



Green Supply Chain Optimization in 10-Minute Delivery Models: A Study of Urban Quick Commerce

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ABSTRACT

This study aims to examine the applicability of green supply chain practices to 10-minute delivery models in urban quick commerce. By analyzing the results of 110 illustrative survey responses, this paper focuses on descriptive statistics (frequencies, percentages, mean, median and standard deviation) to evaluate consumer perceptions of environmental impacts, green logistics, eco-friendly packaging, technology adoption and implementation barriers. The article applies chi-square tests, one-way ANOVA and exploratory linear regression to explore potential associations and underlying patterns between chosen variables. The respondents identified carbon emissions and packaging waste as the primary environmental concerns and highlighted route optimization, electric vehicles and eco-friendly packaging as the most promising sustainability practices. In addition, the participants indicated high technology costs as the key barrier to sustainability. The study highlights the importance of integrating sustainable transportation, efficient inventory management, eco-friendly packaging and technology-based optimization to balance delivery speed, cost and environmental responsibility.

Keywords: Quick Commerce; Green Supply Chain Management; 10-Minute Delivery; Dark Stores; Sustainable Logistics; Eco-friendly Packaging; Chi-Square; ANOVA; Regression.

1. Introduction

Businesses are growing more and more conscious about green supply chain management to enhance environmental performances while improving operational efficiency. Quick commerce has fundamentally changed the way consumers shop by promising to deliver items within ten minutes but has in return generated larger carbon emissions, increased waste production, and promoted higher traffic circulation of vehicles. However, optimizing routes, utilizing electric vehicles, implementing recyclable materials, and applying artificial intelligence can reduce environmental damage and boost efficiency during the distribution process.

The research made aims to discover how businesses can apply green supply chain practices in the fastest commercial system in the city. The main problems this paper focuses on are the key environmental issues in the quick commerce industry, what technologies can help achieve sustainability, and what obstacles firms face while implementing greener methods. This study attempts to find out the potential ways quick-scheme companies can maintain the swiftness of operations while minimizing costs and remaining eco-friendly.

2. Review of Literature

Schorung (2024) studied quick-commerce supply chains in Paris, New York and London and pointed to the environmental strain caused by dark stores, frequent vehicle movements and last-mile delivery.

Kumar (2021) reviewed 63 research papers on green supply chain management and found that green purchasing, eco-design and reverse logistics can improve both environmental and operational efficiency.

Son and Kwon (2024) looked at the environmental effects of quick commerce and found that increased vehicle travel, air pollution and packaging waste were the main concerns.

Prasertwit, Kanchanasuntorn and Vongmanee (2024) applied Life Cycle Assessment to e-commerce logistics in Bangkok. They concluded that cutting unnecessary packaging and improving distribution processes is important for lowering carbon emissions.

Nayak (2025) explored sustainable business models and their link to green supply chain performance, stressing the part played by blockchain, AI, IoT and stakeholder collaboration. High technology cost was identified as a major barrier.

Tathavadekar and Mahankale (2025) studied green IT innovations in sustainable supply chains and found that low-carbon practices and digital technologies both support environmental and operational performance.

Zhang and Liu (2025) analysed green supply chain practices at Cainiao Network, where route optimization, electric delivery vehicles and carbon-footprint tracking are used to support sustainable logistics.

Kavitha and Santhanalaxmi (2026) examined sustainability challenges in quick commerce and suggested electric vehicles, eco-friendly packaging, AI-based route optimization and renewable energy as possible solutions.

Dhillon et al. (2023) reviewed 108 articles on flexible and green supply chain management in emerging economies. They found research gaps in supplier collaboration, reverse logistics, green design practices and the adoption of blockchain, and noted obstacles such as corruption, informal supplier relationships and weak organizational support for sustainability.

Zhao et al. (2024) used a game-theoretic model to study how blockchain technology and uncertain consumer demand affect green supply chain decisions. Blockchain was found to improve profitability and consumer trust in green products, although its environmental benefit depends on technology costs and on whether consumers accept it.

