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Retail Management of the Food Sector in the Indian Economy during Covid-19: A Systematic Review

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Abstract

The coronavirus pandemic caused significant changes to businesses worldwide, its rippling effects still being felt today. As businesses adapt to the new restrictions, multiple researchers have analysed the new environment that these organizations operate in. The changes included less footfall in physical stores and an increase in online deliveries leading to stores having to change their entire format of operations. This paper looks to construct a literary review of food retailing and its changes during the COVID-19 pandemic spanning the agriculture and food retail sector supply and demand fluctuations, supply chain disruptions, and the rise of doorstep food deliveries. This paper involves a holistic review of the challenges faced and overcome by food retailing businesses in the past three years, and the prospects of these evolved business models. Our study includes findings from previous research and tries to establish a connection between the problems mentioned above, the increased use of digital services, and the significance of the pandemic as the exacerbator of existing issues in the established infrastructure of the agriculture and food retail sectors.

Keywords ; Covid-19 Pandemic; Food supply Chain; Retail; Agriculture

Introduction

The years preceding 2022 have challenged the way the global economy functions in various ways, the most prominent of them being the colossal losses to traditional retail setups. Varying from labour shortages to supply chain problems, retailers have faced many challenges in their businesses. This has prompted the retail sector as a whole to adopt innovative methods and utilize the newer retail channels to expand their reach to previously unexplored geographical locations. The pervasive after-effects of this pandemic on retail demand further research. The problems that people have had to endure during the past years have reduced their interactions with traditional or rather, physical retailers. What started as a way to avoid contracting the deadly SARS-COV-2 virus has now become a general practice in almost all urban households with its reach expanding into various select rural areas as well; the general public tends to rely more on online retailers and e-commerce websites rather than physical retailers. This shift in the dynamics of retail caused widespread disruptions ultimately leading to a huge number of consumers expecting uninterrupted switching between integrated retailing channels (Agatz et al., 2008) this forced the brick-and-mortar stores to establish their presence online while utilizing their networks to remain relevant. ((Hübner et al., 2022)

This paper retains its focus on the food retail and agricultural sector during the covid-19 pandemic. The two sectors were characterized by a slowdown in agriculture due to falling yields, contraction in demand for perishables, raw material shortages, lack of storage facilities in rural areas, and last but not the least, labour availability dropping by 25% in India's labour-intensive agricultural sector; has also fuelled the food shortage crisis in India. (Rasul, 2021) To ensure food sustainability during the pandemic and afterward through mitigation strategies that would reduce the risk of further such disruptions should similar situations arise and protect the general public from food security problems in the future. (Adelodun et al., 2021a) The problems in agriculture led to some of the issues in food retailing such as dropping customers, increasing inventory rates, supply chain disruptions, and shortages. Following the changing dynamics of supply and demand, businesses suffered record losses, some even functioning below the break-even point for the sole purpose of overcoming the pandemic, while others lost their entire businesses leading to the closure of a huge number of stores (Brewer & Sebby, 2021).

Following the inability of economies to continue in a physical fashion, many of them shifted to online systems, employing a vast network of delivery executives and high geographical connectivity. A relevant example would be the restaurant industry, which had already suffered losses racking up to $240 billion in 2020 alone (National Restaurant Association, 2020). The select few that remained functional had to shift

to offering OFD (online food delivery) services (Brewer & Sebby, 2021). The result was a huge contribution to expanding online retailing. The future for retailing holds a major overhaul of traditional networks and the usage of highly interconnected, responsive, and flexible retailing channels. As a result of the unprecedented rise in e-commerce, these physical stores may now be used as pickup locations to fulfil online deliveries. The retailers need to manage the locations of the above-mentioned stores and decide the inventories, assortments, and varieties to store so that the neighbourhood areas would be well serviced. The requirement for modelling and quantifying is the need of the hour to secure profitable trade-offs between costs and operational advantages. (Hübner et al., 2022)

The Last Mile Problem has the potential to be quite expensive and represents a sizable portion of the overall business expenses for food platforms. Online platforms should focus on the performance of "Last-Mile Transportation Systems (LMTS)" in order to increase sales, maintain cost control, and guarantee delivery timeliness in light of the growing commercial competition. Therefore, it is essential that online food platforms appropriately address LMP. The last-mile delivery problem is also difficult since, in principle, VRP is a complicated problem, in practice, parameter values in the day to day business are subject to a variety of uncertainties. managers can decide on the algorithm used for order assignment and the delivery route for the last mile. The complex situations can be solved by using appropriate optimization theories. To get accurate results human factors such as the driver's habit, weather conditions have to be taken into consideration which are difficult to calculate

Literature review

The coronavirus pandemic has been studied extensively in the past three years; researchers have analysed its impact on various sectors of the global economy to get a read on the devastating effects. We read 250 over the past three years (2022, 2021, 2020) out of the 16,672 research papers that were found on searching "operations AND research AND food sector AND retail" on https://www.sciencedirect.com/, we opted for this topic, knowing that this catastrophe hit the lives of all. We also included the pandemic effect and narrowed down our research to 1213 papers with "operations AND research AND food sector AND retail AND covid".

In this research paper, we find the quantitative and the qualitative aspects of how covid 19 impacted the production of food and how it overcame with optimal solutions using BOPIS while we write about the Urban retail landscape about the same. (https://www.abeam.com/vn/en/topics/insights/covid19_retail). The

pandemic had adverse effects on the economy, out of the papers that we've referenced most of them discuss the slowdown in agriculture, the fall in yield in turn leading to problems with food supply and demand fluctuations. The multiple waves of the pandemic hit retailers right when they started to get back on their feet, fall in demand led to dropping customers, increasing rates of inventory, and making a profitable business was hard. For instance, transportation has been mostly stopped during the lockdown in India, lowering production and jeopardizing food security. Produce could frequently not reach rural marketplaces or "mandis" during the height of the spring harvest, drastically interrupting regular supply networks. The absence of agricultural and other migrant labour has also affected planting, harvest, and post-harvest operations (Narayanan & Saha, 2021).

While social distance guidelines and lockdown have disastrous effects on the "traditional" retail property sector, they accelerated the evolution process of multi-channel retail and the channel integration role of physical stores and thus, bring in transformations in the urban-retail landscape(Nanda et al., 2021) (Journal of Urban Management).

