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Application of Operations Research in the Food Delivery Industry

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Abstract - *Online food delivery is a service that has become increasingly popular over the last few years and even more so during the Covid-19 pandemic where the only opportunity to 'eat out' was to 'order in'. This paper explores the online food delivery sphere. It looks at it from a consumers' and producers' point of view- pre and post covid. Our research shows consumer preferences in the online food delivery market, problems faced by consumers and producers respectively and suggests various Operation Research methods to solve such problems. We also speak about the pros and cons for each party involved in such an operation. We conclude with various findings based on our research about the delivery services that are preferred by consumers, how these services can reduce their costs and attract new consumers while retaining existing ones, and counter problems such as employee unrest, consumer complaints, and late deliveries.*

Key Words: **online food delivery, consumer perception, customer satisfaction, Covid-19, Delivery services, operations research, food industry, pandemic, demand and supply, delivery problems**

1.INTRODUCTION

The global online food delivery services market is expected to grow from USD 111.32 billion in 2020 at a growth rate of 3.61%. However, 2020's growth slump is mainly due to the economic slowdown across countries owing to the pandemic outbreak and the measures to contain it. The market is still expected to grow and reach USD154.34 billion in 2023 at CAGR of 11.51%. (The Business research Company, 2021). The India online food delivery market reached a value of US$ 4.35 Billion in 2020. In future, the market is expected to grow at a CAGR of 30.1% during 2021-2026. (IMARC, 2020)

Food delivery is now an essential part of the urban lifestyle. As a result, delivery agents can be seen riding their bikes, carrying orders, and wearing their company T-shirt and cap almost the entire day. Contactless delivery has become extremely common in the aftermath of the COVID-19 pandemic outbreak. Food delivery service may also include delivery of groceries and essentials from a supermarket. Technological advancements have made food delivery services even more efficient, keeping customers happy and loyal. As a result, the food delivery industry is rapidly catching up in markets such as America, Asia, Europe, and the Middle East.

After the coronavirus forced the country to undergo quarantine, restaurants, hotels, and cafes were severely affected. To successfully collect and deliver food orders got difficult because of the high increase in demand and the "urgency" of orders. Due to COVID-19, the problems related to food delivery increased with ensuring contactless delivery, ensuring the safety and hygiene of food. For addressing these problems, we are going to use operations research techniques. Operations Research is the application of scientific techniques in the supply chain, food production, army, transportation, and other fields. We are going to utilize operations research techniques to find effective ways and methods by which we find solutions to the problems.

The purpose of our research paper is to determine the factors that influence customer perception when it comes to food delivery, find out the problems faced by both sides of this equation, i.e., supply and demand side, what operation research methodology to use to fix these problems and how the Covid-19 pandemic affected this industry. We try to fill the research gap for this subject in the Indian food delivery industry as we noticed a lot of the research done previously relied on small sample sizes in a particular city/area. We've tried to combine such research and come to our own conclusions based on a collective analysis.

This paper can be used by students in the future to understand the impact of operations research and how it affects the food delivery sphere. By people in the industry to evaluate the factors affecting the satisfaction and loyalty of their customers and how to fix their problems. And by academicians who wish to study this subject a little more, especially in case of the Indian industry.

Through the extensive research we conducted, we were able to give more detail about the delivery services that are preferred by consumers, how these services can reduce their costs and attract new consumers while retaining existing ones, and counter problems such as employee unrest, consumer complaints, and late deliveries. We also discuss the problems faced by producers and give solutions to overcome them.

The paper starts with a literature review which consists of short descriptions of the papers we referred to that guided us in our research, followed by an idea of the methodology used to analyze the data available, there after we cumulate the findings from our analysis, and we end with a conclusion about the same. Lastly, we mention certain limitations that

exist in our study, and we suggest some ideas to remedy them for future studies conducted on this subject.

