

Optimising E-Commerce Delivery Cost in Indian Quick Commerce Using the Transportation Model

Author Details:

Aryaa Sawant¹, Atharva Shetty¹, Aditya Kanodia¹, Chirag Mahajan¹, Dev Khetan¹

¹ Anil Surendra Modi School of Commerce, NMIMS Deemed-to-be University, Mumbai, India

Corresponding Author Email: aryaasawant124@gmail.com



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Abstract—

Quick commerce companies in India promise delivery in ten to fifteen minutes, and the cost of the last mile decides whether each order earns or loses money. This paper studies how a quick commerce firm can assign customer orders to its dark stores so that the total daily delivery cost is as low as possible. Published operating data of Blinkit, Zepto, Swiggy Instamart, Flipkart Minutes and Delhivery are used to set the scale of the problem. A small transportation model is then built with three dark stores and four demand zones in the western suburbs of Mumbai. Delivery cost per order is based on reported rider payouts and map distances. The initial solution is found by Vogel's Approximation Method and tested by the Modified Distribution (MODI) method. The optimal plan costs Rs 1,40,800 per day, which is 11.6 per cent lower than the Rs 1,59,300 given by the North-West Corner Method. The plan stays the same when the rider rate changes between Rs 9 and Rs 12 per km.

Keywords— quick commerce; last-mile delivery; transportation problem; Vogel's Approximation Method; MODI method; dark stores

I. INTRODUCTION AND PROBLEM TYPE

A. Background

Online shopping in India has moved from delivery in a few days to delivery in a few minutes. Quick commerce platforms keep stock in small neighbourhood warehouses called dark stores, and a rider on a two-wheeler carries each order to the customer. The scale is now very large. Blinkit handled 331 million orders in the April to June 2026 quarter through 2,443 dark stores (Singh, 2026). Zepto and Swiggy Instamart ran 1,139 and 1,143 stores at the end of March 2026 (Outlook Business, 2026), and Flipkart Minutes has crossed 1,000 fulfilment centres within two years of its launch (Singh, 2026). In regular e-commerce, Delhivery delivered more than one billion express parcels in the financial year 2025-26 (Indian Transport and Logistics News [ITLN], 2026).

The weak point of this model is the last mile. Earlier studies report that the last mile takes up roughly 41 to 53 per cent of the total delivery expense of an e-commerce firm (Bhattacharya & Kumar, 2025). In quick commerce the margin is

thin. Blinkit's adjusted EBITDA was only 0.6 per cent of its net order value in the June 2026 quarter, even at its present size (Outlook Business, 2026). A saving of a few rupees per order therefore matters a great deal.

B. Problem Statement

A customer in a city can usually be served by more than one dark store. Each store can handle only a limited number of orders in a day, and each store is at a different distance from each locality. The firm has to decide how many orders from each locality should be served by each store. A poor decision sends riders on long trips while a nearer store has spare capacity.

Delivery decision	OR model	Solution method	Used in this paper
How many orders should each dark store send to each zone?	Transportation problem	VAM for the first solution	Section V-A
Is the first solution the cheapest possible?	Transportation problem	MODI optimality test	Section V-B
The same problem written as one cost-minimising model	Linear programming problem	LP solver	Used to verify the result (Section V-C)

Table I. Operations Research techniques applied to the delivery decision.

C. Objectives

- To collect published data on Indian quick commerce and e-commerce delivery and use it to frame a realistic allocation problem.
- To express the problem as a transportation model.
- To solve it by Vogel's Approximation Method and test the result by the MODI method.
- To compare the result with a simple allocation rule and draw practical lessons.

D. Scope

This research considers a single firm, three dark stores, and four different demand areas and evaluates demand within a single 24-hour period. The research models only the rider cost of delivery, and store rent and picking costs are not considered, along with delivery time restrictions.

II. REAL-LIFE CONTEXT: INDIAN QUICK COMMERCE

A. Industry Data

Table II gives the published figures used to set the scale of the problem.

Company	Period	Figure	Source
Blinkit	Apr to Jun 2026 (Q1 FY27)	331 million orders, 2,443 dark stores, average net order value Rs 518	Singh (2026)
Zepto	FY 2025-26	640.2 million orders, 1,139 dark stores	Outlook Business (2026)
Swiggy Instamart	Jan to Mar 2026 (Q4 FY26)	1,143 dark stores in 129 cities, average order value Rs 700	Groww (2026)

Company	Period	Figure	Source
Flipkart Minutes	2026 estimate	1.1 to 1.2 million orders a day, over 1,000 fulfilment centres	Singh (2026)
Delhivery	FY 2025-26	Over 1 billion express parcels, 306 million in the last quarter	ITLN (2026)

Table II. Operating data of Indian delivery companies.

