

A Study on the Influential Factors of the Last Mile Delivery Projects During Covid-19 Era

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Abstract: *The Covid-19 has shifted the face of many markets including e-commerce and online business with many bottlenecks to be cleared. The last-mile delivery project has the greatest effect on all types of e-commerce companies because it has many consumer touchpoints as well as the Covid-19 pain points. Due to these interconnected issues, the delivery projects itself requires modern solutions. The purpose of this paper is to identify, analyse and categorize the major factors that affect the last mile delivery projects in e-commerce, food sector, retail sector and so on using total interpretive structural modelling approach during the Covid-19. Ten major factors are identified from literature review, and expert opinions are collected from multiple organizations that are involved in the last mile delivery projects. The results indicate that types of goods, achieving routing efficiency and meeting fulfilment timeline are the key factors for last mile delivery projects during the time of Covid-19. This study helps the managers to identify the key factors and to focus on these factors for the successful implementation of last mile delivery project.*

Keywords: Covid-19.

I. INTRODUCTION

Mankind faces the greatest challenge in human history because Covid-19 is severely affected on people all over the world. The current Covid-19 cases are exacerbated by the emergence of mutated forms of the corona virus, which may escape from immune surveillance or the immune response obtained against newly developed vaccines (Suresh et al. 2021a). Due to the first and second wave of Covid-19, lockdowns has been imposed in many countries. The Covid-19 pandemic has actually changed the buying behaviour of people all over the world even in e-commerce platform. Many people who were not a fan of online shopping have actually shifted to online platform during this Covid-19 period (Chaudhary 2020). The structure of e-commerce markets are transformed over the period of Covid-19 era and online sales gradually increased (Kim 2020). The resultant, last mile delivery projects managers are facing many challenges to deliver huge quantities of products to their customers door step and adhering the Covid-19 precautionary and contactless delivery (Viu-Roig and Alvarez-Palau 2020).

The process of the last-mile delivery projects are the most impactful one in online businesses as this has multiple touchpoints with the customers as well as the Covid-19 pain points. Due to these connective issues, the process itself needs to be addressed with modern solutions. Last mile shipping is the next stage of the delivery project, where a package is sent from a shipping hub to its actual destination, which is either a person's home or a grocery store (Gevaers et al. 2011). This is the most important step in the distribution process, and companies want to make sure that it goes as smoothly as possible (Vakulenko et al. 2019). This project is to meet the demand for fast shipping among consumers, especially in the e-commerce, food and retail industries. It is probably the most expensive part of the trip that the items take to get to their final destination (Ranieri et al. 2018). Although the significance of the last mile in achieving progress cannot be overstated, the difficulties in making it as effective as possible are numerous (Macioszek 2017). Further this was complicated during the Covid-19 era (Srinivas and Marathe 2021). It is the least effective leg of the chain, despite being the most essential one. The barriers to optimum last-mile delivery must be removed in order to ensure the quality of transportation operations and a pleasant customer experience (Weber and Badenhorst-Weiss 2018).

Many researchers have studied last mile delivery projects in the contexts of consumer driven logistics (Galkin et al. 2019), cost reduction (Ranieri et al. 2018), containerization of products (Dell'Amico and Hadjidimitriou 2012);

analysis of transport operators' needs (Pronello et al. 2017), microhubs and crowd shipping (Ballare and Lin 2020), efficiency and sustainability (Tiwapat et al. 2018). Although, the identification of last mile delivery projects during Covid-19 era factors has not been investigated. The purpose of this paper is to identify, analyze, and categorize the last mile delivery projects during Covid-19 era. The analysis of factors related to the last mile delivery projects fills this research gap. This gap serves as inspiration for the current research, which uses the total interpretive structural modelling (TISM) approach to identify influencing major factors and analyze hierarchical interrelationships among major factors. The fact that the data, which are used in constructing this model obtained from experts participating in various forms of last-mile distribution, make the theoretical model more dependable and accurate. It is the first attempt to analyze the interrelationship among the last mile delivery projects factors during Covid-19 era.