3. Research Gap

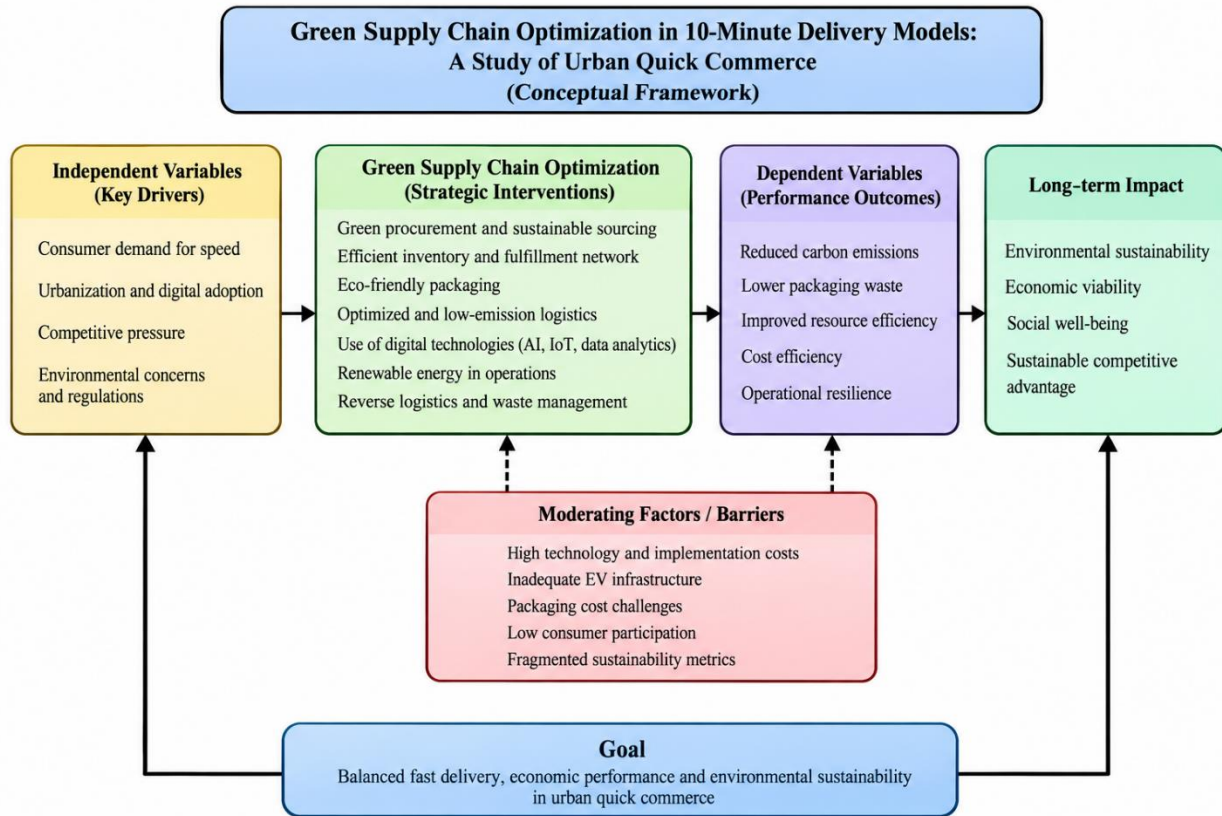
Green supply chain management and quick commerce are both growing fields of research, yet three gaps stand out. First, most green supply chain studies deal with traditional e-commerce or manufacturing rather than 10-minute delivery. Second, the environmental effects of dark stores, delivery transport and packaging waste in urban quick commerce have received little attention. Third, there is limited empirical evidence on how far green technologies are being adopted and what stops sustainable practices from being implemented. This illustrative study therefore looks at environmental challenges, green supply chain practices and technology adoption in urban quick commerce.

4. Objectives of the Study

1. To identify the key environmental impacts of quick-commerce, such as carbon emissions, traffic, packaging waste and energy consumption.
2. To investigate how green supply chain approaches such as green logistics, eco-friendly packaging, sustainable sourcing and reverse logistics can enhance environmental performance.
3. To evaluate how technologies such as AI, IoT, blockchain and route optimization can enhance the sustainability of the quick commerce supply chains.
4. To identify barriers to the adoption of green supply chain practices by quick commerce business such as high technology costs, limited Ev charging infrastructure, packaging costs and low consumer engagement.
5. To propose strategies for balancing speed, economic and environmental performance in urban quick commerce.

5. Conceptual Framework of the Study

The conceptual framework rests on the assumption that green supply chain practices, such as route optimization, electric vehicles, eco-friendly packaging, AI-based demand forecasting and inventory management, can improve the environmental sustainability of 10-minute delivery models. These practices are expected to lower carbon emissions, packaging waste and resource use while also making operations more efficient. Two further factors, the level of technology adoption and barriers such as high implementation costs, are treated as influences on whether sustainable practices get adopted in urban quick commerce.



6. Hypotheses of the Study

H0: There is no significant relationship between green supply chain practices and the environmental sustainability of 10-minute delivery models.

H1: There is a significant relationship between green supply chain practices and the environmental sustainability of 10-minute delivery models.

H0: There is no significant relationship between consumers' environmental awareness and their preference for green quick-commerce practices.

H1: There is a significant relationship between consumers' environmental awareness and their preference for green quick-commerce practices.

H0: Eco-friendly packaging has no significant impact on waste reduction in 10-minute delivery models.

H1: Eco-friendly packaging has a significant impact on waste reduction in 10-minute delivery models.

H0: Efficient inventory management has no significant relationship with the sustainability of urban quick-commerce operations.

H1: Efficient inventory management has a significant relationship with the sustainability of urban quick-commerce operations.

H0: Technology-based supply chain optimization has no significant impact on the green supply chain performance of 10-minute delivery models.

H1: Technology-based supply chain optimization has a significant impact on the green supply chain performance of 10-minute delivery models.

