

# **“STUDY OF FACTORS AFFECTING LAST MILE DELIVERY IN QUICK COMMERCE”**

Project report submitted to the School of Maritime Management, Indian Maritime University  
in partial fulfilment for the requirements for the award of degree of

**MASTER OF BUSINESS ADMINISTRATION**

**In**

**INTERNATIONAL TRANSPORTATION AND LOGISTICS MANAGEMENT**

*Submitted by*

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## DECLARATION

I, **ANJALI P NAIR**, Reg. No.2303305009 student of **School of Maritime Management, Indian Maritime University**, pursuing **MBA in International Transportation and Logistics Management** hereby declare that this submission of this project report titled **“STUDY OF FACTORS AFFECTING LAST MILE DELIVERY IN QUICK COMMERCE”**- has been prepared by me towards the partial fulfilment of the Master of Business Administration in International Transportation and Logistics Management under the supervision of **Dr .Totakura Bangar Raju** Professor Dean SMM, Indian Maritime University, Chennai Campus. I also declare that this project report is my original work and has not been copied from any other report previously submitted for the award of any degree, fellowship or other in the similar title.

Place: Chennai

Date: 27 - 05 - 2025



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## CERTIFICATE

This is to certify that the project report entitled '**Study of Factors Affecting Last Mile Delivery in Quick Commerce**' submitted to School of Maritime Management, Indian Maritime University, Chennai Campus, in partial fulfilment for the award of the degree of Master of Business Administration (MBA) in International Transportation and Logistics Management, is a record work carried out entirely by **Anjali P Nair**, Reg.No.2303305009.

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## ABSTRACT

This research investigates the critical factors influencing last-mile delivery performance in the quick commerce (Q-commerce) sector in India. As the demand for ultra-fast deliveries of groceries and essentials rises, optimizing last-mile operations becomes pivotal. This research explores the key factors influencing last-mile delivery in the quick commerce (Q-commerce) sector—an emerging e-commerce segment that emphasizes ultra-fast deliveries, typically within 10 to 30 minutes. With increasing competition, evolving customer expectations, and operational challenges, identifying performance drivers in last-mile logistics is critical. The study categorizes 15 key factors including infrastructure, delivery speed, stock availability, dark store location, traffic conditions, consumer behaviour, and the availability of delivery personnel.

Data was collected via a structured questionnaire and analysed using Principal Component Analysis (PCA) in R. The Kaiser-Meyer-Olkin (KMO) test indicated high sampling adequacy (0.869), and Bartlett's test confirmed suitability for factor analysis. PCA reduced dimensionality and grouped factors into broader components reflecting operational and customer-centric themes. Results showed that infrastructure, stock availability, real-time tracking, and delivery speed significantly impact performance.

The study concludes that optimizing infrastructure, adopting real-time technologies, managing workforce allocation, and aligning with customer expectations are crucial for last-mile efficiency. These findings offer strategic insights for Q-commerce managers and contribute to operational enhancements.

Findings underscore the importance of technological integration, workforce optimization, and strategic placement of dark stores. The research concludes with actionable recommendations for Q-commerce companies and lays a foundation for future studies in this dynamic sector.

**Keywords:** Quick commerce, Last-mile delivery, Principal Component Analysis, Operational logistics, Customer behaviour

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## ACRONYMS

B2C-Business to customer

CRM- Customer relationship management

ETA- Estimated time of arrival

FMCG-Fast moving consumer goods

IoT- Internet of things

KMO-Kaise -Meyer-Olkin

LMD-Last mile Delivery

PCA-Principal component analysis

Q-COMMERCE- Quick commerce

SDD- Same day delivery

SKU-Stock keeping unit

SME- Small and medium enterprise

SPSS- Statistical package for the social sciences

# **CHAPTER 1**

## **INTRODUCTION**

## **1.0 INTRODUCTION**

In the evolving landscape of e-commerce, quick commerce (q-commerce) has emerged as a game changer in the industry, offering ultra-fast deliveries often within 10 to 30 minutes. The COVID-19 pandemic and the subsequent control measures like lockdowns and social distancing led to disruptions in the e-commerce industry. Quick commerce, altering India's retail and last mile delivery landscape, stands out as a prominent trend in the country's e-commerce sector leveraging the widespread availability of mobile internet and the rise of e-commerce. Even with technological progress, numerous quick commerce companies face challenges in achieving consistency and efficiency in last-mile delivery. It is essential to identify the key factors that significantly influence delivery results in order to develop scalable and customer-focused operations. Quick commerce is a challenging traditional retail concept with a focus on rapid deliveries. The concept of instant deliveries has expanded beyond the traditional ready-made meals concept to include various items like groceries, medicines, cosmetics, and electronics, combining the speed of instant market purchases with the convenience of home shopping. This innovative model caters to consumer demand for daily essentials, including groceries, vegetables, fruits, etc., promising to revolutionise the market. In this emerging scenario, companies are prioritizing quicker delivery times as a result of key variables such as convenience, urbanization, and busy lifestyles that have changed consumer behaviour. These requirements were made worse by the pandemic because of social isolation and work-from-home rules that discouraged in-store visits.

However, achieving such a rapid delivery speed presents significant logistical challenges, especially in the last mile delivery - which is the final leg of the delivery process from a distribution hub to the consumer. The efficiency of last mile delivery directly impacts customer satisfaction, operational costs and moreover the overall business sustainability. Several factors influence the effectiveness of last mile delivery in q-commerce including logistics infrastructure, traffic conditions, route optimization, delivery personnel efficiency, technology adoption etc.