LITERATURE REVIEW

Some of the papers that were reviewed talk about the food delivery industry in the pre-Covid era. Technology industry was booming, and people were getting more accustomed to use mobile applications and thus the food delivery industry was growing as well. The comfort of having food delivered to any location of your choice was what attracted the consumers. The people weren't totally dependent on this as they enjoyed physically having food at a restaurant with friends, family, or colleagues. But this industry had specific categories of consumer base like people that were bored of cooking every day and just wanted to have restaurant like food at home or the people that cannot cook and cannot afford to visit a restaurant every day. These food delivery services help consumers choose from a varied category of restaurants and food places. Although Covid only gave boost to this industry it wasn't far off before the disease came into existence. Let's take the example of the Dabbawallas of Mumbai (Mahadevan, 2021), they deliver home cooked meals to office going workers in a timely manner so that the meals are fresh, this practice has been going on since years before covid even existed. Companies like Zomato, Uber Eats and Swiggy brought this industry into existence in the first place. Their practices and innovations are what paved the way for the industry. They used research and methods of operations efficiently that helped them provide an affordable service and create profit at the same time. There were many problems in the functioning of this industry like late deliveries, compromise of quality, employee dissatisfaction but these firms overcame them through tactical solutions like rider scheduling (Xue, Wang, & Wang, 2021) and resource optimization.

The customers wish to order from multiple restaurants in a single order. (Zachary Steever, 2019) proposes a business model for food delivery using "a mixed-integer linear programming formulation" which will let the customers include multiple restaurants in a single order. A heuristic was generated for its implementation, and the problem formulated was solved by assigning the locations of different nodes, and three objectives were set. The "mixed-integer linear program" was formed with different parameters. We have observed that frozen food delivery faces various problems such as delivery on time and minimize the cost. (Y. Zhang, 2014) proposes an "optimization model" solutions, one being an exact algorithm and the other being the heuristic algorithm. Consequently002C using optimization techniques, the paper concluded that the genetic algorithm was efficient in offering solutions for the problem. There are issues with the systems with some food delivery apps. (Balakannan S.P, 2020) suggests administrator as the "controller" of the system, request, items in cart, "taxi login", "view request", "accepted request", "food item", "orders", "taxi login locations", "new taxi", "book taxi", "food client", and "food selection" features for location-based optimization food delivery apps.

In the light of recent challenges, there is now considerable concern about the food supply chain. Labor-intensive agriculture, such as fruit and vegetable production, relies heavily on temporary or seasonal farm workers particularly during planting, weeding, harvesting, processing, or transporting to markets. People in the informal sector of urban areas who rely on produce from rural areas are impacted by a lack or delay in supply of these products. (The Food and Agriculture Organization of the United Nations (FAO), 2020) Many regions have experienced labor restrictions because of quarantine measures and workforce loss from COVID-19 deaths and serious illness. This caused severe disruptions in sectors, including livestock production, horticulture, planting, harvesting, and crop processing. (Stephens, Martin, Wijk, Timsina, & Snowe, 2020)

Most agricultural activities are season-specific and weather-dependent; they follow a precise pattern of timing, pacing, and sequencing. A delay in one activity can have impact the manufacturing process, affecting yields and output. (The Food and Agriculture Organization of the United Nations (FAO), 2020) There were many reports of how farmers had to destroy their yield because of these delays. Thus, maintaining logistical efficiency is critical for the food industry, especially during times of global crisis. (Aday & Aday, Impact of COVID-19 on the food supply chain, 2020)

The supply chain not only affects producers, distributors, and consumers, but also labor-intensive food-processing plants. Many plants' output has been reduced, suspended, or temporarily stopped, mostly in meat-processing food companies. (Devereux, Béné, & Hoddinott, 2020) The shutdown of food plants caused a ripple effect in the food supply chain. Producers were forced to cull farm animals because they couldn't find a plant to sell their livestock to. (Hobbs, Food supply chains during the COVID-19 pandemic, 2020)

Consumer perception towards online food services has changed drastically over the last few years with its growing popularity (Das, 2018). The mobile application era has opened doors for marketing in the food delivery sector that seemed impossible before. Through data collected by questionnaires, we see people between the ages of 18-30 years were the most avid users of these services, found that the spending limit is usually capped at Rs. 1000 and that Paytm is the most common mode of payment (Beliya, et al., 2019). (Das, 2018) shows that Zomato is the most commonly used online delivery service in India. Doorstep Delivery and Cashback Loyalty programs are the features that make a delivery service more attractive (Saxena, 2019). At one time, consumers could get limited options like burgers and pizzas delivered home but today, they can order everything from local street food to fine dining food right at their doorstep

with a larger variety and discounts (Narayan & Rodhaammal, 2019).