7. Research Methodology

Research methodology is the systematic plan followed to answer the research questions. Here it covers the research approach, design, population, sample, sampling technique, data source, measurement and analytical tools.

7.1 Research Approach

A quantitative approach was adopted because respondent perceptions are expressed in numbers, and statistical techniques are used to look for patterns, associations and group differences.

7.2 Research Design

The study uses a descriptive, exploratory and cross-sectional design. Frequency tables and charts summarize the dataset, while Chi-square tests, one-way ANOVA and ordinary least-squares regression are included to demonstrate the statistical analysis.

7.3 Population of the Study

The target population is urban and semi-urban consumers in India who use quick-commerce platforms such as Swiggy Instamart, Blinkit, Zepto and BigBasket/BB Now.

7.4 Sample of the Study

The sample has 110 respondent records, each representing one quick-commerce user. This is enough to demonstrate descriptive analysis, cross-tabulation, Chi-square testing, ANOVA and regression, but it is small, so only medium-to-large effects could be detected reliably.

7.5 Sampling Technique

A non-probability convenience sampling approach is assumed. In a publishable field study, the researcher should define the sampling frame and, wherever feasible, use probability or stratified sampling to make the sample more representative.

7.6 Sources and Instrument of Data Collection

A structured questionnaire with 27 multiple-choice questions is assumed as the main data-collection instrument. It covers environmental impact, green logistics and packaging, technology, barriers and strategy.

7.7 Variables and Measurement

Most variables are nominal categorical choices. Usage frequency was coded from 1 (rarely) to 5 (daily), and three four-level response items were coded from 1 to 4 for exploratory descriptive summaries. This coding imposes an order on the response categories, so it should not be mistaken for a validated continuous measurement scale.

7.8 Statistical Tools Used

Descriptive analysis uses percentages, mean, median, standard deviation, minimum and maximum, and bar charts give a visual summary of the survey responses. The Chi-square test of independence is used to examine associations between categorical variables, one-way ANOVA to compare mean responses across groups, and linear regression to study relationships between selected variables. A 5% level of significance is applied throughout.

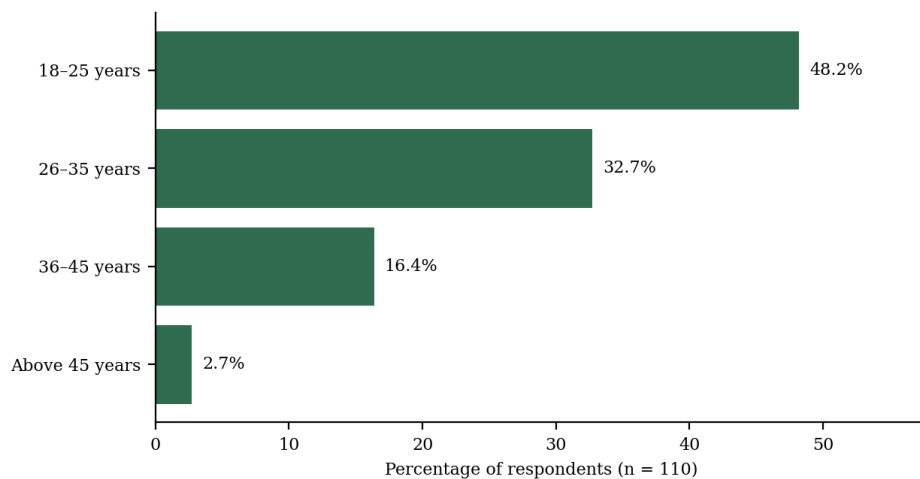
8. Data Analysis and Interpretation

8.1 Respondent Profile

Variable	Category	Frequency	Percentage
Age group	18–25 years	53	48.2%
	26–35 years	36	32.7%
	36–45 years	18	16.4%
	Above 45 years	3	2.7%
Gender	Male	60	54.5%
	Female	47	42.7%
	Prefer not to say	3	2.7%
Education	Higher Secondary	10	9.1%
	Undergraduate	51	46.4%
	Postgraduate	29	26.4%

Variable	Category	Frequency	Percentage
Occupation	Professional qualification	20	18.2%
	Student	43	39.1%
	Salaried employee	42	38.2%
	Self-employed/Business	17	15.5%
	Homemaker	5	4.5%
	Other	3	2.7%
Monthly income	Below ₹20,000	25	22.7%
	₹20,001–₹40,000	41	37.3%
	₹40,001–₹60,000	24	21.8%
	₹60,001–₹1,00,000	11	10.0%
	Above ₹1,00,000	9	8.2%
Residence	Rural area	11	10.0%
	Town	13	11.8%
	Small city	16	14.5%
	Large city	36	32.7%
	Metropolitan city	34	30.9%
Total		110	100.0%

Interpretation: The sample is young and mostly urban: 48.2% are aged 18–25 and 32.7% are 26–35, and 63.6% live in large or metropolitan cities. Men (54.5%) slightly outnumber women (42.7%). Students (39.1%) and salaried employees (38.2%) are the largest occupational groups, and 37.3% earn ₹20,001–₹40,000 a month.