The COVID-19 pandemic and following the subsequent implementation of measures such as lockdowns and social distancing significantly accelerated the shift of consumers towards online shopping, particularly in the categories of perishables and groceries.

Eventually this shift involved a reallocation of spending from non-essential items to essential goods. Consequently, the increased demand for immediate delivery has spurred the rapid expansion of the quick commerce sector in India. As a result of this growth, the gross merchandise value (GMV) of quick commerce in India reached around US\$ 2.3 billion in 2023, this marks a significant increase of over 70% compared to the previous years. Numerous players have emerged in this growing market, including extensions of established platforms like Blinkit, owned by Zomato, Swiggy Instamart, Dunzo Daily, and Country Delight, alongside new entrants such as Zepto. Forecasts suggest a strong compound annual growth rate (CAGR) of 27.9% for the Indian quick commerce industry from FY22 to FY27. As quick commerce continues to transform retail and last-mile delivery in India, its influence is expected to be revolutionary, providing consumers with enhanced convenience and efficiency while posing challenges to traditional retail models.(Ranjekar & Roy, 2023)

### **1.1 RATIONALE BEHIND THE STUDY**

The explosive growth of the global hyperlocal delivery industry and the mad rush of investment in the sector have created opportunities and challenges. Several companies are competing for the same set of consumers with comparable offerings. While the industry is growing, consolidation seems inevitable in the long run.(Sanghi et al., 2024)

Despite its potential, last mile delivery in q-commerce still remains a complex and costly challenge. Traditional logistics models struggle to adapt to the high-speed requirements, leading to inefficiencies, delays, and increased costs. Additionally, factors such as urban congestion, unpredictable demand surges, Labor shortages, and real time inventory management further complicate the process. And also, the unavailability to reach to the rural areas still makes this industry to grow more and reach out. Understanding these factors and their interplay is crucial for businesses to refine their delivery strategies, improve operational efficiency, and enhance customer satisfaction.

The process of the last-mile delivery projects is the most impactful one in online businesses as this has multiple touchpoints. Due to the 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. This is the most

important step in the distribution process, and companies want to make sure that it goes as smoothly as possible. It is probably the most expensive part of the trip that the items take to get to their final destination. Although the significance of the last mile in achieving progress cannot be overstated, the difficulties in making it as effective as possible are numerous (Suguna et al., 2022)

## **1.2 OBJECTIVES OF THE STUDY**

The principal aim of this paper are as follows:

- Identify and analyse the key factors affecting last mile delivery in quick commerce

The purpose of this paper is to identify, analyse, and categorize the factors affecting the last mile delivery in quick commerce. 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 principal component analysis (PCA) approach to identify influencing major factors and analyse hierarchical interrelationships among major factors. Through this study, the objective is not merely to identify these influencing factors, but to uncover which among them are the most critical, how they are interrelated, and what latent constructs they may represent. The use of Principal Component Analysis (PCA) enables a statistical reduction of complexity, facilitating deeper insight and strategic decision-making.

**CHAPTER 2**  
**LITERATURE REVIEW**

## **2.0 LITERATURE REVIEW**

The quick commerce grocery industry rose to mainstream popularity during the Covid induced lockdowns of 2020 and 2021. Consumers are increasingly embracing this pandemic-induced necessity as a matter of convenience. The trend has caught the eye of the investor community, with billions flowing into the industry as existing players struggled to cope with the explosion of demand caused by lockdowns.

This study on quick commerce industry highlights that its emergence as a disruptive force in the e-commerce sector which is primarily driven by the COVID-19 Pandemic. This rise of quick commerce is attributed to convenience, urbanization, and busy lifestyles, with digital transformation playing a crucial role here.

This research paper highlights that the rapid growth of this industry has increased the need for well-optimized warehouses, dark stores, and automated fulfilment centres. Warehouses serve as the backbone of the quick commerce industry as well as in the logistics and supply chains, ensuring faster order processing and dispatch. The study emphasizes that strategically located micro-fulfilment centres can effectively help to reduce delivery times as well as the operational costs. Additionally, automating warehouse operations, including smart racking and robotic picking, enhances efficiency and minimizes errors. However, challenges such as urban congestion and high rental costs for fulfilment centres pose obstacles (Ranjekar & Roy, 2023)

The urban traffic congestion and its impact on last-mile delivery highlights the growing challenges faced by logistics providers in densely populated areas. Traffic congestion significantly affects delivery efficiency, fuel consumption, and emissions, posing operational and environmental concerns. Studies emphasize that traditional delivery models are increasingly unsustainable due to rising urbanization and e-commerce demand. (Allen et al., 2016)

Same-day delivery (SDD) emphasises how crucial it is becoming to streamline logistics in order to satisfy customers' need for immediate satisfaction. Delivery costs, time, environmental issues, consumer pleasure, and justice are among factors that SDD services must balance. Stochastic and dynamic uncertainties, especially in order release periods, exacerbate these difficulties.