The principal aim of this paper are as follows:

- To identify the influencing factors of last mile delivery projects during Covid-19 era.
- To analyze inter-relationships among these factors using TISM.
- To classify and rank the factors based on their dependence and driving power by using MICMAC analysis.

This study applies the TISM technique in the context of last mile delivery projects during Covid-19 era influencing factors, as indicated by the extensive extant literature for successfully implementing it to analyze the interrelationship between factors and create a hierarchical structure. The TISM is developed by Sushil (2012). TISM is used to model and organize the variables to understand their interrelationships better. This is a well-defined model that can be used to realize all factor intersections and relationships. Many researchers have used these methods to solve complex problems (Jena et al. 2017). The MICMAC study includes the development of a graph that categorizes factors based on driving power and dependence. The factors are divided into four categories by MICMAC: driving, autonomous, dependent, and linkage enablers (Patri and Suresh 2017).

II. LITERATURE REVIEW

The implementation of last mile delivery projects are challenging during Covid-19 period. Sarma (2020) has briefed the last mile delivery project. Covid-19 has changed the day-to-day lives of people and increased the burden of supply chain businesses to provide consumers with smarter, quicker and more reliable last-mile deliveries. Businesses also accept the fact that having an Omni channel presence is a must to thrive in the future during the pandemic. At-home services also have been popular. At the same time, people's demand for clean, hygienic and white-glove home facilities has risen dramatically. Home service providers must not only increase the pace of their last-mile operations but also ensure that each job is completed professionally and to the highest possible quality standards. The use of artificial intelligence (AI) to optimize routes eliminates the need for human interference in despatch planning. This increases precision, lowers fuel costs and reduces preparation and delivery time. The AI-driven technology, especially SaaSbased logistic solutions, would be instrumental in optimizing the last-mile distribution operations across industries and geographies.

Market Study Report (2021) has studied with global autonomous last mile delivery market. People in remote areas also have difficulty obtaining everyday essential items due to widespread geography and severe weather conditions, making the process more complicated and expensive. The Covid-19 outbreak has created a number of new possibilities for drone delivery technology to flourish. To avoid human touch, drones have been used to carry facemasks to hospitals around the country. As a result, such factors are expected to support autonomous technology deployment in the last mile distribution phase. Yu and Rehman Khan (2021a) studied green agricultural product supply chain operations during Covid-19 era. Khan et al. (2021) studied the social sustainability implications in multi-tier supply chains. Yu and Khan, (2021b) studied green supply chain optimization process in uncertain situations.

Similarly, Unnikrishnan and Figliozzi (2020) have conducted a study on the impact of Covid-19 upon home delivery. For many customers, home delivery has provided a solution to some of the challenges of Covid -19. During Covid-19 lockout, people who are worried about their health are more likely to invest more money and make more home deliveries. Household income is an important factor to be considered when analyzing adjustments during the lockdown. The households which ordered more home deliveries prior to Covid-19 have a better chance of ordering more during the lockdown.

Viu-Roig and Alvarez-Palau (2020) have dealt with e-commerce which is related to last mile logistics. In recent years, e-commerce has experienced rapid growth, a development that would be compounded by the impact of Covid-19, which has resulted in an increase in the purchase of internet pack. Last-mile logistics can only grow in importance, resulting in an unavoidable shift in how today's urban operate. The aim of urban freight distribution is to deliver unique goods on time and in the correct manner while keeping costs down and providing excellent customer service. It also helps to reduce the expense of urban freight transportation by combining deliveries, eliminating stops and shortening distances.

The insights from the Bangalore Urban Mobility Transition (RMI India, 2020) for final-mile distribution include improving charging and swapping networks. Small and Medium Enterprise (SMEs) would serve as micro-hubs for storing electric vehicles and products, allowing them to be used for final-mile delivery. Connectivity at the first and last mile in high-density areas of the city promotes first-and last-mile connectivity. It is necessary to create and update policies and regulations to encourage the adoption of new first- and last-mile connectivity options. In Bangalore, the construction of first- and last-mile connectivity options is becoming increasingly necessary in order to sustain high levels of public transportation use.