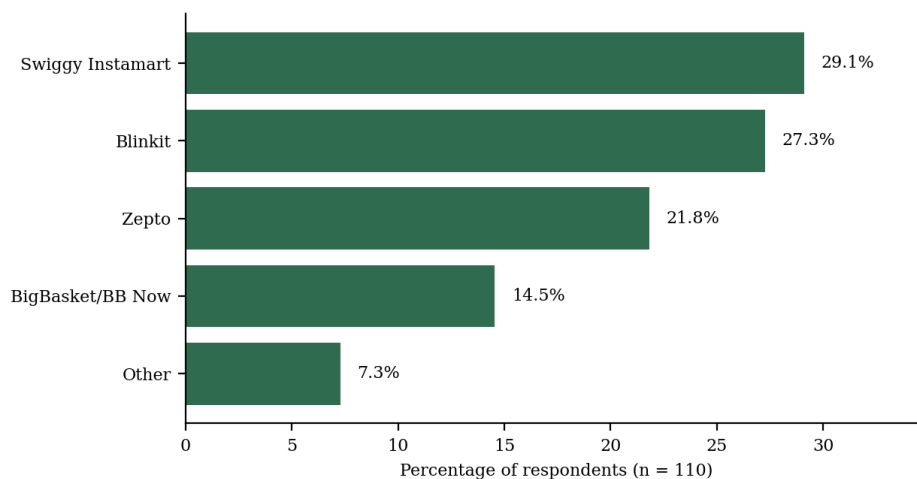


8.2 Quick-Commerce Usage Profile

Variable	Category	Frequency	Percentage
Usage frequency	Daily	6	5.5%
	2–3 times a week	29	26.4%
	Once a week	31	28.2%

Variable	Category	Frequency	Percentage
Most-used platform	2–3 times a month	31	28.2%
	Rarely	13	11.8%
	Swiggy Instamart	32	29.1%
	Blinkit	30	27.3%
	Zepto	24	21.8%
	BigBasket/BB Now	16	14.5%
	Other	8	7.3%
Primary reason	Fast delivery	43	39.1%
	Convenience	30	27.3%
	Product availability	21	19.1%
	Emergency/urgent purchases	12	10.9%
	Discounts/offers	4	3.6%
Length of usage	Less than 6 months	9	8.2%
	6 months–1 year	37	33.6%
	1–2 years	30	27.3%
	2–3 years	23	20.9%
	More than 3 years	11	10.0%
Total		110	100.0%

Interpretation: Six in ten respondents (60.0%) order at least once a week, so most are regular users who can judge delivery practices from experience. Swiggy Instamart (29.1%), Blinkit (27.3%) and Zepto (21.8%) together account for 78.2% of primary platforms. Fast delivery is the leading reason for use (39.1%), followed by convenience (27.3%), which confirms that speed is the core value proposition any green practice has to preserve.

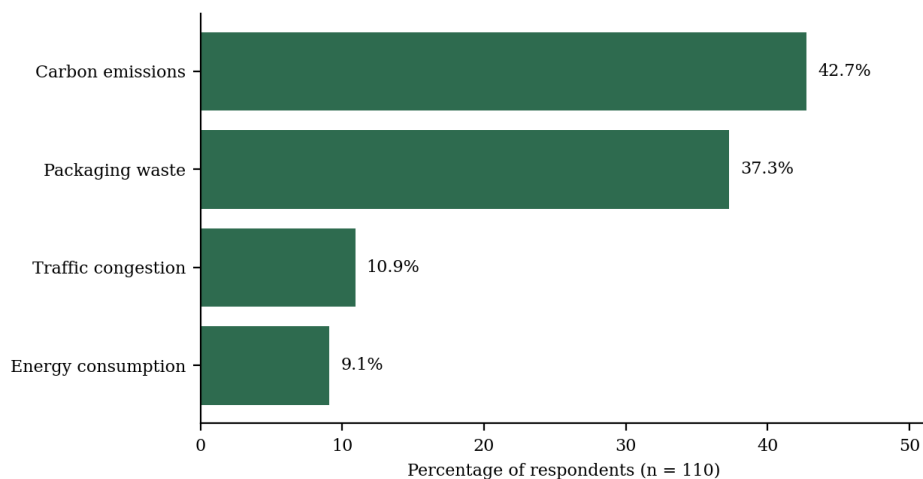


8.3 Environmental Impacts of Quick-Commerce Delivery

Question	Response	Frequency	Percentage
Major environmental impact	Carbon emissions	47	42.7%
	Packaging waste	41	37.3%
	Traffic congestion	12	10.9%

Question	Response	Frequency	Percentage
Contribution to traffic congestion	Energy consumption	10	9.1%
	Never	4	3.6%
	Rarely	17	15.5%
	Sometimes	46	41.8%
Most common packaging waste	Frequently	43	39.1%
	Plastic packaging	59	53.6%
	Food packaging	20	18.2%
	Paper/cardboard	16	14.5%
	All of the above	15	13.6%
Energy use of dark stores	Very low	4	3.6%
	Low	14	12.7%
	Moderate	55	50.0%
	High	37	33.6%

Interpretation: Carbon emissions (42.7%) and packaging waste (37.3%) together account for 80.0% of responses on the major environmental impact, well ahead of traffic congestion (10.9%) and energy consumption (9.1%). In addition, 80.9% believe quick commerce contributes to congestion sometimes or frequently, plastic is the most common packaging waste (53.6%), and 83.6% rate dark-store energy use as moderate or high.