These studies highlight the importance of online food delivery services (OFDS) and how widely they have been used throughout the Covid-19 pandemic's new normal, particularly in underdeveloped nations. The goal of several of the articles was to figure out what elements influence customer satisfaction and loyalty in the OFDS industry. Surprisingly, more complicated characteristics like navigational design and perceived simplicity of use were found to have little effect on customer satisfaction and loyalty in OFDS. COVID-19 has had an impact on the entire food supply chain, from the farmers to the customers, according to another journal article. It discusses how the notion of working from home was introduced in other industries, but because individuals in the food industry do not have the choice of working from home, they had to adapt various strategies and methods. It also discusses how the food industry is one of the country's most vital economic sectors. In a research report, major concerns such as employee health, an insufficient workforce, consumer demands, and many others were discussed. The effects of the pandemic on the food supply chain were discussed in the research report, as well as changes in consumer behavior as a result of the pandemic. It also includes recommendations and strategies that can be implemented by the food industry, local farmers, governments, and businesses to reduce the pandemic's impact. Prior to the pandemic, delivery penetration was already increasing. A transformation that had been expected to take years is now taking place in months. According to the PRIME (POSist Restaurant Industry & Market Evolution) India Report 2020, direct-to-consumer (D2C) channels account for about half of the orders. Food aggregator platforms still account for the majority of orders coming from them. This suggests that, as food delivery becomes more common, consumer behavior is changing, possibly to the restaurant's benefit. Consumers are more likely to choose a direct channel to order from the brand as they become more familiar with delivery and ordering online.

1. METHODOLOGY

We have used secondary data gathered from various research papers and articles to back our analysis. We also studied the impact that the pandemic had on the online food delivery system and examined the shifts in demand and supply. We observed a trend in the demand and supply patterns and consumer behavior in the research papers that we read. We also worked out the solutions to the problems of the demand and supply side. Through this data, we have identified the application of Operations Research in online food delivery along with its pros and cons for consumers and producers respectively.

2. ANALYSIS

Since the advent of online food delivery, we've seen the market for the same expand exponentially and sales skyrocket, especially over the past year- due to the covid-19 pandemic. Consumers found online food delivery convenient, and the demand shot up overnight. Producers had to keep up with this demand and they faced a litany of problems on their end along with problems faced by consumers.

Consumers expect the same level of taste and quality from their orders each time they press confirm and no matter what food quality and packaging measures for online orders are taken, they are prone to quality lapses (Das, 2018). Some food spills, gets sticky or soggy and customers directly equate this to the quality of the food/restaurant. Today, Zomato and Swiggy are leading the Indian online food delivery market (Saxena, 2019) (Das, 2018). The reason that other online services aren't doing so well are due to the expectations of offers and discounts that are available in bulk on Zomato and Swiggy, so customers don't feel the need to look elsewhere. One of the biggest problems faced while ordering food online is not being able to give preferences and exact specifications. (Saxena, 2019). Even if the food is good, people get bored easily. Getting customers and maintaining those customers is a difficult task. Customers need to feel incentivized with new offers, exciting deals, new menus, new cuisines etc. to keep coming back.