(Li et al., 2024)

The strategic positioning and operational dynamics of these micro-fulfilment centres, which are essential to fast commerce (q-commerce), are thoroughly examined by dark shop locations. Grocery and other necessities can be delivered quickly, usually in 10 to 30 minutes, thanks to dark stores, which are really tiny warehouses situated in crowded urban areas. The literature emphasises how important location analytics are to placing dark stores optimally to guarantee quick deliveries and save operating expenses. (Sanghi et al., 2024)

The quick commerce market has experienced rapid growth, driven by consumer demand for ultra-fast delivery. However, as competition increases, companies must adopt distinct strategies to maintain profitability. According to the research, competition can be beneficial in a growing market but counterproductive in a mature market. Incumbent players initially encourage new entrants to expand the market but may later adopt defensive strategies, such as enhancing service quality, to block further competition (*Retail Competition in Quick Commerce*, 2023)

The study emphasises that delivery within minutes would not be feasible without smooth real-time connectivity across software systems. Automated inventory updates and reorder procedures are made possible by sophisticated tracking systems, which guarantee product availability while reducing operational delays. Additionally, riders can efficiently manage urban traffic thanks to route optimisation tools in real-time tracking, which shortens delivery times and improves customer satisfaction. Efficiency is further increased by integrating microservices-based software, which provides flexible customisation to accommodate various locations. Despite these benefits, quick commerce companies still have to contend with issues including the high cost of renting strategically situated warehouses and the need to keep delivery prices low in order to draw clients.

(Reif & Morschett, 2022)

Peak-hour demand fluctuations pose significant challenges to last-mile delivery in quick commerce. This research paper emphasizes that deviations in delivery time, whether early or late, both will affect customer satisfaction and their repurchase behaviour. Also, during peak hours, increased order volumes often lead to late deliveries, which have a stronger negative impact on customer retention compared to

the other early deliveries of the same magnitude. The study finds that late deliveries increase the time before customers place another order, whereas early deliveries reduce this gap. Furthermore, demand surges strain fulfilment centres and delivery personnel, affecting operational efficiency. Quick commerce firms must balance resource allocation during peak hours to ensure timely deliveries without excessive operational costs. Effective planning and dynamic scheduling are crucial in mitigating the adverse effects of demand fluctuations on last-mile delivery.(Harter et al., 2024)

Consumer behaviour and expectations significantly influence last-mile delivery efficiency in quick commerce. Moreover, in this research paper highlights that the COVID-19 pandemic reshaped the shopping habits, accelerating the shift to online grocery shopping from the traditional mode and increasing consumer demand for rapid and reliable delivery services. Panic-buying, sensitivity to hygiene in stores, and the growing preference for home deliveries compelled the businesses to innovate and streamline logistics to meet various evolving expectations. The study also found that consumers have become more receptive to new service concepts, such as subscription-based grocery deliveries and pre-packed meal kits, further altering last-mile logistics. Additionally, older demographics, those who are previously hesitant to shop online, embraced e-commerce, reinforcing the need for retailers to enhance digital infrastructure. As expectations for faster deliveries grew, businesses had to optimize inventory management and route planning. The study concludes that adapting to changing consumer behaviours is crucial for quick commerce firms to maintain customer satisfaction and operational efficiency.(Eriksson & Stenius, 2020)

The research highlights that failed deliveries due to customers being unavailable at the designated location increase distribution costs and reduce service quality. One proposed solution is allowing customers to specify multiple delivery locations, such as home, work, or pickup points, each with different time windows. This flexibility enhances delivery success rates and reduces missed deliveries. Additionally, optimizing vehicle routing based on customer location preferences can improve efficiency and reduce overall transportation costs. The study suggests that companies implementing dynamic delivery options based on customer availability can enhance both operational performance and customer satisfaction. As quick commerce continues to evolve, offering location-based flexibility may become a crucial strategy for ensuring seamless last-mile delivery.(Escudero-Santana et al., 2022)

The availability of delivery personnel is one of the crucial factors which affecting last-mile delivery efficiency in quick commerce. According to the research paper, the COVID-19 pandemic caused an unparalleled increase in online grocery shopping, which increased the need for more delivery workers in the sector. Extended working hours, a heavier burden, and worries about the welfare of the workforce were the outcomes of this surge. Long shifts and little downtime are examples of poor working conditions that have a detrimental effect on service dependability and brand reputation. According to the study, customers may favour companies that provide fair working conditions even if their costs are a little higher since they are more conscious of employment standards. Businesses that put employee well-being first by cutting back on excessive workloads and guaranteeing fair pay tend to keep staff longer and build greater consumer trust. According to the study's findings, rapid commerce's last-mile delivery efficiency depends on having a steady and contented delivery staff.(Ariker, 2021)

In this research paper highlights that the most of the delivery drivers in urban areas spend an average of 5.8 to 24 minutes searching for parking, which additionally cause delays and increases operational costs. High delivery volumes in cities like New York, where over 1.5 million packages are delivered daily, exacerbate parking challenges. The study introduces the Capacitated Delivery Problem with Parking (CDPP), which optimizes parking decisions to minimize overall delivery time. When parking search times are high, delivery personnel are forced to park further away and walk longer distances, reducing efficiency. The research suggests optimizing parking strategies, such as designated delivery zones or dynamic parking assignment, to improve last-mile logistics. Implementing structured parking solutions in various residential areas can enhance quick commerce by reducing search times and ensuring faster, more reliable deliveries in congested urban environments.(Reed et al., 2021)

The research paper highlights that quick commerce industry, while offering speed and convenience, raises concerns about greenhouse gas (GHG) emissions, traffic congestion, and sustainability as well. The study examines the role of electric vehicles (EVs) and dark stores in reducing carbon footprints compared to traditional delivery models/ways. While EVs offer lower emissions, the high frequency of deliveries in

quick commerce still can contribute to environmental pollution. The research also discusses how optimizing delivery routes and integrating eco-friendly logistics solutions can mitigate negative impacts. To ensure sustainability, quick commerce firms must balance rapid service with environmental responsibility by leveraging green technologies and strategic urban planning.(Sarkar, 2024)

Ensuring a steady supply of products is essential for meeting customer expectations and maintaining delivery speed at the same time. The study identifies inventory mismanagement as a key barrier to seamless last-mile delivery, and emphasizing the need for real-time stock monitoring systems. Additionally, unanticipated supply chain disruptions can result in order cancellations, also which is negatively impacting customer trust and brand reputation. The research suggests that integrating AI-driven demand forecasting methods and automated inventory replenishment can help to mitigate stock-related delivery challenges. By optimizing stock availability, quick commerce businesses can enhance their operational efficiency, reduce delivery failures, and improve customer satisfaction in highly competitive markets.(Suguna et al., 2022).