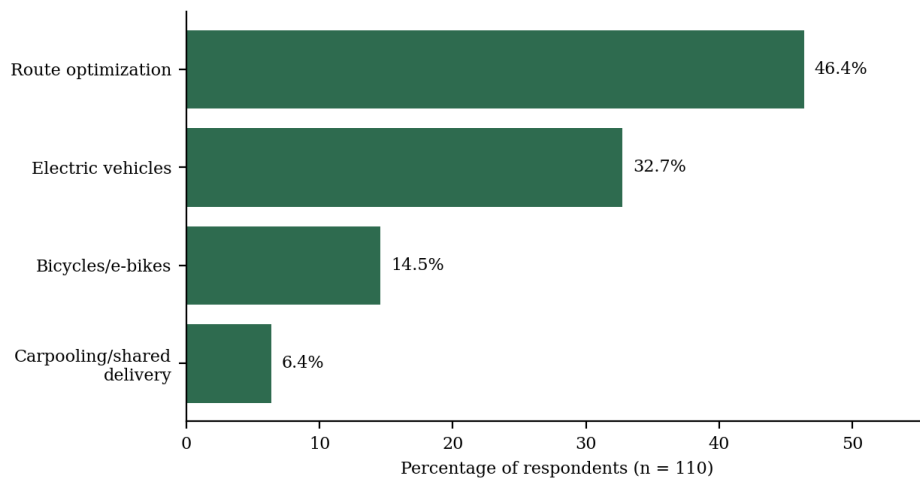


8.4 Green Supply Chain Practices

Question	Response	Frequency	Percentage
Most effective green transport practice	Route optimization	51	46.4%
	Electric vehicles	36	32.7%
	Bicycles/e-bikes	16	14.5%
	Carpooling/shared delivery	7	6.4%
Packaging companies should use more	Recyclable packaging	36	32.7%
	All of the above	29	26.4%
	Reusable packaging	27	24.5%
	Biodegradable packaging	18	16.4%

Question	Response	Frequency	Percentage
Importance of sustainable sourcing	Not important	3	2.7%
	Slightly important	16	14.5%
	Moderately important	40	36.4%
	Very important	51	46.4%

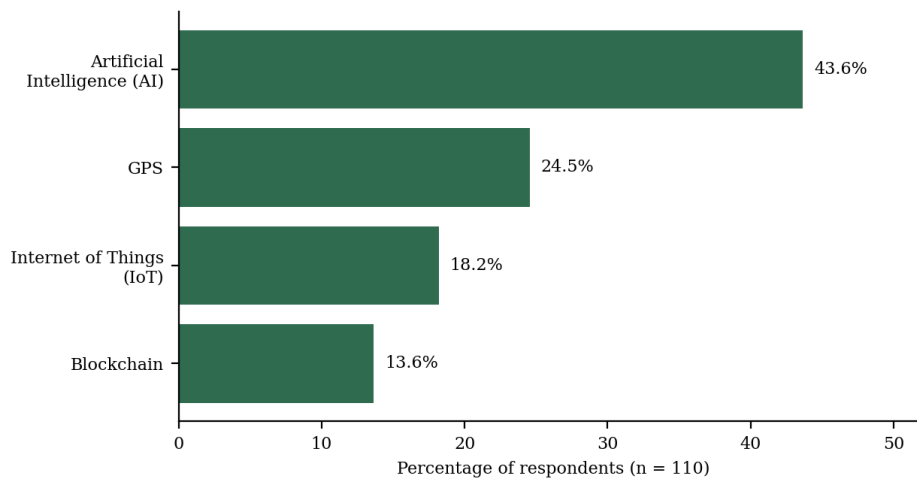
Interpretation: Route optimization (46.4%) is seen as the most effective green transport practice, followed by electric vehicles (32.7%); bicycles/e-bikes (14.5%) and carpooling or shared delivery (6.4%) trail well behind. On packaging, respondents lean towards recyclable (32.7%), reusable (24.5%) or a mix of all options (26.4%) rather than biodegradable packaging alone (16.4%). Sustainable sourcing is rated very or moderately important by 82.7%.