As the COVID-19 pandemic of 2020 unfolds, considerable attention has focused on the resiliency of food supply chains in a time of crisis. (Hobbs, Food supply chains during the COVID-19 pandemic, 2020) Every industry in the world expects to see how the COVID-19 outbreak will affect the manufacturing industry, and the food industry is no different from other industries. As the world faced so many shocks from the demand side like panic buying, changes in purchasing patterns, many supply side disruptions were notices too. This was mainly due to shortage of labor and disturbances in transportation and supply networks. Labor shortages were becoming very common due to worker illness, self-isolation rules, movement restrictions put by various governments. As agriculture is mainly a labor-intensive sector, it was the worst vulnerable to labor disruptions. Many industries were also hit due to the cross-border restriction measures taken by some countries as many skilled workers in the harvest could not access various countries. For example. - the United States is a net importer of Canadian beef and cattle; Canada relies heavily on seasonal imports of fresh produce from the United States and Mexico. (Hobbs, Food supply chains during the COVID-19 pandemic, 2020) As a consequence of the COVID-19 crisis, response plans for food workers were developed to provide guidance for continuity of operations in the food processing facilities and manage coronavirus in the food industry. Especially meat and poultry processing industries can be defined as the critical infrastructure in food and

agriculture. The plan includes a hierarchy of control requirements for cleaning, sanitation, disinfection of facilities, screening, and monitoring of workers for COVID-19, managing the sick employees and education programs for workers and supervisors to prevent the spread of coronavirus. (Meat & Poultry Processors, Interim Guidance from CDC, 2021).

Another element of food distribution that is undergoing significant change during the COVID-19 pandemic is the expansion of online grocery deliveries. With governments issuing "stay at home" orders to citizens, online grocery deliveries may be particularly useful for vulnerable individuals (elderly or those with underlying health conditions) and to assist with social distancing among the population in general. Nevertheless, where online grocery delivery services are more common, these systems have struggled to cope with the sudden expansion in online orders, leaving long time lags before delivery slots are available. The sudden shut-down of many "non-essential" businesses has created a pool of unemployed, or underemployed, labor that could be temporarily redeployed to tasks within the food supply chain, including staffing of grocery stores, warehouses, and food delivery. Despite government reassurances, some of the stores started free delivery services on orders to prevent panic-buying. In addition, supermarkets determined the number of people allowed at any given time to stop overcrowding. Stores also adjusted special shopping hours for vulnerable customers. (Nicola, et al., 2020)

The problems of the demand side can be countered with various solutions. The problem mentioned in Das, 2018 can be solved through operational method of creating a solution to the assignment problem which will help in efficient deliveries before the quality of food is degraded. The chance of human errors through spillage can also be minimized by a fixed scientifically proven packaging. The paper also maps out consumer preferences of apps that are used for food ordering now this is a problem mentioned in Saxena, 2019 as well that consumer prefer discounts and offers, the other apps can solve such a problem by applying methods such as finding an optimal solution to the transportation problem which will cost effectiveness and bring down overall costs. A major problem that customers are not given specific preferences and recommendations on the app can be countered by recording data of every order by every individual customer and then divide them into specific categories and preferences. Customers need new things to try every day and thus they get bored with having the same type of food, this can be countered by frequently adding new restaurants with different cuisines and styles to their app through the method of assignment as significant research can be done on the dataset of restaurants and solution can be brought forward to strike up an efficient and attractive deal with the restaurants. Every demand side problem can be met with a solution this is the objective of operations research which is to find an optimal solution by thorough research and applying quantitative analysis.

As (Hobbs, 2020) discussed the disruptions in supply chains due to the pandemic, the customer and the sellers must collaborate to build confidence. Emergency plans should be formulated on an individual level. Food supply chain and supporting chains including transport, the distribution must be termed as essential supplies in order to ensure that their supply is prioritized and not disrupted. Steps must be taken to alleviate "panic buying" and "stockpiling behavior" by consumers during such unprecedented times. We need to analyze what leads to such responses and what strategies should be adopted to tackle this. The paper (2021). Meat & Poultry Processors, Interim Guidance from CDC. CDC raises the issue of managing covid and operating the "food processing facilities". To prevent workers from getting infected, the "hierarchy of controls" approach must be adopted. Workers need to be kept at least 6 feet apart and barriers such as see-through separation can be utilized. The arrangement of the "workstations" must be altered to ensure an optimum distance between the workers. The mask, hygienic controls must be implemented. Employees should be communicated about the signs, symptoms, and how to tackle the virus. As (Nicola, et al., 2020) mentioned that supermarkets are taking new approaches during this pandemic, retailers must prioritize the food and medicines supply chain for an efficient and quick supply and reallocate the inventory to ensure the surplus of the essential items. Thus, the supply side problems can be solved using a unique approach to the existing supply chains.