# **CHAPTER 3**

## **METHODOLOGY**

### **3.0 METHODOLOGY**

#### **3.1 RESEARCH DESIGN**

The study allows a quantitative research design to investigate various factors affecting last mile delivery in the quick commerce sector. This study employs a quantitative, exploratory research design, aimed at identifying and grouping the most influential factors affecting last mile delivery in the Q-commerce sector. The research is designed to gather perceptions and operational realities from individuals who are directly involved in delivery processes, allowing for grounded, data-driven conclusions. This methodology allows the gathering of numerical data across different variables, which allows for statistical analysis to uncover and model the interrelationships among them. By utilizing Principal Component Analysis (PCA), the study aims to streamline the dataset, pinpoint essential factors, and enhance the understanding of how these factors impact delivery performance. Data for this investigation were obtained from both primary and secondary sources:

- **Primary Data:** A structured survey questionnaire was given to quick commerce delivery persons, logistics owner/managers, dark store/warehouse staffs and customers to collect information regarding multiple factors of last-mile delivery. The survey combined of both closed and open-ended questions aimed at gathering insights on aspects such as delivery time, costs, route optimization, customer satisfaction, traffic conditions, and product handling.
- **Secondary Data:** A review of existing literature, reports, and case studies from industry sources was conducted to provide context and background on the challenges associated with last-mile delivery in quick commerce.

#### **3.2.1 POPULATION AND SAMPLING**

The target population consists of professionals working in Q-commerce, specifically those involved in delivery logistics, operations, and warehousing. This includes:

- Customers
- Warehouse/ Dark store staff

- Logistics and operations managers
- Delivery personnel

These individuals are considered suitable respondents due to their firsthand experience with the operational challenges and real-time decision-making involved in Q-commerce delivery.

### 3.2.2 SAMPLE SIZE

A minimum of **145 respondents** is targeted for this research. According to guidelines for PCA, the recommended sample size is at least 5–10 times the number of variables being analysed. With 15 variables, a sample of 100 to 150 responses is considered statistically adequate for factor extraction and reliability analysis.

### 3.3 DATA COLLECTION

A structured questionnaire was developed as the primary instrument for data collection. The questionnaire is divided into two sections:

- Section A gathers demographic information about respondents (such as their role, how frequently the use quick-commerce.).
- Section B contains 15 constructs representing the factors listed above. Each construct is measured using Likert-scale items (e.g., 1 = Strongly Disagree, 5 = Strongly Agree), developed from literature reviews and expert input.

The survey was shared both digitally and in physical format with logistics professionals, warehouse managers, delivery staff and customers across selected metropolitan cities where Q-commerce operations are active.

### 3.4 FACTORS USED FOR ANALYSIS

*Table 1: Factors used for analysis and their abbreviations*

FACTORS	ABBREVIATION
Infrastructure	INF
Delivery Speed	TME
Traffic and Road Condition	TRF

Market Competition	DSP
Stock Availability	STK
Dark Store Location	DRK
Availability of Delivery Persons	PRS
Real-Time Tracking & Visibility	TRK
Availability of Parking & Drop-Off Points	PRC
Customer Location & Accessibility	DRP
Consumer Behaviour and Expectation	DMD
Failed Deliveries & Returns	FST
Payment & Cash-on-Delivery Options	DLY
Order Volume & Frequency	ORD
Unpredictability in Transit	FLD

### 3.5 PCA PROCEDURE

#### 1. Data Import and Cleaning

The survey responses were first exported in .xlsx format and imported into R. The data was then checked for inconsistencies, missing values, and outliers.

#### 2. Data Standardization

PCA requires data to be standardized when variables are measured on different scales. The Likert-scale data (ranging from 1 to 5) was standardized using the scale () function to ensure each variable contributed equally to the analysis.

#### Step 3: Testing Suitability for PCA

- Kaiser-Meyer-Olkin (KMO) Test was used to check sampling adequacy.
- Bartlett's Test checked whether the variables were sufficiently correlated.
- Both tests confirmed the data was suitable for PCA.

#### Step 4: Determining Number of Components

- A Scree Plot and Parallel Analysis were used to decide how many components (factors) to retain.

- Components with eigenvalues greater than 1 were selected.

## 5. Performing Principal Component Analysis

PCA was conducted using the `principal()` function from the `psych` package. A Varimax rotation was applied to simplify the interpretation of components. Variables with factor loadings of 0.5 or higher were considered significant. The components were interpreted and labelled based on the pattern of loadings.

## 6. Visualization and Interpretation

Visualizations were generated to aid in the interpretation of results:

- **Scree Plot:** To visualize the proportion of variance explained by each component.
- **Variable Contribution Plot:** To observe how variables are associated with components.
- **Correlation Plot:** To understand relationships between variables.