8.5 Role of Technology

Question	Response	Frequency	Percentage
Best technology for demand forecasting	Artificial Intelligence (AI)	48	43.6%
	GPS	27	24.5%
	Internet of Things (IoT)	20	18.2%
	Blockchain	15	13.6%
Best for reducing delivery distance	Route optimization	67	60.9%
	Digital payments	21	19.1%
	Social media	11	10.0%
	Blockchain	11	10.0%
Usefulness of IoT and real-time tracking	Not useful	3	2.7%
	Slightly useful	15	13.6%
	Moderately useful	35	31.8%
	Very useful	57	51.8%
Main benefit of blockchain	Transparency	77	70.0%
	Increased product variety	15	13.6%
	Lower packaging costs	10	9.1%
	Faster delivery	8	7.3%

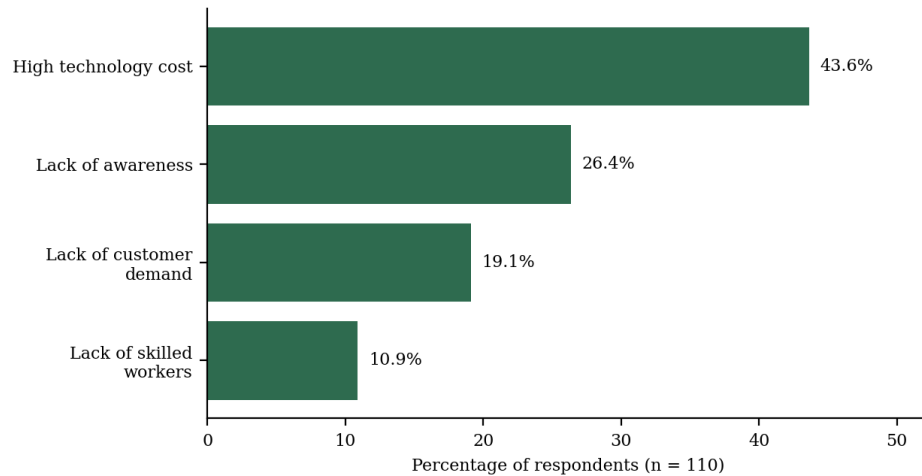
Interpretation: AI is picked by 43.6% as the best technology for demand forecasting and wastage reduction, ahead of GPS (24.5%), IoT (18.2%) and blockchain (13.6%). For cutting delivery distances, route optimization is the clear choice (60.9%). Some 83.6% find IoT and real-time tracking moderately or very useful, and 70.0% see transparency as blockchain's main sustainability benefit.



8.6 Barriers to Green Implementation

Question	Response	Frequency	Percentage
Biggest barrier to green technology	High technology cost	48	43.6%
	Lack of awareness	29	26.4%
	Lack of customer demand	21	19.1%
	Lack of skilled workers	12	10.9%
Major challenge in adopting EVs	All of the above	35	31.8%
	High purchase cost	32	29.1%
	Limited charging infrastructure	27	24.5%
	Limited driving range	16	14.5%
Why companies hesitate on eco-packaging	All of the above	42	38.2%
	Higher cost	40	36.4%
	Limited availability	17	15.5%
	Lack of customer awareness	11	10.0%
Challenge in consumer participation	All of the above	49	44.5%
	Lack of awareness	27	24.5%
	Low recycling participation	24	21.8%
	Lack of convenient return facilities	10	9.1%

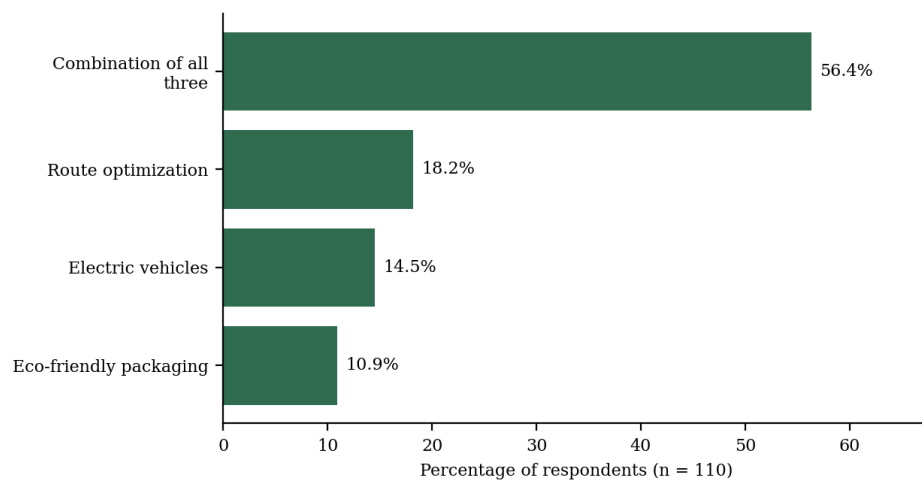
Interpretation: High technology cost is the biggest barrier (43.6%), followed by lack of awareness (26.4%). For EVs, respondents point to high purchase cost (29.1%), limited charging infrastructure (24.5%) and driving range (14.5%), and 31.8% chose all of these. Higher cost (36.4%) and “all of the above” (38.2%) explain why companies hesitate over eco-friendly packaging, while 44.5% say every listed issue limits consumer participation.



