/O.R.-Analytics-Success-Stories/Industry-Profiles/FedEx
- [9] Kathikeyan, M., and Elango, M. D. (2014). Minimization of Transportation Cost in Courier Service Industry. *International Journal of Innovative Reseach in Science, Engineering and Technology*, 3 (3), 1116-1122.
- [10] Larson, R. (1988). *Operations Research and The Service Industry*. Washington, D.C.: National Academic Press.