Susan Meyer (2020) has studies the optimization of the last-mile delivery. Consumers' immediate reaction to the Covid-19 pandemic is panic purchasing and stockpiling necessary goods. The market for online retailing is expected to last well beyond Covid-19, and may even increase in comparison with the conventional retail model, with long-term implications for the overall retail supply chain. Instead of relying on humans, which takes a lot of time, effort, and results in costly errors for the brand, automated route planning tools allow the optimization of delivery scheduling by optimizing the service level and cost. The comprehensive route optimization software must provide a number of features in last mile delivery.

Gupta et al. (2020) have pointed out that the national lockdown has brought the challenges of reaching welfare recipients to the frontline. Agents' lack of sufficient remuneration and rewards have led to a great deal of inefficiency in the last-mile distribution of scheme benefits, including high business correspondent (BCs) turnover rates and instances where consumers are overcharged. It is suggested that the requirements for enrolling in welfare programs need to be relaxed. The government relax requirements for documentation standards are proposed for enrollment at the federal level and harmony programs through welfare programs.

Bauer et al. (2020) also have studied the last mile delivery. Covid-19 has changed a lot of things in the lives of human beings. Moving goods from one location to another has proved to be a more difficult logistical task than moving goods from one factory to another. The last mile accounts for about 40% of total logistic costs globally. This dynamic is a primary driver of migration to autonomous forms of transportation. The expected rise in delivery vehicles on the road would emit an additional six million tons of CO₂, placing additional pressure on the current carbon reduction goals. The level to which last-mile players would shift to more environmentally sustainable modes of transportation, like the use of micro mobility solutions in dense urban areas and the use of autonomous EVs in general, would be critical in mitigating this danger.

Rozycki and Kerr (2020) have examined the last mile delivery before and after the Covid-19. Autonomous Ground Vehicles (AGVs) are used only in a limited number of markets, often in closed environments and on public roads. Drone transport allows for on-demand and same-day delivery, as well as the ability to escape traffic jams, enhances medical delivery performance, reduces costs and improves the patient experience, all of which may save the lives of human beings. WakeMed's flagship hospital and campus in Raleigh has been hosting United Parcel Service's drone network. FedEx also has introduced the Same Day Bot, a robotic delivery vehicle. 'Scout,' Amazon's own AGV, also has been released. Customers would put more pressure on courier and postal systems as environmental awareness grows. In city centers, where millions of people live and work, Evs outperform the conventionally driven vehicles in terms of noise and air quality. Since they are easy to start, virtually silent, and smooth to drive, EVs can be more convenient for short-distance drivers.

Twinn et al. (2020) have noted that the Covid-19 pandemic has had a direct impact upon logistic companies that deal with the movement, storage and flow of goods. The pandemic has spread across the world, resulting in lockdowns and border closures that stifle trade. Additional procedures like social distancing at warehouses implemented to ensure workers' safety have led to freight bottlenecks. Some businesses have implemented new social distancing protocols in

warehouses, disinfected work environments or provided protective gear to protect their employees' wellbeing. Since the demand for critical goods is strong, warehouses and retailers are concentrating on grocery deliveries while companies in the last-mile segment are providing no-contact delivery options which include robots. The logistics industry has been undergoing a technological transformation. In the long run, robots, drones and autonomous vehicles can reduce the risk of labour shortages for logistic service providers.

Narashimman (2020) has pointed out that the last-mile delivery has been taken to new heights, thanks to the same-day delivery. Despite the fact that the same-day delivery is a rapidly expanding market, it mostly appeals to urban millennials. Due to the Covid-19 outbreak, the speed of distribution is now critical in almost every vertical. It is, in reality, one of the most important aspects of customer satisfaction. Due to the pandemic outbreak, the same-day delivery has become more of a requirement than a luxury. Customer preferences are changing, e-commerce adoption is accelerating, and urbanization is rising, both of which are driving the same-day delivery. In many ways, the same-day delivery has changed the way people think of last-mile delivery. Customer satisfaction is increased by faster delivery options like the same-day delivery. Developing quicker delivery solutions allows a company to fulfil customer needs while still distinguishing it from rivals.