Research Methodology

This study uses bibliometric methods to review the existing literature related to Covid 19 and the retail food supply chain. The scientific contribution and impact of publications in a study field are systematically reviewed and evaluated using bibliometric analysis, which employs simple to complex mathematical and statistical methods. (Benckendorff & Zehrer, 2013). It is essential to retrieve papers for bibliometric analysis from various bibliographical databases, including Science Direct, Scopus, and Google Scholar. The formation of the intellectual and conceptual structure of a specific area is then analysed by various bibliometric techniques and graphical representations, such as co-citation, co-word, and co-authorship analysis, on the selected documents (Koseoglu et al., 2016)(Rodríguez-López et al., 2020). Our analysis is partly based on the compilations of 250 research papers that we have referred from and the chart thus formed by VOSviewer. The map thus formed is based on the bibliographic data referred from manager files to select from RIS. The analysis is based on co-occurrence and co-authorship with a unit of analysis as 'keywords' and 'authors' respectively. The counting is done based on 'full counting'. The threshold is kept at 2 co-occurrences and 1 co-authorship for a keyword where out of 362, 53 meet the threshold and 468 where 468 meet the threshold

In this study, publications were mainly retrieved from the Science Direct database. "Science Direct is a website providing access to a large bibliographic database of scientific and medical publications from the Dutch publisher Elsevier. It houses more than 18 million pieces of content from more than 4,000 scientific journals and 30,000 e-books from Elsevier."

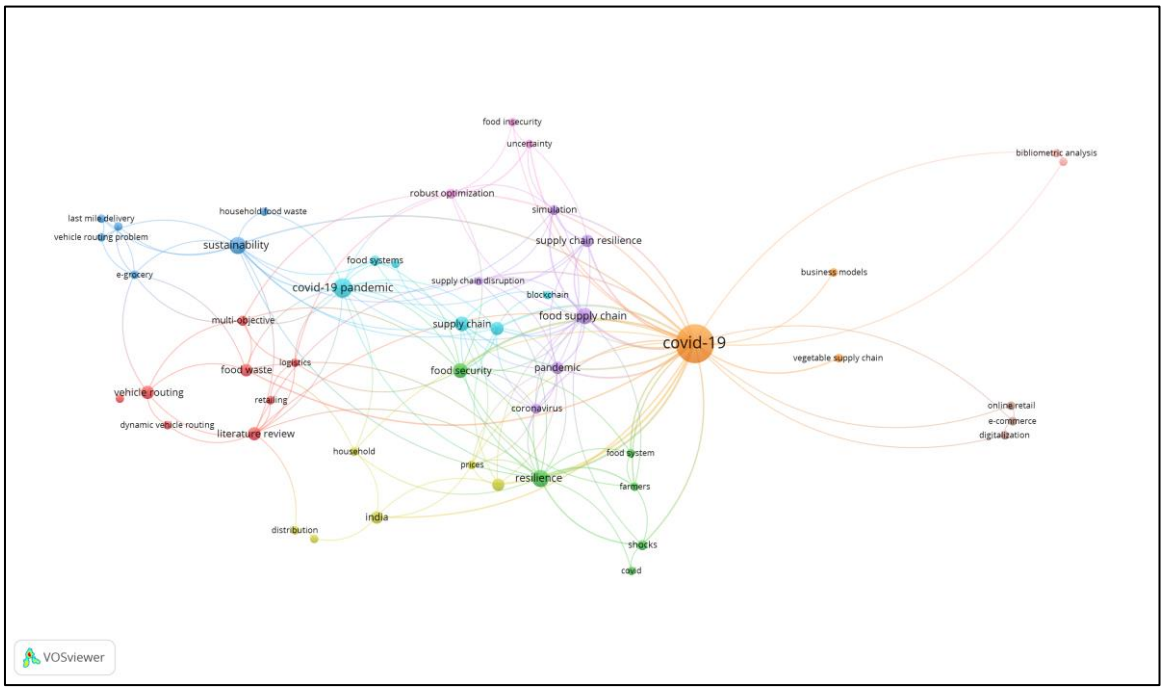

Figure 1. Keyword analysis

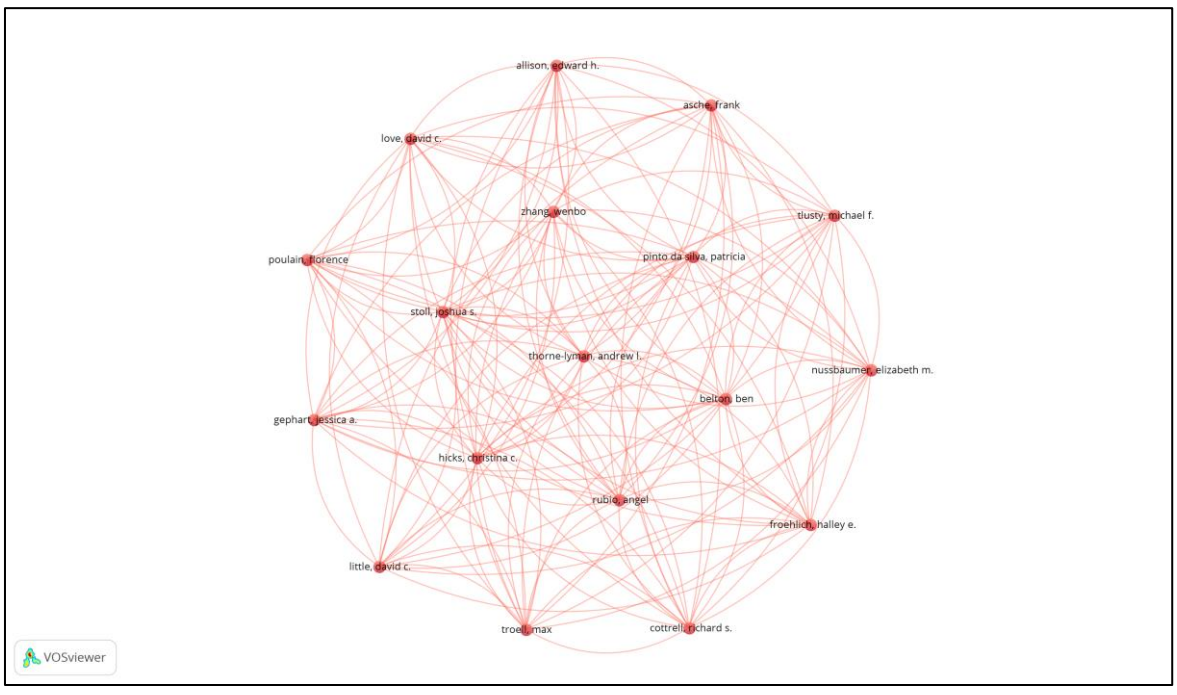

Figure 2. Author analysis

Impact of Covid-19 on the Agricultural sector in India

In addition to economic and health concerns, ensuring adequate and nutritious food for all may be a major concern, because the pandemic impacted various supply and demand side challenges such as non-operational manufacturing mills, interrupted transportation chains, labour-intensive farming systems, and subsequent labour shortages thanks to restrictions imposed (Priyadarshini & Abhilash, 2021); (Nuthalapati et al., 2020); (Workie et al., 2020). Agriculture, a serious influencer of the Indian economy, helped contribute 3,047,187 Crore (30471870 million INR) to the national GVA (Gross Value Added) in 2019-20 (Priyadarshini & Abhilash, 2021). The food processing sector is critical to the event of agriculture, accounting for 11.11% of the former's GVA in 2018-19 and playing a pivotal role in issues like food security, employment, price regulation, and therefore the provision of nutritious food (Priyadarshini & Abhilash, 2021).