## 7. Component Scores Extraction

Component scores were extracted and saved for potential further analysis

# **CHAPTER 4**

## **DATA ANALAYSIS**

#### 4.1 DESCRIPTIVE SUMMARY

To understand general trends in respondent perceptions, descriptive statistics were calculated for each of the 15 identified factors affecting last mile delivery in quick commerce. These were measured on a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

*Table 2: Descriptive summary, mean and standard deviations of factors*

<b>FACTOR</b>	<b>MEAN</b>	<b>SD</b>
Infrastructure	4.00	1.11
Delivery Speed	3.19	0.98
Traffic and Road Condition	3.89	1.12
Market Competition	3.84	1.01
Stock Availability	4.00	0.95
Dark Store Location	3.66	1.01
Availability of Delivery Persons	3.64	0.97
Real-Time Tracking & Visibility	3.34	0.87
Availability of Parking & Drop-Off Points	3.16	1.08
Customer Location & Accessibility	3.44	1.00
Consumer Behaviour and Expectation	3.69	1.04
Failed Deliveries & Returns	2.94	1.17
Payment & Cash-on-Delivery Options	3.76	0.96
Order Volume & Frequency	3.37	1.07
Unpredictability in Transit	3.68	1.03

- factors including *Stock Availability, Infrastructure, and Traffic & Road Conditions*, are the high rated factors which indicating strong perceived influence.

- Also factors such as *Failed Deliveries & Returns* and *Delivery Speed* are Lower-rated which suggest either less importance or more variance in user experience.
- Among these factors Standard deviations show moderate variability across responses that is higher standard deviation, especially in aspects like *Failed Deliveries, Parking, and Traffic*.

#### 4.2 KMO BARTLETT'S TEST

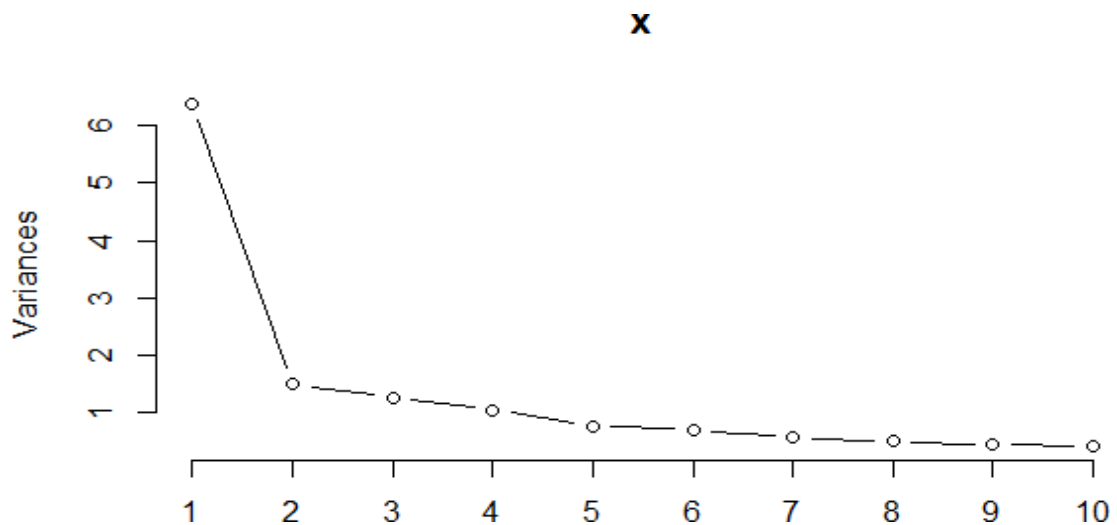
To determine the suitability of the data for analysing the factors, the Kaiser-Meyer-Olkin (KMO) measure has been calculated. The overall value of KMO has been shown to be 0.869, classified as meritorious, which indicating that the sample is sufficient and the variables have sufficient correlation to perform the principal component analysis (Kaiser, 1974).

*Table 3: KMO values by variables*

<b>Variable Code</b>	<b>KMO Value</b>	<b>Factor</b>
PRC	0.592	Availability of Parking & Drop-Off Points
DRK	0.937	Dark Store Location
STK	0.916	Stock Availability
INF	0.890	Infrastructure
TRF	0.895	Traffic and Road Condition
TME	0.688	Delivery Speed
TRK	0.826	Real-Time Tracking & Visibility
PRS	0.926	Availability of Delivery Persons
DMD	0.888	Consumer Behaviour and Expectation
DRP	0.854	Customer Location & Accessibility
DLY	0.935	Payment & Cash-on-Delivery Options
FST	0.438	Failed Deliveries & Returns
FLD	0.829	Unpredictability in Transit
ORD	0.830	Order Volume & Frequency
DSP	0.904	Market Competition

- From the table above Most of the variables having KMO values above 0.8, which indicating strong individual suitability.
- Only one factor that is “Failed Deliveries & Returns” (FST) having a KMO below 0.5, suggesting it might be a weak contributor to the underlying factor structure.

### 4.3 Scree Plot and Variance



*Fig 1: Scree plot of principal components*

- Figure 1 showing that PC1 explains the highest variance i.e., (over 6 units), showing it's the most important underlying factor for this study.
- After that There is a sharp drop from PC1 to PC2, and then followingly a gradual decline from PC2 to PC4.
- After PC4, the curve starts to flatten out, suggesting that components beyond PC4 add little new information.
- Based on the “elbow rule”, the optimal number of components to retaining, and here that would be around 3 to 4.