Similarly, Hinzmann and Bogatzki (2020) have conducted a study on last mile delivery vehicles. To meet the demands of last-mile delivery and increasing customer standards, the last-mile needs an alternative mode of transportation. ADVs seem to be a good choice for last mile delivery to overcome the existing problems of the last mile and reduce customer frustration with parcel delivery. As a result, for the first time, the acceptance of autonomous delivery drones and autonomous delivery robots would be examined in the form of a technology acceptance model. The last mile is a consumer-focused industry with a strong behavioral dimension.

Patel and Parmar (2020) have studied amazon logistics during Covid-19 era. Customers are informed about the delivery within a day with last-mile delivery. Amazon has been unable to come up with a solution for the last-mile delivery which is both cost-effective and timely. The cost of providing last-mile services accounts for 41% of total supply chain costs, which is more than any other segment, including warehousing and parceling. Amazon, however, would have to spend billions in its distribution services. Electric-powered delivery trucks, drones, sidewalk robots and collaborations with third parties are among the investments that have seen varying degrees of success.

In the same way, Deloison et al. (2020) have analysed the future of last mile eco system. However, the labour costs in developing countries are likely to remain low enough to avoid any significant technological changes affecting the last mile in the next five to ten years. Many e-commerce companies and startups are now providing quicker delivery options, like the same-day delivery, due to improved fulfilment processes. Traditional online categories like books, apparel and appliances have fueled the growth of incumbent online retailers like Amazon, Walmart and Alibaba. Groceries and health items are still mostly purchased in stores, but online penetration has significantly increased. However, the same-day and the instant delivery are the fastest-growing segments in the last-mile environment, with annual growth rates of 36% and 17% respectively. With the help of camera based object tracking and machine-learning tools, automated vehicle loading systems, and advanced analytic based driver applications, several automotive original equipment manufacturer (OEM)s have been working on concepts that actively support the work of parcel drivers.

Bopage et al. (2019) have proposed a strategic model to improve the performance of last mile delivery in e-commerce parcel delivery. The cost per parcel in rural areas is extremely high. Retailers, LM service providers and customers are the main players in the last-mile logistics. The current growth and popularity of e-commerce also have an effect on many consumers' daily lives by offering a broader variety of options, more easily available information and ease of purchase. Retailers are under pressure to manage their stock and provide efficient distribution in terms of speed, price, service and quality as the online shopping and delivery markets expand as well as the rapid rise in the number of orders. The speed at which customers obtain their orders is a major factor in the success of e-commerce. The customers of e-commerce expect the same-day deliveries; thus, shorter delivery times must be given to ensure greater customer satisfaction.

Mishra and Balsara (2020) have pointed out that the Covid-19 related lockdown has brought everyday life to a halt and disrupted all the economic activities. The lockdown has slowed down people's movement, caused labour shortages, disrupted factory operations, forced non-essential commodity and food service providers to close their doors, sparked panic buying among customers for staples, and left retailers with stock-outs in a few categories. The Indian consumer

goods industry is in a state of flux. Due to the slow down in agriculture, liquidity crunch and employment challenges, the industry has been facing demand pressure, especially from rural consumers. The onset of the Covid-19 pandemic has intensified an increasingly difficult market climate. Consumers' shopping patterns would presume a much greater prevalence of e-commerce and home delivery. The future of consumer's digitalization would be years ahead of schedule. As a result, businesses that digitally transform their route to market and develop robust positive capabilities, including e-commerce, would win in the long run.

Jacobs et al. (2019) have pointed out that in the food and grocery industries, the last-mile delivery has become a primary customer expectation. Since grocery stores are as busy as public transportation during rush hour, 63% of customers shop online. As the popularity of online shopping grows, delivery would become increasingly necessary. Early adoption of new autonomous-delivery models in developed markets, as well as a compelling business case based on urban demand. Customers would be attracted to and retained by a great last-mile delivery service that delights them. As a value-added service, satisfied customers are willing to pay more for faster delivery. This provides a way for businesses to cover distribution costs.

