



A STUDY ON THE APPLICATION OF OPERATIONS RESEARCH IN COURIER SERVICE INDUSTRY

Rimjhim Khandelwal¹, Akshat Tiwari², Mahak Jain³, Ritika Dube⁴,
Armaan Sachdeva⁵

¹SAP ID:74022119259

²SAP ID:74022121303

³SAP ID:74022120149

⁴SAP ID:74022119983

⁵SAP ID: 74022120275

ABSTRACT

The paper deals with the application of Operational research techniques in the courier industry and how it impacts the efficiency of its operation. Using the Hungarian method used to solve assignment problems and apply certain assumptions, we analysed actual data for the city of Indore to find out the practicality of using these techniques. Our analysis shows the capability of Operation research tools and their usage in a practical situation.

INTRODUCTION

Operations research as a field developed around World War 1 as a way to gain strategic advantage. The field that this paper focuses on is Courier/parcel delivery services.

Operational research is a set of technical and analytical methods of solving problems regarding management decisions more accurately and according to the database.

This research paper is an attempt to understand the application of operation research in the courier service industry. Our study has been focused in the city of Indore with its dependence on certain assumptions.

The largest city in the state of Madhya Pradesh is Indore, which is located in the centre of the state. It has seen tremendous industrial and infrastructure development. There are about 32 lakh people living there, and that number will increase significantly over the coming years.

The courier industry is stated to grow at a 10.5% annual growth rate in the future due to technological advancements, growth of the e-commerce industry, and wide adoption in Indian markets. Reachability to each individual at the earliest with minimal utilization of resources is a huge challenge for any courier service company.

In this courier service industry, the application of OR is crucial as courier management includes handling parcels, assigning optimal routes, keeping track of the cost of fuel, and less delivery time. These objectives can be easily achieved with the collection of databases and properly allocated resources put in use with various forms of analytical tools such as transportation models, assignment models, etc.

Assignment model is being applied in the research paper, to solve the problem faced in the courier service industry. The technique used in this paper to apply assignment model is the Hungarian method, developed by Harold Kuhn, to bring out the practical application of Operations research in the Courier industry.

LITERATURE REVIEW

To begin with, we must define what a courier is in order to comprehend what courier services are. A courier is a person or business hired to deliver products, and other parcels, and mail them to the specified customer. With a well-organized, coordinated transportation system that includes vans, buses, trains, and air couriers to interconnect all destinations, the courier services have a systematized network in the typical hub center in-charges. The most up-to- date electronic information technologies, including truck radios, cellular phones, and geographic positioners, are being deployed to achieve improved operational efficiency and high productivity. (Anvekar, 2007).

Numerous services, like Delivery, DTDC, Blue Dart, and others, are available in the Indian context and are a part of the country's 4.29 billion USD courier business. (Indian courier express and parcel cep market,



2022).

The three main objectives of courier services are as follows:

1. Delivering the goods on time
2. Assisting the couriers in delivering the goods.
3. Make sure clients have a wonderful and simple experience.

Although everything seems rather straightforward, each aim has its own set of challenges. Deliveries must be made on schedule, and commodities are easily damaged in transportation. In the field, couriers also encounter challenges including traffic, trouble finding addresses, and clients who aren't at home. (Courier Management, 2022). Worldwide, millions of people use courier delivery services. This field has a broad range. The majority of businesses in this industry offer essentially the same services. The efficient use of resources and the way these businesses cut their transportation costs while still offering quality service set them apart.

Businesses frequently ignore important factors and only consider the shortest route when determining the best route. (Fernandes, Tulsyan, Nisar, Rawat, & Kumar, 2017).

Operations research can be useful in this situation. Operation research is the use of analytical techniques to address issues and make decisions, such as cost reduction, job assignment, and other choices that improve the effectiveness of an organization's management. The delivery system and lowering associated expenses are the main issues that the delivery system is dealing with. These expenses make up about 40% of the total costs, according to one approximation. 4 models are presented here: the Vehicle Routing Problem, Traveling Salesman Problem and the Assignment model using Hungarian method, and the Transportation problem. (Shah, Lunia, Bagaria, Shah, & Killa, 2019)

The travelling Salesmen Problem involves a single route that starts and ends at the same point. The cities and the distance between them are taken to be fixed and the problem can be solved.

An extension of the Traveling Salesman problem is the Vehicle Routing Problem. The main thing it determines is the collection of routes that various vehicles would have to travel.

Additionally, it presupposes the number of vehicles to be employed and the routes. (Toth, 2002).