As per the data the company claimed to have fulfilled 331 million orders in 91 days, which comes to about 3.64 million orders a day. When equally divided among its 2,443 stores the number per store would be about 1,490 orders per day. Hence three stores would then fulfill 4,470 orders, which can be taken as 4,500 here.

B. Delivery Cost Data

The press coverage of the pay scales for Blinkit delivery persons describes a distance-based model of delivery, Rs 9-Rs 12 per km at an average of Rs 10 per km (The Morning Context, 2023). The minimum pay is also Rs 15 per order (Butani, 2023). These reports from April, 2023 are the most complete information publicly available, so the delivery cost per order is assumed to be:

$$c = 15 + 10d$$

Here c is the cost in rupees and d is the road distance in km between the store and the zone.

C. Why Operations Research Is Suitable

- The decision is a matter of numbers: how many orders go from which store to which zone.
- The costs can be measured from map distances and reported payout rates.
- Store capacity is limited, so the best use has to be worked out and cannot be guessed.
- The same model can be solved again whenever demand or payout rates change.

III. LITERATURE REVIEW

A. Search and Selection of Studies

The review began with a structured search so that the choice of studies can be traced. The search was run on OpenAlex (Priem et al., 2022), an open index of scholarly works, on 4 October 2026. Titles and abstracts were searched with two groups of terms joined by AND. The first group named the method: "transportation problem", "transportation model", "Vogel's approximation", "Vogel approximation", "MODI method" or "modified distribution method". The second named the setting: "e-commerce", "online retail", "online business", "last mile", "last-mile", "quick commerce", "dark store" or "home delivery". Only works published from 2010 onwards were taken.

The search returned 82 records. Three duplicates and two records that were not research papers were removed, which left 77 for screening. A study was kept only if it was in English, dealt with the delivery of goods for an online seller and used a transportation problem model. On title and abstract, 62 records were excluded: 28 used routing, scheduling, forecasting or network models, 19 dealt with passenger transport or personal mobility, 10 were unrelated to delivery optimisation, 4 covered other freight settings and 1 was not in English. Of the 15 records that remained, 5 had no abstract available and could not be assessed. The other 10 were read in full abstract, and 4 of them were included. Ten further sources, mainly the classical papers and textbooks on the method and key works on last-mile delivery, were added from reference lists and course texts. The review therefore rests on 14 studies. Figure 1 shows the process in the PRISMA 2020 format (Page et al., 2021).

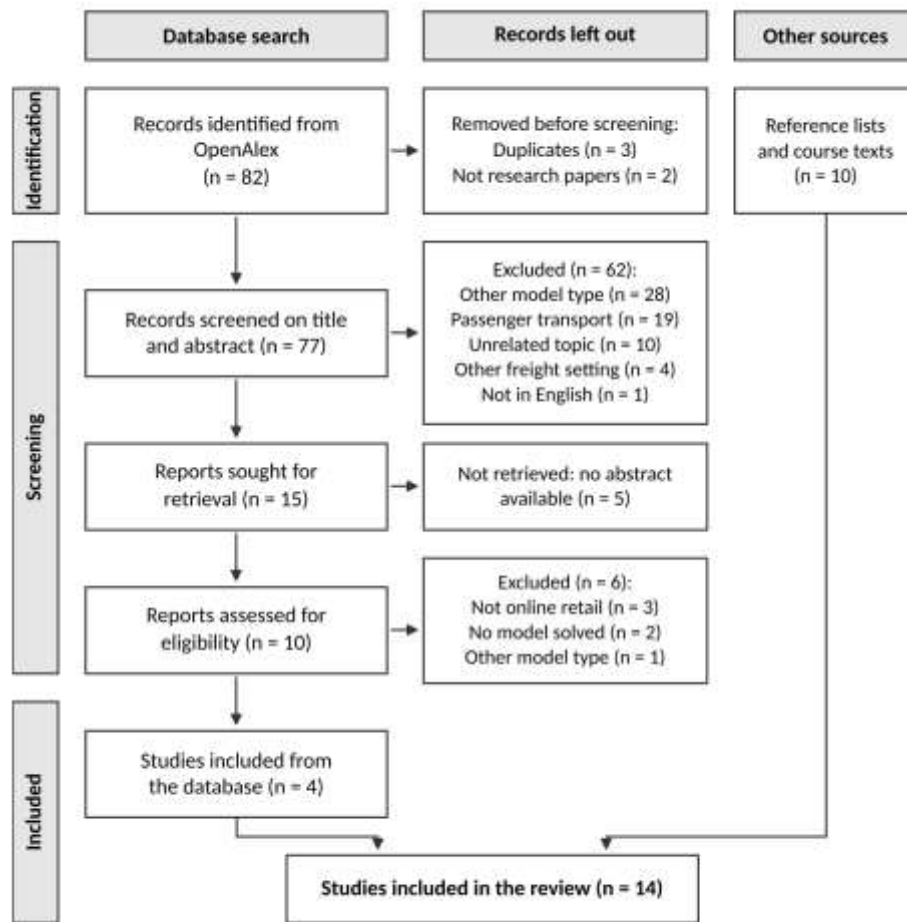


Figure 1. PRISMA flow diagram of the search and selection of studies.