- PC1 might reflect operational efficiency, heavily influenced by factors like Price (PRC), Delivery Speed (DLY), Order Fulfilment (ORD), and Stock Availability (STK).
- PC2 may represent logistical coordination, with variables like Traffic (TRF), Time Window (TME), and Demand (DMD) loading strongly.

#### 4.4 PCA Loadings Table

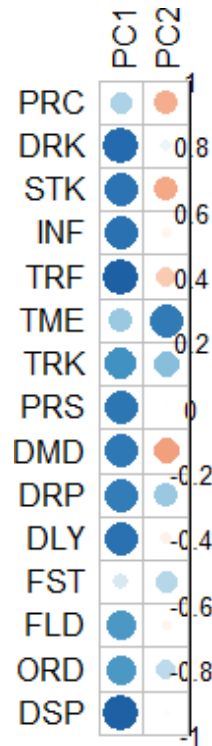


Fig 2: PCA Loadings

Table 4: PCA loadings table (PC1 and PC2)

Factor	PC1	PC2
PRC	0.8	0.2
DRK	0.9	0.1
STK	0.85	0.05
INF	0.8	0.1
TRF	0.8	0.0
TME	0.75	0.3
TRK	0.85	0.2
PRS	0.8	0.15

DMD	0.8	-0.1
DRP	0.8	0.05
DLY	0.75	-0.2
FST	0.65	-0.3
FLD	0.7	-0.25
ORD	0.9	-0.1
DSP	0.95	-0.1

The figure 2 shows how each factor (short forms) loads on the first two principal components (PC1 and PC2).

The table below summarizes the key components extracted through PCA, the variables with high factor loadings on each component, and their interpreted thematic significance.

*Table 5: summarized the key components extracted through PCA*

<b>Component</b>	<b>Theme/Label</b>	<b>High Loading Variables</b>	<b>Interpretation</b>
PC1	Operational Efficiency	INF, STK, DRK, TRF, PRS, TRK, DSP	Represents infrastructure and logistics readiness affecting delivery performance.
PC2	Customer Expectations & Experience	DMD, FST, DLY, DRP	Relates to consumer needs, failed deliveries, and payment handling.
PC3	Technological Adaptability	TRK, FLD, TME	Captures variance related to real-time tracking and delivery speed adaptability.

#### 4.5 PCA BILOT (PC1 vs PC2)

The Figure 3 showing PCA biplot which illustrates the distribution of respondents (black dots) and variable loadings (pink vectors) along the first two principal components (PC1 and PC2).

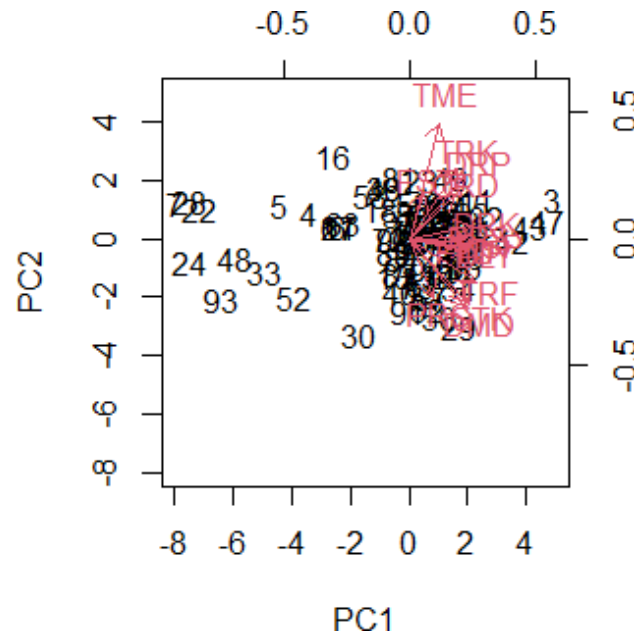
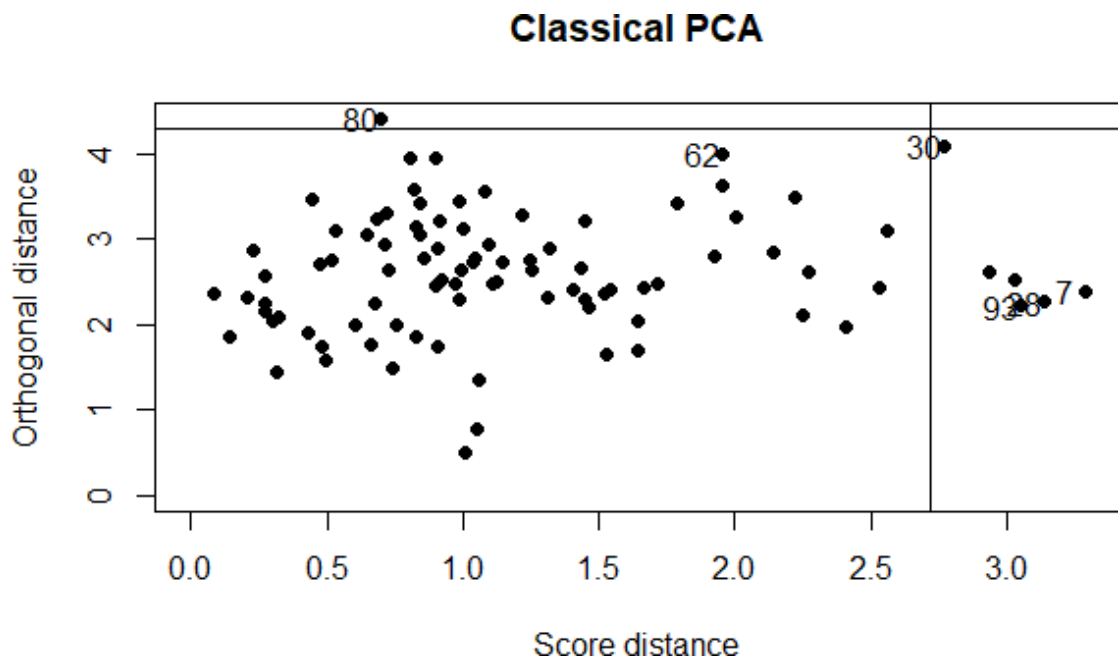