The first lockdown in India occurred during the apex harvest season of winter wheat (Priyadarshini & Abhilash, 2021). However, to minimize grain loss and other negative impacts, the govt later included agriculture, fisheries, and livestock farming on the list of selected activities permitted during the second phase of the lockdown (Priyadarshini & Abhilash, 2021). COVID-19-induced agricultural system disruption is the result of various climate change-related concerns, like rising temperatures, environmental pollutants, declining groundwater levels, and worsening air quality, on crop yields (Rasul, 2021).

The impact on food systems is probably going to result from national-scale restrictions or lockdowns imposed to contain the pandemic's spread by disrupting world trade and transportation chains, foodstuff volatility, reducing buffer stocks of perishable commodities, and creating labour supply constraints (Priyadarshini & Abhilash, 2021). Although India is the third largest producer of oilseeds (33.50 million tonnes) and cotton (36.05 million bales), the Department of Agriculture, Cooperation, and Farmers' Welfare estimates record production for oilseeds (33.50 million tonnes) and cotton (36.05 million bales) (Priyadarshini & Abhilash, 2021). Meanwhile, the horticulture sector's 2nd Advance Estimates show a 3.13% increase in total production over the previous year, with a rise in fruits and veggies, aromatic and medicinal plants, and a reduction in plantation crops and seasonings (Priyadarshini & Abhilash, 2021).

Food Availability and Storage	
All India production of food grains (cereals and pulses), 2019-20	296.65 million tonnes
2020-21(for Kharif season only)	144.52 million tonnes
All India procurement for cereals (rice, wheat, and coarse grains), 2019-20	865.52 lakh tonnes
2020–21	611.15 lakh tonnes
Per capita net availability of food grains (per annum) 2019(P)	(kilograms per year)
Rice	69.1
Wheat	65.2
Pulses	17.5
Per capita net availability of food grains (per day) 2019(P)	(grams per day)
Rice	189.3
Wheat	178.6
Pulses	47.9
The stock of Rice and Wheat (FCI and State Agencies), 2020	512.94 lakh tonnes
Allocation of food grains (Rice and Wheat), 2019-20	659.57 lakh tonnes
2020–21	452.39 lakh tonnes
Offtake of food grains (Rice and Wheat), 2019-20	621.90 lakh tonnes
2020–21	389.21 lakh tonnes
All India Storage capacity (FCI and State Agencies), October 2020	802.70 lakh metric tonnes
All India cold storage capacity (March 2018)	36229675 metric tonnes

“P = Provisional; FCI = Food Corporation of India (nodal agency for procurement and storage of food grains), 1 lakh = 100,000; 10 lakhs = 1 million.” (Priyadarshini & Abhilash, 2021)

Source: (Priyadarshini & Abhilash, 2021)

Furthermore, the movement was at its lowest in March thanks to the nationwide lockdown but saw a pointy increase in April due to the proper revival of goods trains. Furthermore, thanks to disruptions in supply chains, the arrival of food commodities in markets decreased by 64% within the first phase of the lockdown compared to the previous year (Priyadarshini & Abhilash, 2021) additionally, food exports (US$ 21260.91 million) and imports (US$ 13162.80 million) decreased in 2019-20 (April-November) compared to the previous year (Priyadarshini & Abhilash, 2021).

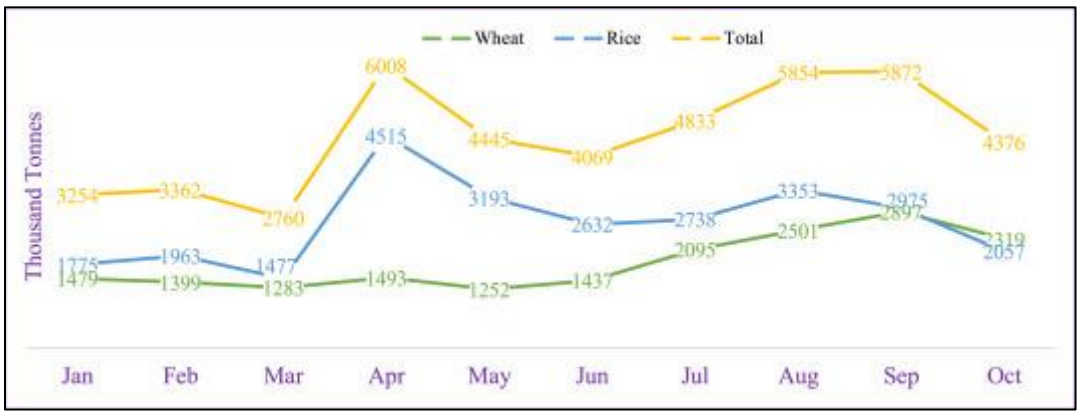

Figure 3. Transportation

The figure above shows the movement of food grains (rice, wheat, and total) by road and rail 2020. In 2015, the annual value of harvest and post-harvest agricultural losses was estimated to be 92,651 crores, with approximately 23 million tonnes of grain loss reported (Priyadarshini & Abhilash, 2021). While cereal losses are observed during farm-level activities, fruit and vegetable losses occur as a result of limited processing facilities, institutional gaps, and underutilised existing capacity (Priyadarshini & Abhilash, 2021); (Sivaraman 2016). Such losses are likely to extend during the pandemic due to movement restrictions and labour shortages caused by migrations, particularly in states that rely heavily on agricultural labour, like Punjab and Haryana (Adelodun et al., 2021b).

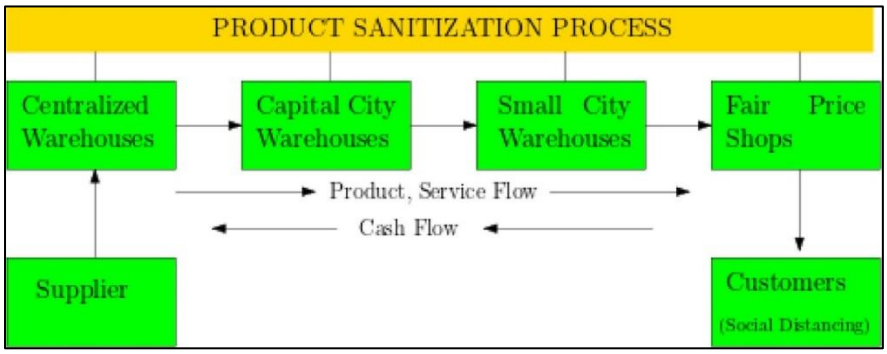

Figure 4. Product sanitization Process

It is suggested that the Government run the PDS – Public Distribution System. This is to ensure that the poorer strata of the society get the food delivered at reasonable rates. According to the figure below, the supply chain network of PDS includes the supplier, who is the farmer, the central warehouses, warehouses

in the capital city as well as the small city, which are then put in the FPS – Fair Price Shops to be sold to the customers.