The vehicle routing problem is more suited to the courier service as usually the companies don't involve a single route and have multiple hubs as starting points. It is further divided into many types. The important problems are VRP with Time Windows, VRP with Pick-Up and Delivery and Capacitated VRP. (CY Liong, 2008) The several approaches that can be employed to address the vehicle routing issue directly should also be known to us. These techniques include those based on the greedy algorithm, the mayor approach, the Clarke-Wright method, the Vogel approximation method, etc. (Kampf, Hlatka, & Savin, 2017)

Vehicle Routing Problems can also be solved efficiently by using optimization tools such as Google Optimization tools and algorithms such as DBSCAN AND RECURSIVE DBSCAN. (Bijuel, 2019). Studies have shown that implementation of VRP Algorithms leads to substantial cost savings.

Another constraint can be added is including the urgent demand of the consumer in the model and also, we can create a multi trip Vehicle Routing Problem to consider the practicality of the model. (Wang, 2015)

We can also use assignment model to find out the approximate optimal routes and which delivery partners to assign to get the minimal cost. By using the assignment model, a company can cut the cost of sending couriers to various locations. In a similar way to assigning delivery personnel to services, we can take into account the distribution of hubs and which hubs will be delivering to the destined location, resulting in decreased travel time.

Delivery time, cost, resource availability, and distance can all be taken into account in various assignment models to support the best route. (Sudradjat, 2018)

It is important to note that a number of scholars have used the Hungarian technique and a variety of heuristics to solve the logistical issues that arrive with having a courier business, with some degrees of success. (Ioannou & Kritikos, 2004).

Vogel's approximation method(VAM), which is used to solve the transportation problem, has proved to be successful at large scale operations. (Nahar, 2018). A practical example of this is case study of a Brewery in Ghana, where the transportation model was implemented with good success. (Ablordeppey, 2012).

It is estimated that costs can be reduced to around 70% of their original number, rendering these techniques extremely important for these businesses. (Takai, 2009).

Courier service industry also requires excellent warehouse management as they have goods that require timely receipt and timely delivery.

We also have to understand the wear and tear the capital equipment face during their daily usage. Various delivery vehicles are easily the most used capital equipment and this causes them to wear down easily. We can use replacement theory to find out the appropriate time when we should replace them.



The main objectives of this study are –

1. To learn more about novel operation research techniques that can be applied to maximize delivery efficiency for courier companies.
2. Implementation of these methods to actual data.
3. To find out how these can be implemented at an organizational level.

ANALYSIS AND INTERPRETATION

When it comes to delivering individual couriers to their holders as quickly as possible, the courier sector has numerous challenges. In order to achieve this, we attempt to build a case in this study paper from which we may extract the best solutions.

Consider the following scenario: There is a courier delivery service firm operating in the city of Indore. As of right now, it only serves a limited number of consumers due to its modest operations. The business operates 5 hubs around the city from which it dispatches couriers to customers. We have assumed each hub to have only 1 driver, who will be assigned to the delivery for that hub

The parcels are collected at the various hubs according to delivery feasibility.

Below mentioned are the details of hubs and delivery areas:

HUBS	AREAS
H1	Scheme no. 54
H2	Airport Road
H3	New Palasia
H4	Scheme no. 140
H5	Bhanwarkuwa

CUSTOMERS	AREAS
C1	Azad Nagar
C2	World Cup Square
C3	Vishnupuri
C4	Gandhi Nagar
C5	Mahalakshmi Nagar

For our study to be authentic and accurate, we worked on and employed real-time data in terms of minutes to reach the respective places. We got the data from the google database. For rational calculation, we took the time taken to travel the shortest route by a two-wheeler.

Random Allocation

We have demonstrated a possible random allocation that the firm could have carried out. Other possibilities may be selected by combining the random assignment of the parcels to the drivers of the specific hub and the customers.

HUBS	CUSTOMERS	OPTIMAL TIME TAKEN (in minutes)
H1- Scheme no. 54	C1- Azad Nagar	31
H2- Airport Road	C5- Mahalakshmi Nagar	46
H3- New Palasia	C2- World Cup Square	18
H4- Scheme no. 140	C3- Vishnupuri	24
H5- Bhanwarkuwa	C4- Gandhi Nagar	43
		162 MINUTES

Allocation using Assignment Model

For the calculation, we used the assignment model.

The assignment model is a special case of Linear programming problem, and the main goal of the model is to assign the task to a group of subjects

Conditions of assignment model:

1. The number of tasks and the number of assignees are equal.
2. There should only be one job given to each assignee.
3. There must be precisely one assignee per task.