Figure 2 shows the 77 screened records by year of publication. Fifty-eight of them, or 75 per cent, appeared from 2021 onwards, which reflects the growth of online delivery in recent years. The search has limits. It used one database, and the screening was done on abstracts by a single reviewer.

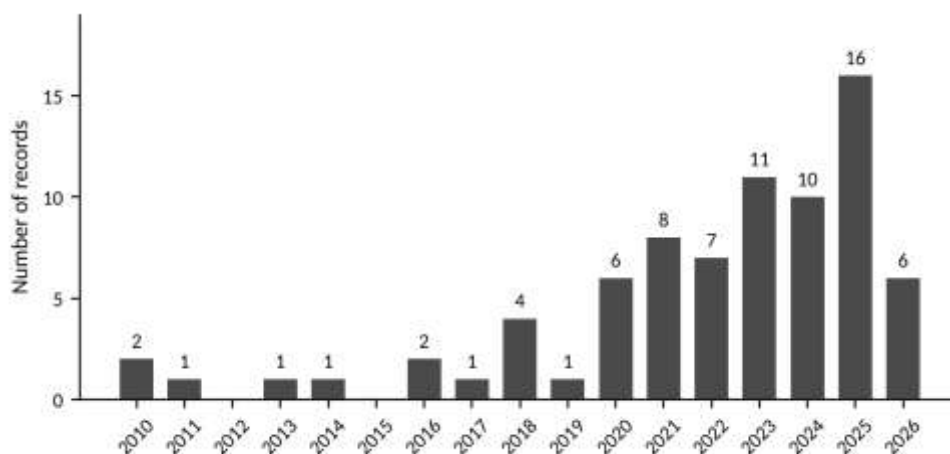


Figure 2. Records screened, by year of publication (n = 77). The figure for 2026 covers January to early October.

B. The Transportation Problem

The transportation problem was first formulated by Hitchcock in 1941 to determine the most effective way to ship products from a set of sources to a set of destinations with a minimum overall cost. Later, in 1951, Dantzig proved that this problem is a special case of linear programming and can be solved by the simplex method. Because the general simplex method is long for this type of problem, simpler table-based approaches were developed.

In 1954, Charnes and Cooper described the stepping stone method for improving a single solution by one cell at a time.

The MODI method may accelerate the same test by means of row and column values, and is now regarded as the standard test of optimality in textbooks (Taha, 2017).

C. Methods for the Starting Solution

Three methods are commonly used to get a first feasible solution: the North-West Corner Method, the Least Cost Method and Vogel's Approximation Method (VAM). VAM was proposed by Reinfeld and Vogel (1958). It looks at the penalty of not using the cheapest route in each row and column, and fills the route where this penalty is highest. Mathirajan and Meenakshi (2004) tested several versions of VAM on a large number of problems. Their best version reached the optimal solution in about 20 per cent of the cases and came within 0.5 per cent of it in about 80 per cent. Das et al. (2014) proposed a logical refinement of the way penalties are worked out in VAM. On the whole, the literature agrees that VAM is the most dependable of the three starting methods.

D. Applications to Online Retail

Banik and Hasan (2018) applied VAM to an online business in Bangladesh that supplied twelve destinations from three warehouses. They measured distances on Google Maps, turned them into unit costs and found a minimum transport cost of 11,576 BDT. Their paper shows that a classical method is enough to give a clear answer for a small online seller, and the present study follows a similar design.

The search found three more studies of this kind. Sonia and Chidambaran (2022) studied a time-minimising transportation problem with e-commerce delivery time in mind. Gladys L and Vinotha (2025) built a two-stage, multi-objective transportation model for third-party e-commerce logistics and tested it on smartphone distribution data. Zelena and Bányaí (2025) reviewed the classical methods, including VAM, and used home delivery of e-commerce parcels as one of their examples. None of the three deals with dark stores or with quick commerce.

E. Last-Mile Delivery and Quick Commerce

Boysen et al. (2021) surveyed last-mile delivery concepts from an operations research view and listed the decisions involved, such as where to place depots, how to assign orders and how to route vehicles. Gevaers et al. (2014) built a tool to simulate last-mile cost and showed that it depends on factors such as the service level promised, the type of delivery and the density of customers in the area. For India, Bhattacharya and Kumar (2025) studied routing in quick commerce in Bengaluru and noted that route plans based only on rough distances can give poor results on real roads.