3. FINDINGS

We have discussed throughout the analysis the problems of the demand and supply side and what the solutions to those problems could be using Operations Research. Expectations of the customers are still high concerning the food they order. Some quality lapses and spills are bound to happen sometime or the other. Expectations of great offers and huge discounts also are a burden on food delivery apps. Lack of personalization and specific instructions is faced by the consumers while ordering online whereas on the other hand, maintaining customers is a huge task because the consumers expect different food items, incentives, and what not to order from one place again and again. As the 2020 COVID-19 pandemic progresses, much emphasis has been paid to the resiliency of food supply chains in a pandemic. A hierarchy of control requirements for cleaning, sanitation, and disinfection of facilities is included in the plan. During the COVID-19 pandemic, the food supply system is undergoing dramatic changes. Many "non-essential" firms have closed unexpectedly, leaving a pool of unemployed or underemployed workers who may be temporarily redeployed to activities like store staffing and food delivery. With the government issuing "stay at home" orders to residents, online grocery and food deliveries may be quite useful for vulnerable people like the elderly or those with

underlying health concerns and help with social isolation. Every demand-side problem has a solution, which is the goal of operations research, which essentially is to find the best answer through extensive research and quantitative analysis. Consumer preferences for meal ordering applications are also mentioned in the report. The issue of customers requiring fresh experiences every day can be addressed by frequently adding new restaurants with a variety of cuisines. The food supply chain and its supporting chains, such as transportation and distribution, must be classified as critical supplies. Hygienic controls must be established in addition to the mask. Employees should be informed of the signs and symptoms of the pandemic, and how to deal with it. Barriers, such as see-through separation, can be used to keep workers at least 6 feet apart, and many more such precautions can be taken to ensure the safety of employees.

4. CONCLUSION

The food delivery industry has seen huge growth in the past decade and is expected to grow further. Extensive research and development need to be done to help in the growth of this industry. After reviewing several research papers, we have found that all these papers cover various aspects of the food delivery industry, some analyze the growth in digital use and mobile applications that enable consumers to order food whereas, some tend to find optimal solutions to problems in the industry. The research can be divided into two aspects: supply-side and demand side. We have discussed throughout the analysis the problems of the demand and supply side and what the solutions to those problems could be using Operations Research. The findings indicate solutions and statistics such as what Delivery services are prominent and preferred by consumers, how can these services reduce cost, and counter problems such as employee unrest, consumer complaints, and late deliveries. During the COVID-19 pandemic, the food supply system is undergoing dramatic changes. Many "non-essential" firms have closed unexpectedly, leaving a pool of unemployed or underemployed workers who may be temporarily redeployed to activities like store staffing and food delivery. From the analysis and research, we were able to conclude that operations research can be used by businesses to determine how to choose between different food delivery companies to reduce costs and increase profit margins. The researchers also attempt to analyze the working of these food delivery services and how they manage to make a profit.

LIMITATIONS AND RECOMMENDATIONS

Although we found extensive research on operation research in online food delivery, we would like to acknowledge some limitations of our study. Firstly, our study is entirely dependent on secondary data, therefore our conclusions are based on the honest responses of the respondents of the original studies and the accuracy of the original authors who recorded the same. Secondly, much of the secondary data used in our paper captures audiences in the demographic of gen-z and millennials. Hence, our study does not represent the entire Online Food Delivery Service userbase. Our suggestion is for future studies to expand their sample demographics. Next, our study focuses on data recorded both pre and post the Covid-19 pandemic. This data corresponds to the usage of online delivery services during the last 2 years predominantly in India. Therefore, our final conclusions derived, rely largely on the delivery platforms used in India. There are other types of delivery platforms and services used in other parts of the world so future research should accommodate for the same. Another limitation observed is that most of the data is predominantly based in urban areas due to unavailability of these services in rural areas. This fails to give a well-rounded idea of the advancement of online food delivery in India and can overstate the statistics.

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