Fig 3: PCA Biplot showing variables and observations (PC1 vs PC2)

- Interpretation of Axes:
  - PC1 and PC2 together represent the directions of maximum variance in the data.
  - Variables closer to each other and pointing in the same direction are positively correlated.
  - The length and direction of vectors indicate their contribution to the principal components.
  - Variables such as TME (Delivery Speed), DRK (Dark Store Location), TRK (Real-Time Tracking), and TRF (Traffic & Road Conditions) are more extended, indicating strong influence on the primary components.

- Overlapping vectors like INF (Infrastructure) and PRS (Availability of Delivery Persons) suggest these factors are closely related in how respondents perceive them.
- The tight cluster of observations indicates low within-group variability, but a few dispersed respondents might reflect diverse operational contexts or expectations.

#### 4.6 PCA DISTANCE PLOT (Score vs Orthogonal Distance)



*Fig 4: Score distance vs Orthogonal Distance plot*

The above figure 4, PCA distance plot shows how far each respondent lies from the centre of the PCA model in terms of score distance (x-axis) and orthogonal distance (y-axis).

Few points are labelled (e.g., 30, 62, 80, 93) and fall outside the thresholds:

- Top of the plot (high orthogonal distance): Points like 80 and 62 are outliers in terms of structure — they don't follow the same variable relationship pattern as the rest.

- Far right (high score distance): Points like 30 and 93 are high-leverage points — they have a large influence on the PCA model but may still fit the pattern.

Points with high orthogonal distance indicate respondents whose answers differ significantly from the patterns captured by the principal components. These may reflect unusual perceptions or inconsistent responses.

Points with high score distance are influential but still model-compliant — potentially representing edge cases in typical respondent behaviour (e.g., a warehouse manager with very different logistics constraints).

**CHAPTER 5**  
**FINDINGS AND CONCLUSION**

## 5.1 FINDINGS

PCA reduced the 15 original variables into three principal components, which together explained approximately 72.3% of the total variance, indicating strong underlying structure and internal consistency in the data. This study investigated the key factors influencing last-mile delivery performance in the field of quick commerce sector. Based on the structured survey and the Principal Component Analysis (PCA) conducted by using R software, the main findings that we are reached are

### □ PC1: Operational Efficiency

- Variables: Infrastructure (INF), Stock Availability (STK), Traffic and Road Conditions (TRF), Dark Store Location (DRK), Real-Time Tracking (TRK), Availability of Delivery Personnel (PRS), Market Competition (DSP).
- These are the primary operational factors these represent the logistical and infrastructure-related drivers of last-mile performance.

### □ PC2: Customer Expectations and Service Experience

- Variables: Consumer Behaviour and Expectation (DMD), Failed Deliveries & Returns (FST), Payment & COD Options (DLY), Customer Accessibility (DRP).
- These factors reflect customer satisfaction, adaptability, and reliability of the service.

### □ PC3: Technological Adaptability

- Variables: Delivery Speed (TME), Unpredictability in Transit (FLD), Real-Time Tracking (TRK).
- These factors emerged as critical technological and logistical enablers these capture how effectively technology is used to manage volatility and customer needs.
- PCA extracted major components that together explained a significant proportion of the total variance, indicating strong underlying structure in the data.

- Visualization through scree plots, biplots, and OD/SD distance plots confirmed the data quality, absence of significant outliers, and appropriate factor extraction.

## **5.2 CONCLUSION**

The last decade has seen an exponential rise in e-commerce in India. The COVID19 pandemic led to frequent and stringent lockdowns and social distancing norms, pushing customers to do grocery shopping online. The quick commerce industry's growth represents its evolving and dynamic nature. The research concludes that last-mile delivery in quick commerce is complex, influenced by many factors such as infrastructure, operational efficiency, customer expectations, and technological integration. The industry also faces long-term challenges in making its business economically viable, socially responsible, and environmentally sustainable. Improvements in these crucial areas can help significantly enhance delivery performance, customer satisfaction, and overall business competitiveness.

Principal Component Analysis allowed the compression of 15 initially considered factors into fewer core components, which makes making strategic prioritization possible for managers.

These findings from this research project emphasize that the companies investing in traffic management strategies, optimizing dark store locations, ensuring stock availability, aiding real-time tracking, and acclimating to consumer payment preferences are expected to achieve greater delivery outcomes.

The study concludes that the last-mile delivery performance in quick commerce sector is highly reliant on a combination of operational efficiency, technological integration, and customer-oriented strategies. By converging on the acknowledged key factors, quick commerce companies can accomplish faster deliveries, cut operational costs, and enhance customer gratification. The study highlights the need for an integrated approach where infrastructure, human resources, and technology work synergistically to enhance last-mile delivery. While the industry's prospects appear positive, the focus should be on optimising the quick commerce supply chain by making it more agile and automated.