F. Summary of the Studies

Study	Focus	Relevance to this paper
Hitchcock (1941); Dantzig (1951)	Statement of the transportation problem and its link to linear programming	Basis of the model in Section IV
Reinfeld and Vogel (1958)	Vogel's Approximation Method	Method used for the first solution
Charnes and Cooper (1954); Taha (2017)	Stepping stone and MODI tests	Method used to test optimality
Mathirajan and Meenakshi (2004); Das et al. (2014)	Performance and correction of VAM	Support the choice of VAM
Banik and Hasan (2018)	VAM for an online seller in Bangladesh	Design followed in this study

Study	Focus	Relevance to this paper
Sonia and Chidambaran (2022); Gladys L and Vinotha (2025); Zelená and Bányai (2025)	Transportation problem models for e-commerce logistics	Closest earlier work, none on quick commerce
Boysen et al. (2021); Gevaers et al. (2014); Bhattacharya and Kumar (2025)	Last-mile delivery decisions and costs	Context of the delivery problem

Table III. Summary of the literature reviewed.

G. Research Gap

The studies reviewed in the previous section can be divided into two sets, which are limited in their own ways. The classical studies of the transportation problem fall into the first set. They demonstrate how to set up methods effectively but present examples with factories, warehouse, and bulk goods in mind.

For example, Banik and Hasan (2018) study an online seller; however, they design the problem around weekly shipment and use local buses in Bangladesh to deliver goods.

An Indian quick commerce company, with small order sizes, stores located in residential areas and rider payments per trip, is not discussed in any of the classical studies reviewed here.

The second set of papers includes some up-to-date literature on last-mile delivery and quick commerce, thereby reflecting a wide perspective of the business. Nevertheless, the majority of these papers rely on vehicle routing models, simulation or machine learning, for example, Bhattacharya and Kumar (2025), Boysen et al. (2021). These types of models demand a huge amount of data and complex software, making the procedures opaque and difficult to follow for either store managers or undergraduate students who want to know about the procedures.

From this analysis, three distinct gaps in the research are identified. Firstly, the assignment of dark stores to specific localities in the context of a simple transportation problem using Indian data has not been explored in the papers reviewed. Secondly, figures of costs are all too often invented in educational illustrations, and published company data and rider payout reports have rarely been used to create cost tables.

Thirdly, studies that apply Vogel's Approximation Method (VAM) often stop at the initial solution and do not test for optimality, leaving the status of the cost solution open to debate.

A properly planned literature search agrees with these gaps - only four of the 77 records reviewed reported using the transportation problem methods on online retail distribution - none using for quick commerce.

The current paper aims to fulfill each of the aforementioned three gaps. This paper frames the store-to-zone distribution of a quick commerce company as a transportation problem, using published order volumes, reported payout rates and map distances. It also validates the VAM solution with the Modified Distribution (MODI) method and studies the effect of different rider rates on the solution, which was missing in the earlier applied papers.

IV. MATHEMATICAL MODELLING

A. Stores, Zones and Distances

The area of study is located in Andheri West, Juhu and Vile Parle West, Mumbai. 3 dark stores are located in Four Bungalows (S1), Juhu circle (S2), Irla (S3). Four demand zones are identified as Lokhandwala complex (D1), JVPD scheme (D2), Seven Bungalows (D3) and Vile Parle West near Mithibai College (D4). Co-ordinates for all seven locations were obtained from Google maps (Google, 2026). The research analysis in the following paper develops by using the straight-line distance obtained using the Co-ordinates multiplied by a factor of 1.3 to find out the approximate road distances.

Store	D1 Lokhandwala	D2 JVPD Scheme	D3 Seven Bungalows	D4 Vile Parle West
S1 Four Bungalows	2.2	2.9	1.1	4.2
S2 Juhu Circle	4.0	0.9	2.6	2.2
S3 Irla	5.7	1.5	4.7	1.1

Table IV. Road distance from each store to each zone (km).

B. The Cost Table

Applying the cost formula to Table IV gives the cost per order. Supply and demand are stated in hundreds of orders per day, so each cell cost is read as rupees per order and the total cost is multiplied by 100 at the end.

	D1	D2	D3	D4	Supply
S1	37	44	26	57	18
S2	55	24	41	37	15
S3	72	30	62	26	12
Demand	14	12	10	9	45

Table V. Delivery cost per order (Rs), with daily supply and demand in hundreds of orders.

Total supply equals total demand at 45, so the problem is balanced.

C. The Transportation Model

Decision variables: $x_{ij} \geq 0$ is the number of orders (in hundreds) sent from store i ($i = 1, 2, 3$) to zone j ($j = 1, 2, 3, 4$), which gives 12 variables. c_{ij} is the cost per order on that route.