More measures are needed as we move towards the final stages of the production network because more people are a part of the cycle. Currently, the risk of disease transmission through food is regarded as trivial and tracing Covid in food territory and regular conditions are not regarded as demand for public trained professionals. A PDS is intended to be a revitalizing strategy. PDS coordination frameworks are also proposed to investigate COVID-19 conditions by emphasizing key activities. (Barman et al., 2021)

Supply Chain Management

COVID-19, caused by a novel coronavirus (SARS-Cov-2), has disturbed all the sectors of the Indian economy and led to a nationwide lockdown on March 25, 2020. This sudden move left people with no time to respond or prepare for this crisis in any way.

However, the lockdown instantly had an impact on the production to consumption chain of food supplies. Production interruption results from the lack of essential inputs or their limited availability. Workforce reductions brought on by pandemics, different workdays, and reductions in hours worked were the factors restricting productivity. Vehicle movement restrictions impede transportation, which has a detrimental effect on the efficient flow of goods. Additionally, the lack of connection between the various supply chain partners resulted in ambiguous information and a lack of responsiveness, which had an impact on supply chain management. From the perspective of the customer, there was a significant rise in the demand for necessities, which resulted in a transitory market shortage and significant alterations in consumer behaviour around food waste management. Due to a sudden rise in demand and restricted movement, deliveries were delayed, which resulted in the loss of production, especially perishables like food items.(Cariappa et al., 2021) For many countries and firms, the inability to respond to the Covid-19 outbreak lies in its supply chain—transportation of goods whether it is masks or ventilators or grocery items, or even services. (Ranney et al., 2020)

A supply chain (SC) is a planned system of people, equipment, labour, resources, and technology used in the production and delivery of a product to customers. It encompasses the entire process, from the suppliers delivering raw materials or semi-finished goods to the manufacturer through the manufacturers transforming and shipping the finished product or service to the end-user or customers.(Bassiouni et al., 2023)

Production and price concerns are two types of risks that agriculture supply networks have experienced during the pandemic. Production risk is a situation in which actual output differs from the anticipated output. Price risk also arises from differences between expectations and actual prices. Both risks increased as a result of the food supply chain shocks brought on by COVID-19. The fact that COVID-19's disruptions to the food supply chains simultaneously altered production and price risks, which businesses had to traverse and manage, was one of the major issues it presented. (Anderson et al., 2021)

The other major impacts could be on supplies of meat, dairy, fruit, vegetables, and grains, due to logistical disruptions in the movement of food from fields to forks. In the research paper "India's Supply Chain during the Covid-19 Pandemic", data was used mainly using the government's "Ministry of Agriculture's" online database. The "Ministry of Agriculture" connected mandis through an integrated scheme for agricultural marketing to increase transparency and improve price discovery. This resulted in the formation of a network of mandis. Each mandi reported to the Agricultural Marketing Network the number of arrivals of each food variety as well as price data (maximum, minimum, and modal traded price), which is then combined and daily published to the network's webpage, agmarknet.gov.in. (Belton et al., 2021)

It was observed using the database that the arrivals drastically decreased after the lockdown on March 24, 2020, compared to levels in 2018 and 2019, and only gradually increased after Phase 2 of the lockdown.

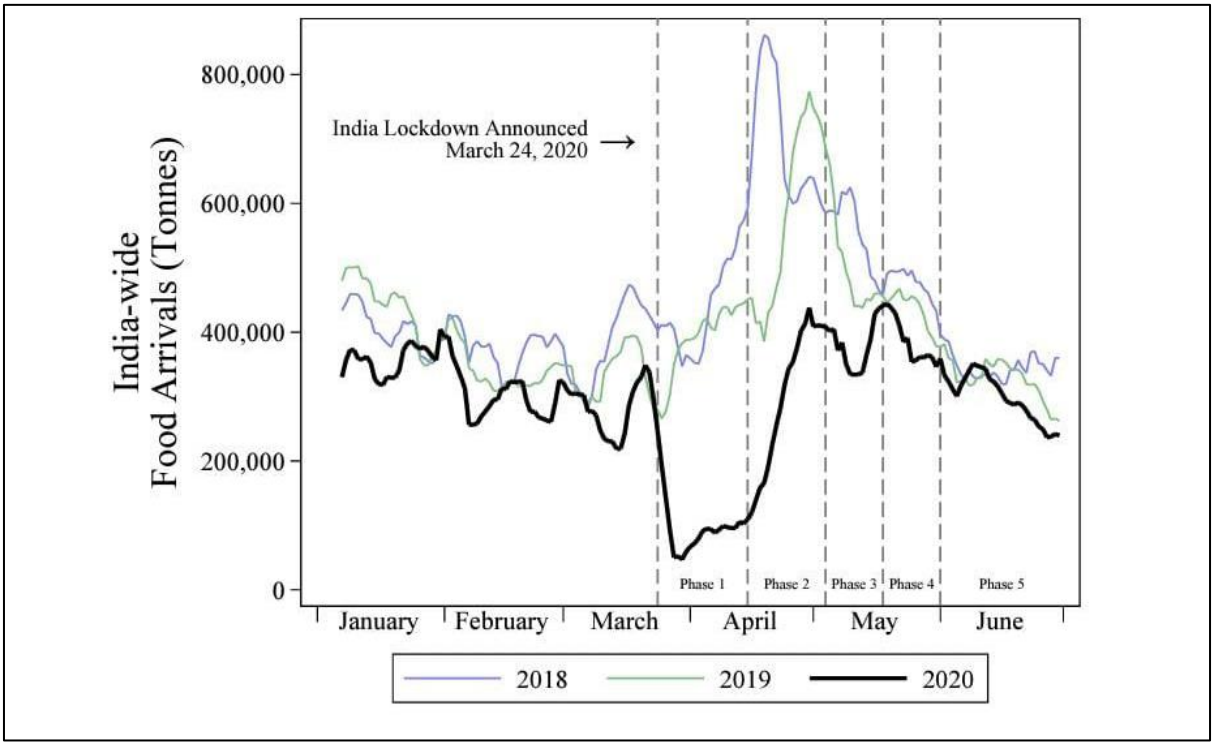

Figure 5. The Lockdown Caused Wholesale Volumes to Plummet

Source: agmarknet.gov.in

To quantify the aggregate patterns in Figure 5 we use variants of the following difference-in-difference specification:

$$ln\,(\text{Volume})_{yd} = \alpha_y + \alpha_d + \sum_{t=1}^{5} \beta_t \text{Phase}_{yd}^{t} + \varepsilon_{yd}$$

Source: (Lowe et al., 2021)

where ln (Volume) yd is the log of the total volume of food arrivals in tonnes on calendar date d (e.g. January 1) during year y (either 2019 or 2020). αy and αd are a year and calendar date fixed effects, respectively, making this a difference-in-difference design where they are drawing comparisons in the volume change before and after the lockdown began in 2020 with the volume change before and after March 24 in 2019. They only included data from March 1 to June 30 in these regressions, making the "before" period March 1 to 24.