Mangiaracina et al. (2019) have dealt with the efficiency of last mile delivery. e-commerce is a fast-growing phenomenon, with the global retail industry valued at more than € 2500 billion in 2018. Due to the difficult target service levels, small order dimensions, and high level of dispersion of destinations, the last-mile delivery is the least effective and most costly component of the delivery process. The cost can equate half of the overall logistic costs. Identifying the most creative ideas and comprehending how they can reduce the expense of last-mile distribution is important.

Lim and Srari (2018) have studied the last-mile distribution in e-commerce omni channel retailing. It requires difficult trade-offs among delivery responsiveness, product range, and convenience, as well as enterprise-wide data visibility. The construction of a logistic supply chain's last-mile is often the most costly section. Due to the continued growth of internet based transactions, the study is directly relevant to managerial practice.

Joerss et al. (2016) have pointed out that the parcel delivery is the future of last mile. Global parcel delivery costs, excluding pickup, line-haul and sorting, are estimated to be around € 70 billion. This means that in mature markets, volumes would double in ten years, hitting 5 billion and 25 billion parcels per year in Germany and the United States respectively. However, labour costs in developing countries are likely to remain low enough to avoid any significant technological change affecting the last mile in the next five to ten years. Many e-commerce companies and startups are now providing quicker delivery options like the same-day and instant deliveries due to improved fulfilment processes.

The development of project charter is the most important process in pursuing a delivery project (Ayers, 2003). The knowledge of advanced logistic and distribution is required because this area of knowledge assigns all the tasks in the project process. The performance of delivery project is measured based on on-time delivery, distribution cost minimization, and without damage to the product. Delivery projects are judged against one or more of these measures (Hughes et al., 2020). In addition to the wellbeing of the staff is a concern with the management as it is challenging to maintain the Covid-19 protocol of social distancing while at work. There is a delay in transportation due to the government regulations during Covid-19. Further, there is uncertainty of demand and period (Bushuyev et al. 2020). All these directly increase the cost of delivery projects (Muller and Klein 2020).

III. RESEARCH METHODOLOGY

Interpretive structural modelling (ISM) was developed by Warfield 1976. It is useful to analyse the interrelationships between the factors. The ISM approach has been extensively used in project management field (Hughes et al. 2016; Shrivastava and Singla 2020; Samantra et al. 2016). The ISM has been updated by Sushil (2012) as Total Interpretive Structural Modelling (TISM). The TISM provides the interpretations of the links, i.e., how factor-L is influencing factor-M. TISM is a theory building approach and it interprets both the nodes and the links. TISM approach is used by many researchers to solve complex problems in manufacturing and services sectors (Menon and Suresh 2019). The TISM approach has been extensively applied in project management field (Sandbhor and Botre 2014; Wuni and Shen 2019). The TISM has been used in analysing the supply chain operational performance and challenges (Bag 2016; Agarwal and Seth 2021; Mathivathanan et al. 2021). Also, the TISM has been used to analyzing Covid-19 challenges and impacts (Lakshmi Priyadarsini and Suresh 2020; Lakshmi Priyadarsini et al. 2020; Sreenivasan and Suresh 2021).

In this Study, TISM methodology is adopted to understand the interrelationship between the factors that influence the last mile delivery projects during Covid-19 era.

The list of factors that influence the last mile delivery projects during Covid-19 era have been identified from literature review and experts opinion. Initially, selected experts from the last mile delivery organizations are consulted to identify the major factors. The closed-ended questionnaire has been developed based on pairwise comparisons of the identified major factors. Then the scheduled interviews are conducted with managers, supervisors, and delivery executives in the last mile logistics organizations. Face-to-face meeting invitations are sent to 31 respondents in India. Finally, 20 respondents are interviewed based on their willingness and available time to participate in this study. Each interview has been scheduled for 50 min duration in which 10 min are spent for clarification of study and factors definitions and the rest 40 min are utilized to gathering information from the respondents.