Objective function: minimise the total delivery cost

$$\text{Minimise } Z = \sum_{i=1}^3 \sum_{j=1}^4 c_{ij} \cdot x_{ij}$$

Supply constraints (one per store):

$$S1: x_{11} + x_{12} + x_{13} + x_{14} = 18$$

$$S2: x_{21} + x_{22} + x_{23} + x_{24} = 15$$

$$S3: x_{31} + x_{32} + x_{33} + x_{34} = 12$$

Demand constraints (one per zone):

$$D1: x_{11} + x_{21} + x_{31} = 14$$

$$D2: x_{12} + x_{22} + x_{32} = 12$$

$$D3: x_{13} + x_{23} + x_{33} = 10$$

$$D4: x_{14} + x_{24} + x_{34} = 9$$

Non-negativity: $x_{ij} \geq 0$ for all 12 variables.

Assumptions:

- The cost per order on a route stays fixed during the day.
- Every store stocks all the items ordered, so any store can serve any zone.
- Each order is delivered in a separate trip.
- Daily demand of each zone is known in advance.

D. Note on the Data

The industry figures, payout rates and map coordinates are real. The three store points are real localities chosen for the study and are not the actual addresses of any company's dark stores, since those are not published. The split of the 4,500 orders across stores and zones is assumed by the authors.

V. SOLUTION METHODOLOGY

A. Vogel's Approximation Method

- **Step 1:** for every row and column, find the penalty, which is the difference between its two lowest costs.
- **Step 2:** choose the row or column with the largest penalty.
- **Step 3:** in that row or column, place as many units as possible in the cheapest cell, then remove the exhausted row or column.
- **Step 4:** work out the penalties again and repeat until all supply and demand are met.

Step	Row penalties (S1, S2, S3)	Column penalties (D1 to D4)	Largest penalty	Cell chosen	Units	Result
1	11, 13, 4	18, 6, 15, 11	18 (D1)	S1 to D1, cost 37	14	D1 satisfied, S1 has 4 left
2	18, 13, 4	6, 15, 11 (D2, D3, D4)	18 (S1)	S1 to D3, cost 26	4	S1 exhausted, D3 needs 6 more
3	13, 4 (S2, S3)	6, 21, 11 (D2, D3, D4)	21 (D3)	S2 to D3, cost 41	6	D3 satisfied, S2 has 9 left
4	13, 4 (S2, S3)	6, 11 (D2, D4)	13 (S2)	S2 to D2, cost 24	9	S2 exhausted, D2 needs 3 more
5	Only S3 remains			S3 to D2, cost 30	3	D2 satisfied
6	Only S3 remains			S3 to D4, cost 26	9	All supply and demand met

Table VI. Steps of VAM.

	D1	D2	D3	D4	Supply
S1	14 (37)		4 (26)		18
S2		9 (24)	6 (41)		15
S3		3 (30)		9 (26)	12

	D1	D2	D3	D4	Supply
Demand	14	12	10	9	45

Table VII. Initial solution (orders in hundreds, cost per order in brackets).

The total cost of this solution is:

$$Z = 14(37) + 4(26) + 9(24) + 6(41) + 3(30) + 9(26) = 518 + 104 + 216 + 246 + 90 + 234 = 1408$$

Since the units are hundreds of orders, the daily delivery cost is Rs 1,40,800. The solution has six occupied cells, which equals $m + n - 1 = 3 + 4 - 1 = 6$, so it is non-degenerate and can be tested directly.

B. MODI Optimality Test

The MODI method gives a value u to each row and a value v to each column so that $u_i + v_j = c_{ij}$ for every occupied cell. Setting $u_1 = 0$ and using the six occupied cells in turn gives the values in Table VIII.

Occupied cell	Equation	Value found
S1 to D1	$u_1 + v_1 = 37$	$v_1 = 37$
S1 to D3	$u_1 + v_3 = 26$	$v_3 = 26$
S2 to D3	$u_2 + v_3 = 41$	$u_2 = 15$
S2 to D2	$u_2 + v_2 = 24$	$v_2 = 9$
S3 to D2	$u_3 + v_2 = 30$	$u_3 = 21$
S3 to D4	$u_3 + v_4 = 26$	$v_4 = 5$

Table VIII. Row and column values from the occupied cells.

For each empty cell the opportunity cost is $d_{ij} = c_{ij} - (u_i + v_j)$.

Empty cell	Calculation	Opportunity cost
S1 to D2	$44 - (0 + 9)$	35
S1 to D4	$57 - (0 + 5)$	52
S2 to D1	$55 - (15 + 37)$	3
S2 to D4	$37 - (15 + 5)$	17
S3 to D1	$72 - (21 + 37)$	14
S3 to D3	$62 - (21 + 26)$	15

Table IX. Opportunity cost of the empty cells.

All six values are positive. No empty cell can reduce the cost, so the VAM solution is optimal and also unique. The minimum daily delivery cost is Rs 1,40,800.

C. Verification Using a Linear Programming Solver

In order to confirm that the manual calculation is accurate, the model of Section IV-C was also solved with the Solver add-in in Microsoft Excel, using the Simplex LP method. Solver yielded the same allocation as well as the same minimum of 1,408.