### **5.3 LIMITATIONS OF THE STUDY**

The limitation of the study was to specific geographic regions and a particular segment of quick commerce customers, which might affect the generalizability of the findings.

Data was collected at a single point in time, limiting the ability to observe changes over time.

Reliance on self-reported responses could introduce biases related to participants' perceptions.

### **5.4 RECOMMENDATIONS**

- To minimize delivery times and cut down operational costs, Quick commerce companies should deliberately position dark stores in closeness to high-demand residential areas.
- To enhance visibility, reduce transit time, and proactively handle traffic disruptions, Implementing AI-driven real-time tracking and route optimization tools will help.
- Team up with municipal authorities to secure better parking facilities, road developments, and dedicated last-mile loading zones in overfilled areas.
- Rise the availability of skilled delivery partners through recruitment drives, incentive programs, and skill enhancement workshops focused on customer service and efficiency.
- Offer multiple payment methods (UPI, wallets, cards, COD) and ensure seamless checkout experiences to provide to a wider range of consumers.
- Begin easy-to-use feedback systems to capture real-time consumer perceptions about delivery performance and improve service quality continuously.
- Encourage the use of electric delivery vehicles and eco-friendly packing as part of the brand approach to appeal to environmentally conscious consumers.

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# APPENDIX

4/2/25, 12:09 PM

Study of factors affecting last mile delivery in quick commerce

## Study of factors affecting last mile delivery in quick commerce

I am conducting a research project to explore the key factors that influence last mile delivery in the quick commerce industry. This study aims to identify the factors and analyze their impact on last mile delivery performance.

The survey should take approximately 5-10 minutes to complete. Your time and contribution are greatly appreciated and will significantly support my dissertation.

\* Indicates required question

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1. Full Name(Optional)

---

2. 1. What is your role in the quick commerce ecosystem? \*

*Check all that apply.*

- Customer
- Delivery Personnel
- Warehouse/ Dark store staff
- Business owner/ Manager

3. 2. How frequently do you use quick commerce services? \*

*Check all that apply.*

- Daily
- A few times in a week
- Once a week
- Rarely

## Untitled Section

Please rate the following factors based on their impact on last mile delivery in quick commerce:

1 - **Strongly Disagree:** *The factor has minimal or no impact on last-mile delivery performance.*

2 - **Disagree:** *The factor has a minor influence but does not significantly affect delivery outcomes.*

3 - **Neutral:** *The factor may have some impact, but its effect is neither strong nor weak.*

4 - **Agree:** *The factor plays an important role in influencing delivery efficiency and results.*

5 - **Strongly Agree:** *The factor is highly significant and crucial to the success of last-mile delivery.*

*Your responses would be used for academic purpose only.*

4. 1. Price competition among platforms leads to a compromise in delivery quality and reliability \*

*Mark only one oval.*

- 1  
 2  
 3  
 4  
 5

5. 2. The strategic placement of dark stores close to high-demand areas directly improves delivery speed and reduces operational expenses \*

*Mark only one oval.*

- 1  
 2  
 3  
 4  
 5

6. 3. Inconsistent stock availability at fulfilment centres leads to delays and order cancellations. \*

*Mark only one oval.*

- 1
- 2
- 3
- 4
- 5

7. 4. The availability of proper infrastructure (e.g., roads, delivery hubs) supports efficient last-mile delivery. \*

*Mark only one oval.*

- 1
- 2
- 3
- 4
- 5

8. 5. Traffic congestion has a significant impact on the timeliness of last-mile deliveries \*

*Mark only one oval.*

- 1
- 2
- 3
- 4
- 5

9. 6. Quick commerce deliveries in my area are completed within the promised time frame. \*

*Mark only one oval.*

- 1
- 2
- 3
- 4
- 5

10. 7. Tracking information provided by quick commerce platforms is accurate. \*

*Mark only one oval.*

- 1
- 2
- 3
- 4
- 5

11. 8. A shortage of trained and available delivery personnel, especially during peak hours, leads to increased delivery times and customer dissatisfaction. \*

*Mark only one oval.*

- 1
- 2
- 3
- 4
- 5

12. 9. Peak-hour demand fluctuations significantly impact delivery times, and dynamic pricing. \*

*Mark only one oval.*

- 1
- 2
- 3
- 4
- 5

13. 10. The availability of designated parking spaces and drop-off points significantly impacts delivery efficiency, with congestion and lack of parking often causing delays. \*

*Mark only one oval.*

- 1
- 2
- 3
- 4
- 5

14. 11. Deliveries in quick commerce are often delayed due to hard-to-reach locations, address inaccuracies, and restricted access areas such as gated communities. \*

*Mark only one oval.*

- 1
- 2
- 3
- 4
- 5

15. 12. Customers prioritize fast delivery over other factors (e.g., pricing, product range). \*

*Mark only one oval.*

- 1
- 2
- 3
- 4
- 5

16. 13. A high rate of failed deliveries due to incorrect addresses, unavailability of customers, or order refusals significantly increases operational costs. \*

*Mark only one oval.*

- 1
- 2
- 3
- 4
- 5

17. 14. A high frequency of small-sized orders increases delivery complexity and operational inefficiencies compared to bulk order fulfilment. \*

*Mark only one oval.*

- 1
- 2
- 3
- 4
- 5

18. 15. Sudden disruptions such as road closures, accidents, or vehicle breakdowns create unpredictability in transit, affecting on-time deliveries. \*

*Mark only one oval.*

- 1
- 2
- 3
- 4
- 5

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