The Fig. 1 shows the flow of detailed steps related to modelling for last mile delivery projects during the Covid-19 era using the TISM approach. The following steps are adopted (Vaishnavi et al. 2019b; Vaishnavi and Suresh 2020; Menon and Suresh 2021a) for the successful application of the TISM model:

- Identification of the factors: the major factors that influence the last mile delivery projects during Covid-19 era have been identified through expert opinion and literature review and depicted in Table 1.
- Initial Reachability Matrix (IRM): the contextual relationships between the pair of factors have been established in IRM (Sreelekshmi and Suresh 2021) and shown in Table 2. In this study, 20 responses have been collected and the respondents are managers, supervisors, and delivery executives in the last mile logistics organizations in India.
- Interpretation of relationship between factors: how factor-A influences factor-B (Patil and Suresh 2019).
- Developing the final reachability matrix (FRM): the FRM has been derived through transitivity check (Menon and Suresh 2021b) as shown in Table 3.
- Partition of the factors from FRM into levels (Suresh and Arun Ram Nathan 2020)
- Designing the interaction matrix: the significant transitive links are identified through expert opinions and direct links are depicted in Table 4.
- Creating the digraph and the TISM model: it is created by using level partitions and interaction matrix (Suresh and Abhishek 2021). The TISM model is shown in Fig. 2. In addition, the reasons behind the direct and the significant transitive links are presented.

IV. THEORETICAL AND PRACTICAL IMPLICATIONS

In this study, develops conceptual framework using theory building approach like TISM. It has been used to develop a theoretical framework, through the principles established in the current literature and experts opinion (Corbin and Strauss 1990). TISM answer the following key questions of what, 'how', and 'why' (Vaishnavi et al. 2019a). The identified major factors related to last mile delivery projects during Covid-19 era answers answer 'what'. The interrelationship between the pair of factors answers 'how'. The interpretation of pair of factors provides the causality to answer 'why' (Sushil 2012). Dubey et al. (2015) and Dubey et al. (2017) have developed theoretical frameworks for sustainable manufacturing and green supply chain networks respectively by using TISM to answer the of 'what', 'how' and 'why' questions.

The key factors influencing the last mile delivery projects during Covid-19 era are meeting fulfilment timeline, types of goods, achieving routing efficiency. Using the findings of TISM model often makes better the possibility of more effective use of capital to balance key factors, rather than attempting to do the same through simplistic reasoning. The results would help the management to prioritize its activity so as to streamline its project execution during Covid-19 era. The present research has delved deep into the repercussions of the last mile delivery projects during pandemic on the cash flow, availability of delivery staff, movement of products, contractual obligations being infringed, transportation bottlenecks and degradation of perishable products. This gives a clear picture to the management as to which areas need to be addressed as to maximize the performance of delivery projects. This model would help the management to decide areas where immediate resumption of work is viable in terms of minimum disruption due to the

various factors that can slow down delivery. It gives a clear picture to the management about the important precautions that they need to look into like establishing a steady flow of staff reserves to keep the projects up and going.

V. CONCLUSION

The current study has identified the major factors that would help the management understand the implications of the last-mile delivery projects during Covid-19 era. The factors such as meeting the fulfilment timeline, types of goods and achieving routing efficiency have higher driving potential than the other factors. This paper has used the TISM approach to identify the factors and developed a model that leads to the successful understanding of the factors influencing the last mile delivery projects during the Covid-19 era. The proposed model would definitely improve the performance of the last mile delivery projects and would also help in attaining the goals of both delivery team and logistic organisations. The key factors identified are to support e-commerce and online businesses for the successful implementation of change. The pandemic has resulted in an increase in online purchase and products are delivered at customers' location/home. To cater to the changing delivery needs and delivery mode due to the Covid-19 pandemic disruptions, last mile logistic organizations need to formulate clear and well-defined cloud based planning and optimising processes that would serve as a roadmap for their organizations. The post-Covid-19 e-commerce projects may see integrated growth in new technological tools and applications and a parallel increase in the demand for last mile delivery capabilities. This helps in enriching the process along with solving many pain points faced by the last mile delivery person and the customer based on the factors presented.

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