VI. RESULTS AND INTERPRETATION

A. The Optimal Plan

According to the optimal plan, Four Bungalows caters to all of Lokhandwala as well as some part of Seven Bungalows. Juhu Circle caters to most of JVPD Scheme and the rest of Seven Bungalows. Irla caters to all of Vile Parle West as well as the rest of JVPD Scheme.

The cost can also be calculated as Rs 31.29 per order ($1,40,800/4,500$) which is around 6 per cent of Blinkit's average order value i.e. Rs 518 (Singh, 2026).

B. Comparison with the North-West Corner Method

The North-West Corner Method fills the table from the top left without looking at cost. For the same data it gives S1 to D1 = 14, S1 to D2 = 4, S2 to D2 = 8, S2 to D3 = 7, S3 to D3 = 3 and S3 to D4 = 9, with a total of 1,593.

Plan	Daily cost (Rs)	Cost per order (Rs)
North-West Corner Method	1,59,300	35.40
VAM, confirmed optimal by MODI	1,40,800	31.29
Saving	18,500	4.11

Table X. Comparison of the two plans.

The optimal plan saves Rs 18,500 a day, or 11.6 per cent. Over a 30-day month this is Rs 5,55,000 for only three stores.

C. Sensitivity to the Rider Rate

The reported rider rate varies between Rs 9 and Rs 12 per km with the time of day (The Morning Context, 2023). The model was solved again at both ends of this range.

Rate per km (Rs)	Minimum daily cost (Rs)	Optimal allocation
9	1,33,400	Same as Table VII
10	1,40,800	Table VII
12	1,54,700	Same as Table VII

Table XI. Effect of the per-km rate.

The cost changes but the plan does not. The allocation therefore depends on the distances and capacities, and a manager can rely on it even when payout rates move.

D. Managerial Implications

- The nearest store is not always the most optimal. Even though Seven Bungalows is closer at 1.1 Km from Four Bungalows, 600 of its orders could be serviced more cost-effectively by Juhu Circle 2.6 Km away, as Four Bungalows is the only location that can service Lokhandwala cheaply, and therefore its capacity is better utilised there.
- Regarding opportunity costs, the opportunity cost of the route from Juhu Circle to Lokhandwala is only Rs 3 which means that it would hardly cost anything if it was used during peak hours. However, the opportunity cost of the route from Four Bungalows to Vile Parle West is Rs 52 and so it should not be used.
- Additionally, 4 to 6 km routes were even more expensive at Rs 55-Rs 72 per order, which is more than 10 per cent of the average order size. This is in line with the industry standards in recommending a store to be located about 2 to 3 km away from consumers (Butani, 2023; Singh, 2026).

VII. CRITICAL ANALYSIS

This part of the write-up is written on the broader perspective of the entire study. It describes the results that were received and discusses the strengths and the weaknesses of the methodological part of the research.

A. Key Findings

The most significant fact derived is that all 4,500 orders could be completed through the three stores at minimum cost Rs 1,40,800 (Rs 31.29 per order). A plan made without looking at cost comes to Rs 1,59,300, so in total Rs 18,500 is saved per day by the rational allocation. That is 11.6 per cent. It is significant in that the cost saving is solely attained by proper allocation of store zone without the need of extra store, rider or technologies.

The second result reveals the source of the saved cost. The best alternative does not mean serving every order from the geographically closest location. Interestingly, Four Bungalows gives up some of the service territory of the closest Seven Bungalows so that it can serve Lokhandwala, which is expensive to reach from the other stores.

The third observation shows that the plan is stable. Though the rider rate varied from Rs 10 to Rs 9 and Rs 12 per km the total amount changed between Rs 1,33,400 and Rs 1,54,700 and the allocation did not change. This reinforces the point made earlier that the plan is fundamentally geography based and store capacity based and so should not change with each change in payout.

B. Strengths

- The procedures used, VAM and MODI, are clear and reproducible, and described in a simple way. Each step is tabulated so that anyone in the audience can follow the process and get the same result.
- This paper relies on published data; the number of orders per store is derived from Blinkit's reported volumes, the cost rate is from press reports on riders' wages, and distances are calculated from map coordinates. While the problem size is relatively small, it appears to resemble realistic working conditions.
- The result of the VAM solution is validated by means of a few validation techniques. For instance, we verified that all opportunity costs were positive with the MODI method and a linear programming solver obtained the same solutions.
- These results go beyond the picture of total costs; opportunity costs described in Table IX offer valuable guidance to managers regarding where other viable routes exist as alternatives to those being chosen, and where they do not.
- Another feature of the method is that it can be reused so the same table can be recalculated with new demand or supply information within minutes either manually or through the use of spreadsheet applications.

C. Limitations

- **Assumed Split of Orders:** The total 4,500 orders is based on published data but the distribution of these orders between the three stores and four zones is assumed, as store level data are not published by any of the companies. Different distribution of orders might result in a different operational plan.