8.7 Strategies for Balancing Speed and Sustainability

Question	Response	Frequency	Percentage
Best strategy to keep fast delivery while reducing impact	Combination of all three	62	56.4%
	Route optimization	20	18.2%
	Electric vehicles	16	14.5%
	Eco-friendly packaging	12	10.9%
Green practice that reduces long-term operating cost	All of the above	38	34.5%
	Route optimization	28	25.5%
	Energy efficiency	22	20.0%
	Waste reduction	22	20.0%

Interpretation: Many (56.4%) prefer a combination of route optimization, electric vehicles and eco-friendly packaging over any single measure (route optimization 18.2%, EVs 14.5%, eco-friendly packaging 10.9%). On long-term cost reduction, 34.5% choose all of the listed practices, while route optimization (25.5%), energy efficiency (20.0%) and waste reduction (20.0%) each draw smaller shares.



8.8 Descriptive Statistics of Ordinal Variables

Variable	Mean	Median	Std. Deviation	Minimum	Maximum
Usage frequency (1–5)	2.855	3.00	1.107	1	5
Monthly income (1–5)	2.436	2.00	1.185	1	5
Length of usage (1–5)	2.909	3.00	1.130	1	5
Contribution to traffic congestion (1–4)	3.164	3.00	0.819	1	4
Significance of dark-store energy use (1–4)	3.136	3.00	0.772	1	4
Importance of sustainable sourcing (1–4)	3.264	3.00	0.809	1	4
Usefulness of IoT/real-time tracking (1–4)	3.327	4.00	0.814	1	4

Interpretation: All four attitudinal items (maximum score 4) have means between 3.14 and 3.33 and medians of 3 or 4, which points to moderately high agreement that quick commerce affects traffic and energy use, that sustainable sourcing matters and that IoT tracking is useful. IoT usefulness has the highest mean (3.327; median 4) and dark-store energy significance the lowest (3.136). Standard deviations of 0.77–0.82 show that opinions are fairly consistent. Usage frequency (M = 2.855), income (M = 2.436) and length of usage (M = 2.909) all sit slightly below the scale midpoint, in line with a young, moderate-income sample of mostly weekly users.

8.9 Hypothesis Testing

Chi-square tests are used for H1 to H3, one-way ANOVA for H4 and linear regression for H5.

8.9.1 Chi-Square Tests (H1, H2 and H3)

Preferred strategy	Carbon emissions	Energy consumption	Packaging waste	Traffic congestion	Total
Combination of all three	25	7	25	5	62
Eco-friendly packaging	4	2	5	1	12
Electric vehicles	11	1	3	1	16
Route optimization	7	0	8	5	20
Total	47	10	41	12	110

Cross-Tabulation (H1): Preferred strategy and Major environmental impact

Environmental awareness	Combination of practices	Single practice	Total
High (very important)	31	20	51
Low (not/slightly important)	10	9	19
Moderate	21	19	40
Total	62	48	110

Cross-Tabulation (H2): Environmental awareness and Practice preference

Preferred packaging	All of the above	Food packaging	Paper/cardboard	Plastic packaging	Total
All of the above	3	4	5	17	29
Biodegradable packaging	3	3	3	9	18
Recyclable packaging	6	8	3	19	36
Reusable packaging	3	5	5	14	27
Total	15	20	16	59	110

Cross-Tabulation (H3): Preferred packaging and Most common packaging waste

Hypothesis	Variables tested	χ^2	df	p (asymptotic)	p (Monte Carlo)	Cramér's V	Decision at 5%
H01	Preferred strategy × Major environmental impact	12.416	9	0.1909	0.1886	0.194	Not rejected
H02	Environmental awareness × Practice preference	0.756	2	0.6854	0.7176	0.083	Not rejected
H03	Preferred packaging × Most common packaging waste	3.024	9	0.9634	0.9696	0.096	Not rejected

Chi-Square Test Results (H1 to H3)

Interpretation: None of the three Chi-square tests found a statistically significant association at the 5% level (all $p > 0.05$), so H01 ($p = 0.191$), H02 ($p = 0.685$) and H03 ($p = 0.963$) were not rejected. Preferred strategies were not significantly associated with perceived environmental impacts, environmental awareness or packaging preferences. These results need to be treated with caution, however, because more than 40% of cells in H1 and H3 had expected counts below five.