Additionally, the graphs below (Figure 6) illustrate this basic pattern for all of the six significant food groups, indicating that the recovery was not fuelled by government purchases of particular products.

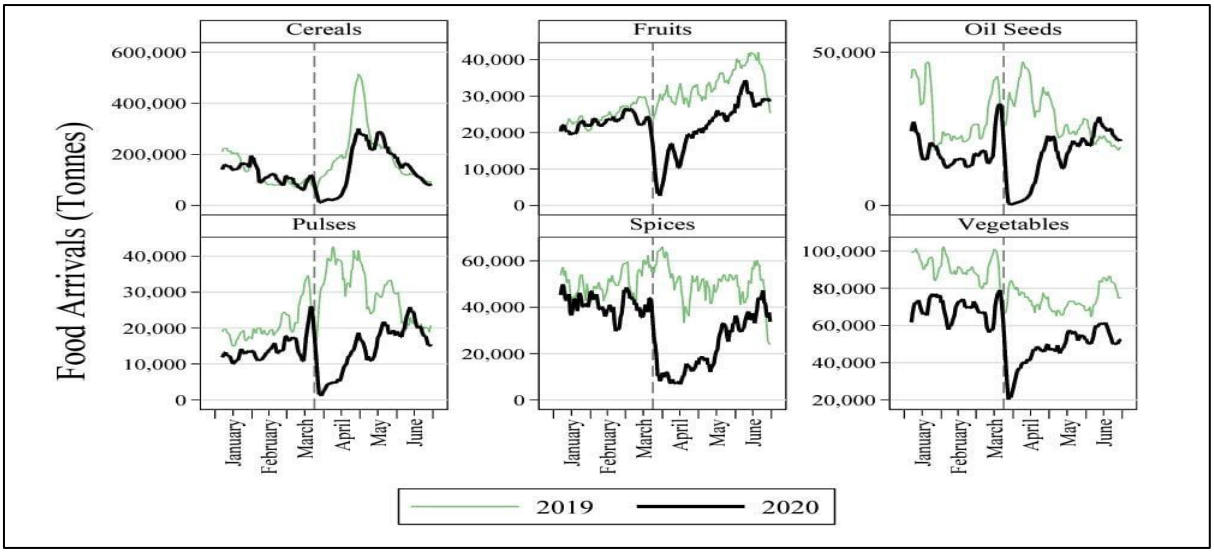

Figure 6. The Lockdown's Impact on Food Group

Source: agmarknet.gov.in

All necessary measures must be taken to remove the major barriers to food procurement as a result of the lockdown while ensuring the safety of workers and consumers. In addition, the adoption of targeted hygiene measures to prevent human-to-human transmission of this virus in grocery stores is mandatory. FSSAI has issued detailed guidelines and training programs (as part of FoSTaC) for food businesses to emphasize food safety and hygiene principles to prevent spread. Currently, supermarkets and grocery stores in many countries may not feel the impact immediately due to strong food storage infrastructure. But the situation can be critical if supply chains are disrupted or the food industry cannot operate at full speed due to labour shortages, raw material shortages, or quarantines. (Pandhi et al., 2020)

Online food delivery (OFD)

Online delivery has been an area that experienced significant growth in the pandemic years, with customers moving more toward the ease of digital transactions it became imperative for delivery services to be efficient and flexible. (Teng et al., 2021) In this era of convenience, inconvenience in the form of late deliveries can cost companies a significant amount of customers due to the high availability of service providers that promise lower costs or shorter delivery durations (Tayfun¨oztas et al., 2022a).

Optimization of delivery routes poses a big problem for the highly unplanned cities of India with many geographical areas still lying unexplored. The costs associated with delivery executives, fuel, pickup-delivery delays, and other associated expenses need to be minimized. Since online deliveries contain several customers on the same route, it becomes imperative to plan out these routes to secure the least possible duration for all deliveries to be completed. For takeaway orders that involve cooked food and perishables, services like Zomato, Swiggy, Blinkit, etc. offer an estimated time of arrival which sets consumers' expectations, failure to complete deliveries within the stipulated time limits can lead to the cancellation of orders and a rise in consumer complaints. In this situation, it becomes a task of utmost importance to properly conduct information planning, and management needs to be monitored more efficiently or they could otherwise lead to large disruptions in operations. (Tayfun¨oztas et al., 2022a)

The research papers summarized in this paper proposed various algorithms to minimize costs and optimize the delivery routes to be taken, some of them have been discussed below.

"Matching Algorithm with Adaptive Tie-breaking Strategy" (MAATS)

It is a method devised to efficiently address the OFDP by identifying the association between newly-arrived orders and riders (Online Food Delivery Problem). The majority of the MAATS is made up of a machine learning (ML) model, several tie-breaking carriers, and a best-matching heuristic. The best-matching thought experiment distributes orders to the best riders to ensure the quality of the solutions. If multiple orders are aligned with a single transport, the best match heuristic may result in ties. Numerous tie-breaking operators are suggested to efficiently break the ties to adapt to various conditions and varied optimization aims. An adaptive tie-breaking strategy is designed to dynamically determine the best tie-breaking operators to utilize in the current scenario, which is implemented by ML techniques of an eXtreme Gradient Boosting (XGBoost) algorithm and a modified Deep Factorization Machine (deep M).(Chen et al., 2022)