- **Estimated Distances:** Distances by roads are calculated using a multiplier of 1.3 on the straight line distance. This approximation ignores one-way streets, traffic lights and congestion, so the actual cost of some routes will be different.
- **Dated and Simplified Cost Rate:** The compensation amounts are based on press reports from 2023. Please note that additional components of the actual payout to riders, such as surge, incentives and time spent waiting, are not included in the calculation $c = 15 + 10d$.
- **No Time Limit:** The model only minimises cost. The 5.7 km route might be acceptable for the model but it may not be acceptable in terms of a 10-minute delivery guarantee.
- **One Order per Trip:** One thing to keep in mind is that riders commonly receive many orders in a batch. Such batching may tend to lower the cost per order, which the model does not capture.
- **Single Day and Fixed Demand:** In reality, the demand varies on an hourly and daily basis, and its exact nature cannot be forecasted or isolated with complete certainty in advance.
- **Small Size:** Although having three stores and four zones is enough to illustrate the proposed methodological approach, in an actual city there are hundreds of stores and a computer solution is needed.

These constraints do not change the approach or the general direction of the results but suggest that the rupee numbers should be taken as illustrative for the broad ranges, not as an indication of what any particular company paid.

D. Possible Extensions

The table of costs could be improved if actual road distances and times were used rather than estimates. A delivery time constraint (i.e. discarding routes that would take too long to deliver) would let the plan satisfy the 10-minute delivery time while staying cost effective.

Demand would probably be significantly different in peak and non-peak periods, and these could be analysed separately because the best allocation of customers at 8 pm may be very different from that at 11 am.

The unbalanced case could be dealt with by adding a dummy store which caters for the excess demand at each zone and illustrates the zones which would not be served. The allocation of orders to stores has been discussed, and the assignment of riders to orders could be addressed using the Hungarian method. The model could be expanded to a whole city and implemented using the solver.

VIII. CONCLUSION

This paper aims to illustrate how a quick commerce company can decide which dark store to assign a specific locality to reduce costs. The problem is modeled as a balanced transportation problem with three dark stores and four demand zones in western Mumbai. Order volume is taken from published order figures, cost per order is taken from reported rider payment, and distance is taken from map coordinates.

The initial solution was obtained by Vogel's Approximation Method, which yielded a plan costing Rs 1,40,800 per day. The opportunity cost was found to be positive for all the unoccupied routes using the MODI test. This plan is therefore optimal and was also confirmed by a linear programming solver.

Since the above plan was more economic than the North-West Corner plan which costs Rs 1,59,300 we save Rs 18,500 i.e. 11.6 per cent with our optimal plan. The allocation was found to be the same for the rider rates of Rs 9 to Rs 12 per kilometer.

Two lessons stand out for managers. Firstly, the nearest store may not necessarily be the most economical choice, given that capacity at a particular store should be utilized for areas that it can service most efficiently. Secondly, a route that covers 4-6 km is surprisingly expensive compared to the average order size, and this explains why firms are perpetually increasing store coverage as close to the user base as they can afford to. If the margin in a business is one-half of one per cent of the order value, saving Rs 4 on each order is significant.

However, there are some limitations as of now. The deployment of orders in stores and zones has been assumed, distances are approximated, and there are additional parameters (delivery time, order batching) that have not been considered and incorporated. As a result, these numbers should be taken as a demonstration of the technique and do not signify the actual costs that any firm would incur.



However, the paper does show that the classical technique, a cornerstone taught at the first course in Operations Research, can be adapted to address the problems faced by Indian organizations and generate a solution that is simple to explain and validate.

With distances, time constraints and demand per hour being incorporated, the technique could be evolved into a viable planning tool.

APPENDIX: KEY TERMS

Term	Meaning
Dark store	A small local warehouse that serves only online orders and is closed to walk-in customers.
Last mile	The final leg of delivery, from the store or hub to the customer.
Balanced problem	A transportation problem in which total supply equals total demand.
Initial basic feasible solution	A first shipping plan that meets every supply and demand figure.
Penalty (VAM)	The gap between the two lowest costs in a row or column. A large gap means it is costly to miss the cheapest cell.
Occupied cell	A route that is used in the plan. A non-degenerate plan has $m + n - 1$ of them.
MODI	Modified Distribution method, which checks whether any unused route could lower the total cost.
Opportunity cost	The change in total cost if one unit were moved to an unused route.
North-West Corner Method	A starting method that fills the table from the top left cell and ignores cost.