The method we are using is the Hungarian method and it can be explained as a computational optimization technique that addresses the assignment problem in polynomial time.

CALCULATIONS

Step 1 □ the objective is minimization, as we are using the time taken in minutes for a parcel to reach it, holder.

Step 2 □ the data is balanced, with number of hubs equal to number of customers. $m=n=5$.

HUBS/CUSTOMERS	C1	C2	C3	C4	C5
H1	31	21	42	48	15
H2	37	42	26	13	46
H3	16	18	25	42	29
H4	15	4	24	54	25
H5	14	24	6	43	44

Step 3 □ Row Reduction- For row reduction we need to subtract the smallest number in each row from all the elements in that row.

HUBS/CUSTOMERS	C1	C2	C3	C4	C5
H1	16	6	27	33	0
H2	24	29	13	0	33
H3	0	2	9	26	13
H4	11	0	20	50	21
H5	8	18	0	37	38

Step 4 □ Column Reduction- For column reduction we need to subtract the smallest number in each column from all the elements in that column.

Column reduction is the next step but as we can see that every column has a zero in it, there is no need to perform the reduction.

Step 5 □

Initial Assignment

H1-C5	15
H2-C4	13
H3-C1	16
H4-C2	4
H5-C3	6
	54

The optimal assignment of the parcels according to assignment model are

HUBS	CUSTOMERS	OPTIMAL TIME TAKEN (in minutes)
H1- Scheme no. 54	C5- Mahalakshmi Nagar	15
H2- Airport Road	C4- Gandhi Nagar	13
H3- New Palasia	C1- Azad Nagar	16
H4- Scheme no. 140	C2- World Cup Square	4
H5- Bhanwarkuwa	C3- Vishnupuri	6
		54 MINUTES

FINDINGS

We have allocated the parcels to the various drivers of the hubs using two methods, the first one is the random allocation and the second is using the assignment model.

According to calculations, it took each driver 162 minutes to reach their respective customers when a random allocation method was applied. When we contrast this with the allocations carried out using the



assignment model, the time required was 54 minutes.

Our findings show that the time required by the assignment model is 200 percent less than the time required by random allocation.

LIMITATION

- OR only provides a solution when all elements of a problem can be quantified. Quantification is not possible for all relevant variables. Factors that cannot be quantified have no place in OR research. OR models do not account for qualitative or emotional factors, which may be significant. For example, we cannot take into account the productivity of a worker on a particular day.
- For a business it is important to take decisions according to its social environment but using operation research decision is taken irrespective of it which might hurt the sentiments of some social groups leading to disturbing the model.
- The implementation of decisions made by the model cannot take into account various issues that might arise in the delivery of goods. For example, a road might be blocked or the customer might not be able to take the delivery at a particular time, the vehicle could get damaged or the delivery boy might not be available. The model cannot allow for such specific exemptions.
- Any decision's implementation is a delicate task. It must account for the complexities of human relationships and behaviour. Sometimes resistance is offered due to psychological factors that have nothing to do with the problem or its solution.
- Due to a lack of accurate primary data, secondary sources of information were used to collect information, and thus findings may be influenced. To calculate the time duration of various routes, we have used google maps. Using the maps might cause inaccuracies in the data to show up in our model as well.
- The assignment problem is based on certain assumptions, such as fixed quantities and only a few parties involved, which may not hold true in real life, complicating decision-making and the problem.
- At the end of the day due to variables such as demand patterns, predictions are unlikely to equal actuals.

RECOMMENDATION

- Given the massive growth of the logistics industry, constant innovation is required to stay ahead or on par with the competition, forcing firms to invest heavily in research and analysis.
- Implementation of optimal assignment should be done properly and smoothly without any conflict to get the most efficient result.
- The analysis should be based on actual data to get real-time solutions to a problem.
- Try to minimize the time taken to complete simulations and analysis so that timely implementation can take place.

CONCLUSION

Through the study and analysis of the same, we can conclude that when the allocation was done by using the assignment model the efficient utilization of resources was achieved. It has been observed that it substantially helps reduce the cost of transportation and delivery time.

Our results conveyed that these techniques can be applied to an actual organizational structure as well.

Using the supplied resources at a random level may accomplish the task, but it will undoubtedly not be the best or most useful way. By using the Hungarian method to solve the assignment problem, we know that by applying the operations research methods, one can efficiently use the resources which will significantly reduce the costs for a company.

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