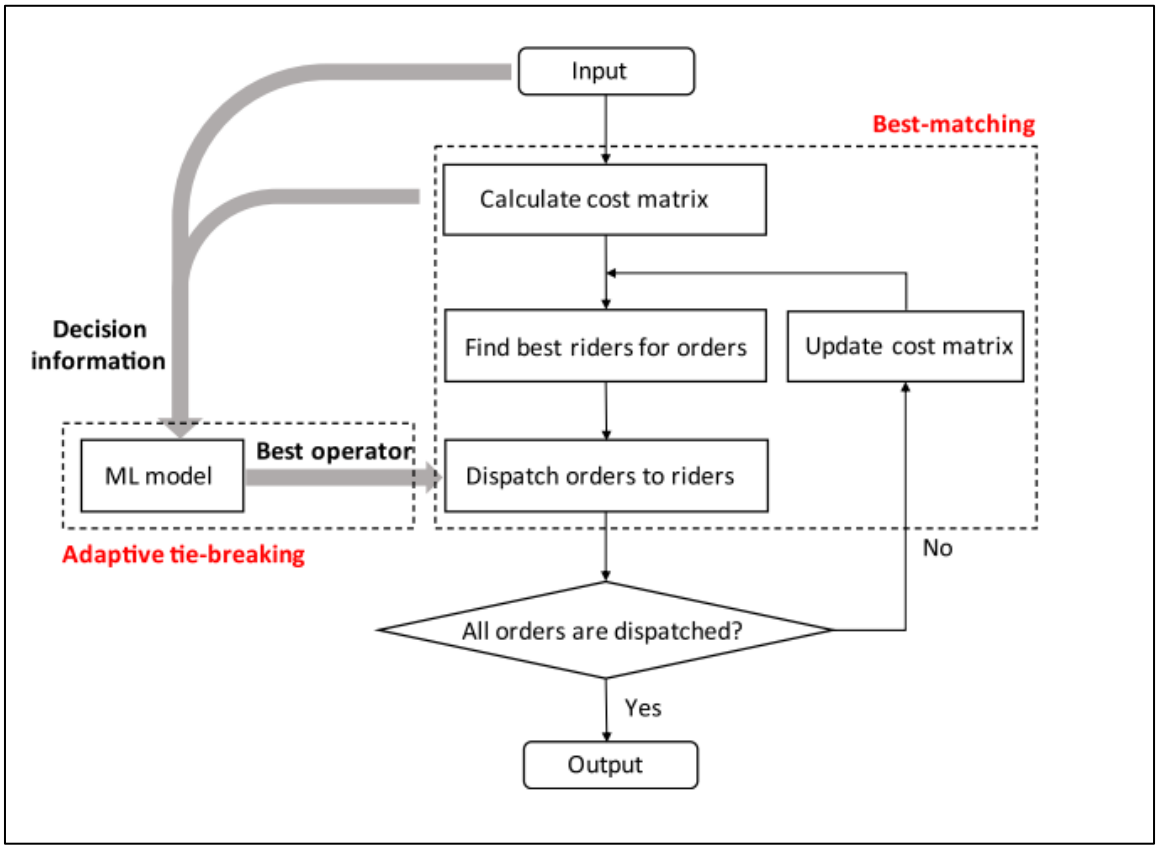

Figure 7. Framework of MAATS

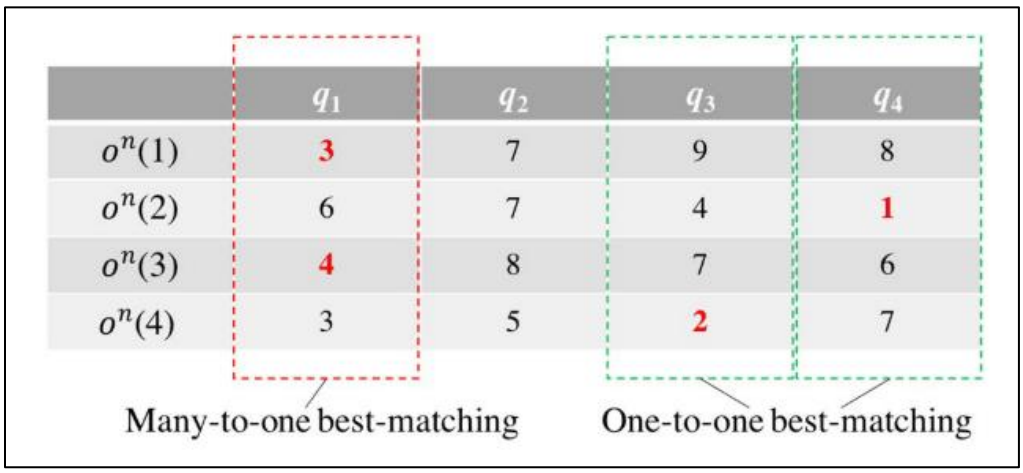

Figure 8. An example of a cost matrix and best-matching

Source: (Chen et al., 2022)

We suggest the MAATS architecture to get a high-quality solution quickly. It primarily consists of a best-matching component and an adaptive tie-breaking component. By tentatively dispatching each new order to each rider, the best-matching component creates a cost matrix. The best riders, or those with the lowest dis-patching costs, will then be efficiently matched with fresh orders to create a partial solution with a given level of quality. Regarding adaptive tie-breaking, the ML model will forecast the best operator to break ties based on the decision information retrieved from input data and cost matrix when ties exist when order is matched with several best riders. By using the best operator, a specific order is selected and then dispatched to the best rider. (Chen et al., 2022)

Star Graphs using the Postpone and Anticipation First (PAF) Algorithm

Myopic algorithms and far-sighted algorithms are the two categories of algorithms that we explore. When an algorithm tries to contact the server anytime there are any unmet requests, it is said to be myopic. If an algorithm is not myopic, it is said to be far-sighted; for example, it might decide to keep the server running for a while to see if any additional requests come in. The Earliest Anticipation First (EAF) algorithm and the Earliest Released First (ERF) method are two natural myopic algorithms that we take into consideration. The ERF is a straightforward greedy technique that sends the server to the report that is submitted first whenever the server is at the centre and there are unmet requests. The EAF algorithm is similar, only that

it will choose to serve the request ρ = (rρ, vρ) with the least anticipated serving time, which is defined to be rρ +d(vρ, o). (Guo et al., 2022)

The goal of this method is to allocate all the requests to the server as fast as possible to lessen the flow time. Flow time is the highest amount of time taken between the submission and completion of a request.

The Postpone and Anticipation First (PAF) Algorithm is used mostly for far-sighted requests and provides a better solution than Earliest Anticipation First (EAF) algorithm. Whenever the server is in the centre, the PAF Algorithm checks the waiting time of the request. If the request has waited for more than the length of the farthest unserved request, PAF will serve the request with least scaled anticipation serving time.