REFERENCES

- Banik, D., & Hasan, M. Z. (2018). Transportation cost optimization of an online business applying Vogel's approximation method. *World Scientific News*, 96, 179-190. <https://fs.unm.edu/DSmT/TransportationCostOptimization.pdf>
- Bhattacharya, M., & Kumar, M. (2025). *Optimizing delivery for quick commerce factoring qualitative assessment of generated routes* (arXiv:2510.08671). arXiv. <https://arxiv.org/abs/2510.08671>
- Boysen, N., Fedtke, S., & Schwerdfeger, S. (2021). Last-mile delivery concepts: A survey from an operational research perspective. *OR Spectrum*, 43(1), 1-58. <https://doi.org/10.1007/s00291-020-00607-8>
- Butani, A. (2023, April 19). New pay structure slashed income: Blinkit protests in NCR. *The Quint*. <https://www.thequint.com/news/new-pay-structure-slashed-income-blinkit-protests-ncr>
- Charnes, A., & Cooper, W. W. (1954). The stepping stone method of explaining linear programming calculations in transportation problems. *Management Science*, 1(1), 49-69. <https://doi.org/10.1287/mnsc.1.1.49>
- Dantzig, G. B. (1951). Application of the simplex method to a transportation problem. In T. C. Koopmans (Ed.), *Activity analysis of production and allocation* (pp. 359-373). Wiley.
- Das, U. K., Babu, M. A., Khan, A. R., Helal, M. A., & Uddin, M. S. (2014). Logical development of Vogel's approximation method (LD-VAM): An approach to find basic feasible solution of transportation problem. *International Journal of Scientific & Technology Research*, 3(2), 42-48.
- Gevaers, R., Van de Voorde, E., & Vanelander, T. (2014). Cost modelling and simulation of last-mile characteristics in an innovative B2C supply chain environment with implications on urban areas and cities. *Procedia - Social and Behavioral Sciences*, 125, 398-411. <https://doi.org/10.1016/j.sbspro.2014.01.1483>
- Gladys L, B., & Vinotha, J. M. (2025). Sustainable rough multi-objective two-stage solid transportation problem of third-party e-commerce logistic providers with conditional fixed parameter on safety. *The Scientific Temper*, 16(1), 3611-3620. <https://doi.org/10.58414/scientifictemper.2025.16.1.05>
- Google. (2026). *Google Maps* [Coordinates of Four Bungalows, Juhu Circle, Irla, Lokhandwala Complex, Seven Bungalows, JVPD Scheme and Mithibai College, Mumbai]. Retrieved October 2, 2026, from <https://www.google.com/maps>
- Groww. (2026, May 21). *Swiggy Q4 FY26 results*. <https://groww.in/blog/swiggy-q4-fy26-results>
- Hitchcock, F. L. (1941). The distribution of a product from several sources to numerous localities. *Journal of Mathematics and Physics*, 20(1-4), 224-230.
- Indian Transport and Logistics News. (2026, May 21). *Delhivery posts Rs 105 billion FY26 revenue, turns cashflow positive*. <https://www.itln.in/logistics/delhivery-posts-105-billion-fy26-revenue-turns-cashflow-positive-1359229>
- Mathirajan, M., & Meenakshi, B. (2004). Experimental analysis of some variants of Vogel's approximation method. *Asia-Pacific Journal of Operational Research*, 21(4), 447-462. <https://doi.org/10.1142/S0217595904000333>
- Outlook Business. (2026, July 23). *Blinkit widens q-commerce lead, matches rivals Zepto and Instamart combined in scale*. <https://www.outlookbusiness.com/corporate/blinkit-widens-quick-commerce-lead-matches-rivals-zepto-and-instamart-combined-in-scale>
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., ... Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, 372, Article n71. <https://doi.org/10.1136/bmj.n71>
- Priem, J., Piwowar, H., & Orr, R. (2022). *OpenAlex: A fully-open index of scholarly works, authors, venues, institutions, and concepts* (arXiv:2205.01833). arXiv. <https://arxiv.org/abs/2205.01833>
- Reinfeld, N. V., & Vogel, W. R. (1958). *Mathematical programming*. Prentice-Hall.



Singh, R. (2026, September 6). Flipkart Minutes vs Blinkit: Can Flipkart become Blinkit before Blinkit becomes Flipkart? *Open Magazine*. <https://openthemagazine.com/business/flipkart-minutes-vs-blinkit-can-flipkart-become-blinkit-before-blinkit-becomes-flipkart>

Sonia, N. A., & Chidambaran, S. (2022). Time paradox in transportation problems. *International Journal of Operational Research*, 45(4), 540. <https://doi.org/10.1504/ijor.2022.128397>

Taha, H. A. (2017). *Operations research: An introduction* (10th ed., Global ed.). Pearson.

The Morning Context. (2023, April 12). *Blinkit delivery partners on strike in parts of Delhi NCR*. <https://themorningcontext.com/chaos/blinkit-delivery-partners-on-strike-in-parts-of-delhi-ncr>

Zelena, B. E., & Bányai, T. (2025). Modeling and solving transportation problems as a decision support tool in logistics process design and optimization. *Advanced Logistic Systems - Theory and Practice*, 19(3), 51-71. <https://doi.org/10.32971/als.2025.016>