Two-Stage Solution for Meal Delivery Routing Optimization

To increase timely client satisfaction, this study offers a two-step approach for obtaining optimal delivery routes. A number of orders are clubbed together, based on the closest pickup locations to achieve quick food deliveries. The cluster-based routing is solved using a general algorithm that ascertains the best feasible delivery route for each of these bundles. The strategy is useful in scheduling on-time deliveries which in turn, enhances customer satisfaction. Research shows that the proposed metaheuristic guarantees better consumer satisfaction and the delivery durations do not exceed 60 minutes. (Wang & Jiang, 2022a)

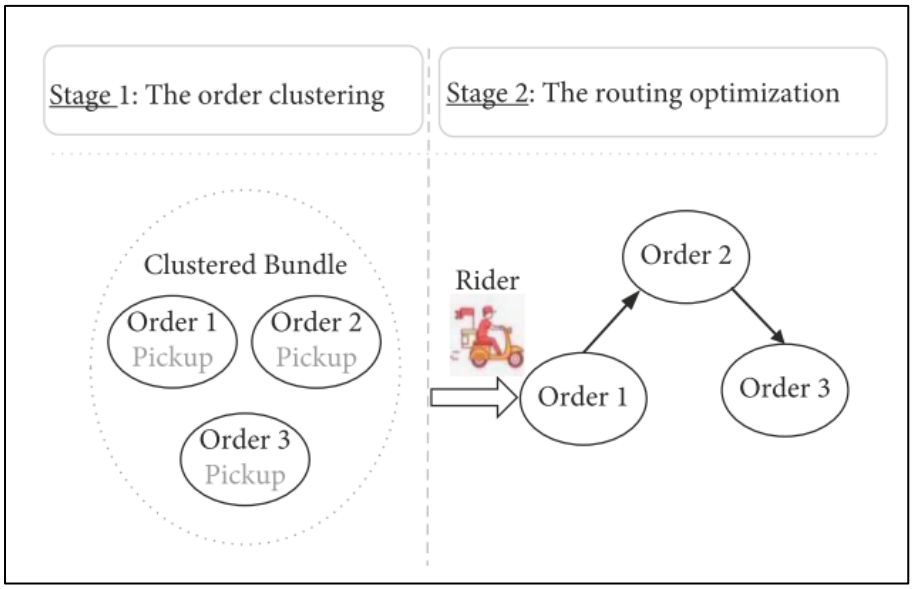

Figure 9. The framework of Two Stage solution

Source: (Wang & Jiang, 2022b)

Artificial Bee Colony (ABC) Algorithm

In 2007, Karaboga proposed the artificial bee colony (ABC) algorithm, a stochastic method based on well-known swarm intelligence that may be used to solve a variety of optimization issues. This program tries to find the source of food by acting like an intelligent honey bee. The position of the food supply is considered a potential solution to the problem in the artificial bee colony optimization algorithm, and the amount of fluid (nectar) of the food source is considered fitness, or the quality of the related solution. Given that each delivery person delivers one food source, there are exactly as many food sources as there is delivery personnel. (Katiyar et al., 2021)

This method is famous because it improves the convergence time and is very useful in the delivery of e-groceries. ABC algorithm is preferred by the researchers above other methods because of the robust nature, fewer control parameters, and the ability of the approach to adapt to unique problems and provide simple solutions within the stipulated time duration.

LMP Modelling using the SPO Paradigm

LMP stands for Last Mile Problem. The delivery service's LMP is to first assign the different orders to a fleet of vehicles considering the order quantity, distance, and other factors, and then decide the delivery sequence for each vehicle. The drivers delivering the goods have different driving habits and preferences which leads to different delivery durations.

When orders are improperly distributed to drivers, delays are inescapable. Due to the fierce market competition and the customers' expectations for speedier delivery, the provider places a strong emphasis on delivery timelines. As a result of the aforementioned reasoning, it is possible to structure the relevant last-mile problem as a capacitated vehicle routing problem with an on-time delivery goal function. (Chu et al., 2021)

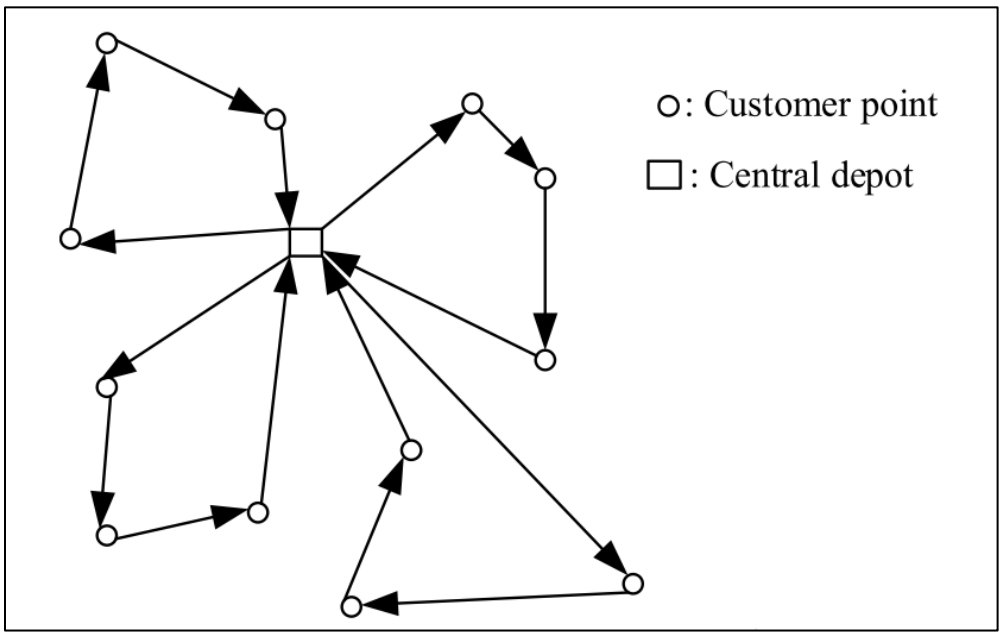

Figure 10. Last Mile Problem Framework

Source: (Chu et al., 2021)

The SPO paradigm helps to integrate the machine learning method with optimization programming. The SPO framework uses the problem structure to improve the travel time, and prediction model and then construct the solution intelligently.

Hybrid Metaheuristic Model

This research paper proposes a hybrid metaheuristic algorithm called ILS-RVND-TA for VRPSPD (Vehicle Routing Problem with Simultaneous Pickup and Delivery). It combines several metaheuristic models namely Iterated Local Search which involves running iterative models and the algorithm walks randomly and builds a feasible solution. (Tayfun¨oztas et al., 2022b) Variable Neighbourhood Descent uses multiple neighbourhood structures and the search runs according to the order of these multiple neighbourhoods. The Threshold Acceptance is used to compare the current solution and proposed solution using a threshold t and if the proposed solution crosses this threshold, it is accepted as the new solution. (Tayfun¨oztas et al., 2022b)

The ILS-RVND-TA model uses these three metaheuristics to obtain the optimal answers and has obtained the best possible solutions in significantly less time than it would take for traditional metaheuristics to work. These shorter durations become increasingly helpful when the routes need to be changed owing to road blockages or other events that are out of the control of the delivery service providers. However, this model faces problems when presented with a group of clustered customers. (Tayfun¨oztas et al., 2022b)

Results and discussion:

An up-to-date picture of interruptions and shocks at various levels of the supply chain is provided by data that is disseminated by news organisations, social media platforms, governments, and development partners. These changes have had a number of generalizable effects on numerous industries, markets, consumer categories, and product types. (Love et al., 2021)

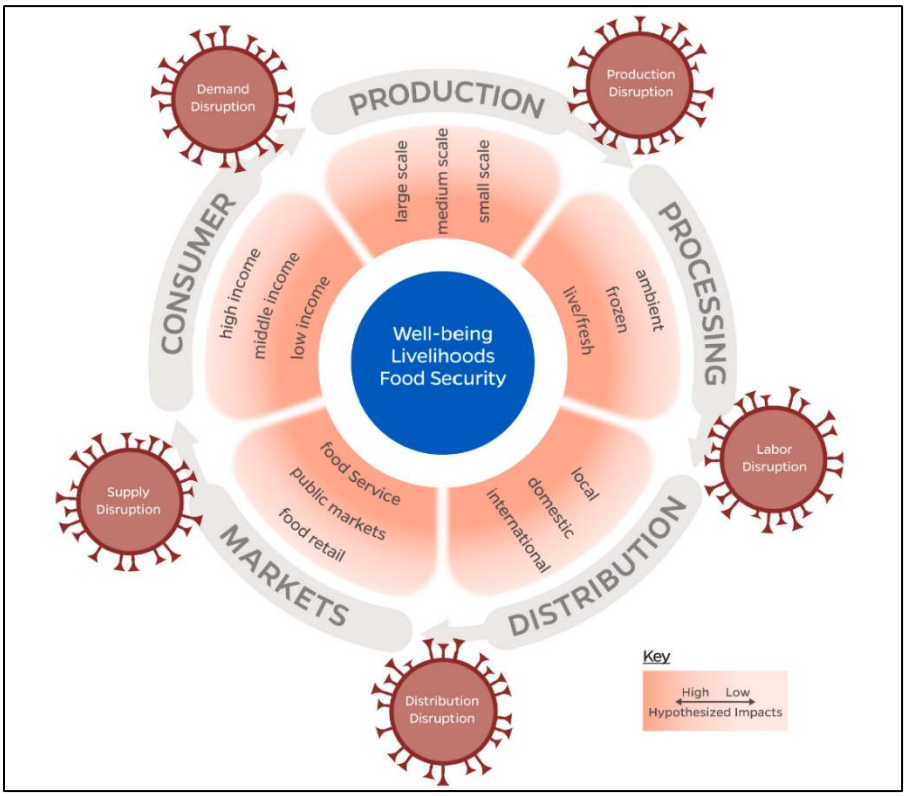

Figure 11. shocks at various levels of supply chain.

source: (Love et al., 2021)

The main drawback of using Matching Algorithm with Adaptive Tie-breaking Strategy (MAATS) framework is that it doesn't take the Vehicle Routing Problem (VRP) into consideration. The delivery time

is a very critical factor for online food delivery platforms and is also regarded as the main challenge in order assignment and routing service. This method focuses more on the assignment rather than the optimum route to minimize the delivery time.

When solving the food delivery problem using the Star Graphs and PAF Algorithm the main advantage of this method over the others is that it takes the density (importance) of the orders into scope. Myopic requests are quickly served and the rest are assigned using the algorithm. The PAF helps in reducing the overall flow time which is the primary objective of the OFDs. However, using this method a driver can serve only one order at a time and the distances between the different rides are neglected.

The objective of the two-stage solution using the HAC and GA Algorithm is to maximize the satisfaction of the time-sensitive customers. The main advantage of using this method is that it can handle heavy traffic and solve complex situations faster. The OFD platform is in dire need of such solutions because they receive too many orders during peak hours. At the same time, this solution guarantees delivery of most of the orders within 30 minutes and all orders within 60 minutes.

However, the Artificial Bee Colony (ABC) Algorithm method is not suitable for quick deliveries because of its inability to handle peak hour traffic on the basis of the assumption that the number of orders is equal to the number of the people delivering the orders. The main advantage is of ABC is that this algorithm ensures the food quality of the products delivered.

The main advantage that the SPO model has over other methods is that it can take into account the driver's profiles, route length, weather, season, and traffic information, which help determine the delivery time more accurately. These are very common variables with the OFD platforms and this method provides application of those variables. In short, this method helps in minimizing the delivery time while considering the human and seasonal factors.

Conclusion

Considering the drastic changes brought in by the pandemic, food shortages, supply chain abruption, uneven demand, inflated prices, India has successfully stood up to its worth by ensuring a halt in the spread of the virus withal maintaining the economic flow. The Indian crowd also fought in co-operation. Several sectors did feel the lack of funds to achieve basic needs where the government aided with subsidies. In relation to its consequences on worldwide supply chains, the COVID-19 pandemic in 2020 has possibly been the most unsettling event of the past generations. While the goal of improving the resilience of

the food supply chain is valuable, there will be no easy way to achieve it(Anderson et al., 2021) During the first few weeks of the lockdown, the total volume of food arrivals decreased by 69%, although it later entirely recovered. Likewise, wholesale prices initially increased by 8% but then started to decline(Lowe et al., 2021). The food sector has undergone significant dynamic changes amid this pandemic. These changes in food dynamics have presented certain opportunities and challenges to the food industry. Opportunities for the food industry include (1) increased demand for foods with added macronutrients and phytonutrients to boost immunity, and (2) alternative protein sources such as plant sources (such as quinoa), microalgae, and engineered meat. produced by research. laboratories under aseptic conditions, and (3) non-contact and antimicrobial food packaging systems. Governments and the food industry should work closely with research institutes to build strong R&D support for the development of nutrition, preservation, and packaging materials. Moreover, supply chain disruptions and food insecurity are among the biggest challenges in this pandemic era. Resilience and sustainability are two key parameters related to tackling food supply chain disruptions. Under these circumstances, adopting a just-in-time supply chain model is efficient and effective to maintain and improve supply chain resilience. Integrating food and agriculture under one roof could also make India a major hub for the food processing industry. (Pandhi et al., 2020)

When it comes to online food delivery, platforms such as Ubereats, Zomato, Swiggy have to take numerous factors such as delivery time, food quality, customer satisfaction into consideration. The methods discussed above have their own advantages and drawbacks and each platform can choose which algorithm to use based on their primary objective. For e.g. for e-groceries delivery, food quality is the main factor for which the Artificial Bee Colony (ABC) Algorithm is suitable whereas for Zomato where delivery time and handling peak hour traffic is the major concern, methods such as the Two Stage Solution for MDRO, MAATS would be more suitable. Food delivery is a part of the Vehicle Routing Problem with Time Windows (VRPTW), which is an ongoing field of research and new methods or algorithms keep coming up with time.

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