8.9.2 One-Way ANOVA (H4)

Hypothesis	Dependent variable	Forecasting technology group	N	Mean	Std. Deviation
H04	Energy-use significance	Artificial Intelligence (AI)	48	3.229	0.660
H04	Energy-use significance	Blockchain	15	3.267	0.458
H04	Energy-use significance	GPS	27	3.000	0.920
H04	Energy-use significance	Internet of Things (IoT)	20	3.000	0.973

Group Descriptives for One-Way ANOVA (H4)

Source	SS	df	F	p	η^2	Decision
Between groups	1.542	3	0.859	0.4648	0.024	Not rejected
Within groups	63.412	106				

One-Way ANOVA Result (H4): Perceived Energy-Use Significance by Forecasting Technology

Interpretation: Respondents who chose AI ($M = 3.229$) or blockchain ($M = 3.267$) as the best forecasting technology rated dark-store energy use slightly higher than those who chose GPS or IoT (both $M = 3.000$), but the difference is not significant, $F(3, 106) = 0.859$, $p = 0.465$, $\eta^2 = 0.024$. H04 is therefore not rejected: the technology respondents prefer for inventory forecasting is not significantly related to how serious they consider dark-store energy use. Levene's test is borderline ($p = 0.073$) and the Kruskal–Wallis test supports the result ($p = 0.768$). The effect is small, and the groups are of unequal size (15 to 48).

8.9.3 Linear Regression (H5)

Predictor	B	Std. Error	t	p	r
(Constant)	3.194	0.327	9.754	< 0.001	—
IoT usefulness	0.021	0.096	0.219	0.827	0.021

Simple Linear Regression (H5): Importance of Sustainable Sourcing on IoT Usefulness

Interpretation: Perceived usefulness of IoT and real-time tracking explains almost none of the variation in the importance given to sustainable sourcing ($R^2 < 0.001$). The slope ($B = 0.021$) is not significant, so H05 is not rejected in the simple model. A Spearman rank correlation tells the same story ($\rho = 0.002$, $p = 0.983$).

Predictor	B	Std. Error	t	p	95% CI	VIF
(Constant)	3.860	0.535	7.211	< 0.001	[2.798, 4.921]	—
IoT usefulness	0.036	0.097	0.369	0.713	[-0.157, 0.229]	1.06
Usage frequency	-0.138	0.071	-1.954	0.053	[-0.278, 0.002]	1.04

Predictor	B	Std. Error	t	p	95% CI	VIF
Monthly income	0.044	0.067	0.653	0.515	[-0.090, 0.178]	1.09
Education	-0.180	0.088	-2.039	0.044	[-0.355, -0.005]	1.06
Age group	0.016	0.094	0.168	0.867	[-0.171, 0.203]	1.05

Multiple Linear Regression (H5): Importance of Sustainable Sourcing

Interpretation: Even after controlling for usage frequency, income, education and age, IoT usefulness has no significant effect ($B = 0.036$, $p = 0.713$). The model explains 6.6% of the variance (adjusted $R^2 = 2.2\%$) and is not significant overall, $F(5, 104) = 1.479$, $p = 0.203$, so H05 is not rejected. Education has a small negative coefficient ($B = -0.180$, $p = 0.044$) and usage frequency is borderline ($B = -0.138$, $p = 0.053$), but with five predictors in a non-significant model these are best treated as exploratory signals rather than evidence. VIF values (1.04–1.09) show no multicollinearity, and the Durbin–Watson statistic is 2.07. Residuals are not normal (Shapiro–Wilk $p < 0.001$) because the outcome is a skewed four-point item, so the coefficients should be read with caution.

8.9.4 Summary of Hypothesis Testing

Hypothesis	Test	Statistic	p-value	Decision
H01	Chi-square	$\chi^2(9) = 12.416$	0.191	Not rejected
H02	Chi-square	$\chi^2(2) = 0.756$	0.685	Not rejected
H03	Chi-square	$\chi^2(9) = 3.024$	0.963	Not rejected
H04	One-way ANOVA	$F(3, 106) = 0.859$	0.465	Not rejected
H05	Linear regression	$F(5, 104) = 1.479$	0.203	Not rejected

Summary of Hypothesis Testing

Interpretation: All five null hypotheses are retained. In this dataset, no statistically significant relationship was found between green supply chain practices, awareness, packaging choice, inventory-related technology or technology usefulness and the corresponding sustainability measures. Given the sample size ($n = 110$), the proxy measures and the synthetic nature of the data, this should be read as a lack of detectable association, not as proof that such relationships do not exist.

9. Major Findings

- Respondents are young (81 % aged 18–35) urban (63.6 %) and regular users (60 %). Fast delivery is their reason for using quick commerce (39.1 %).
- Carbon emissions (42.7 %) and packaging waste (37.3 %) are the environmental worries. Eighty-nine percent (80.9 %) report congestion occasionally or frequently and plastic is the common waste (53.6 %).
- Route optimisation (46.4 %) and electric vehicles (EVs) (32.7 %) lead as green transport practices. Recyclable packaging is the popular single packaging option (32.7 %).
- Artificial intelligence is the favoured forecasting technology (43.6 %). Route optimisation is seen as the way to cut delivery distance (60.9 %). Point six percent (83.6 %) value IoT tracking and seventy percent (70 %) regard transparency as blockchain's benefit.
- High technology cost (43.6 %) and lack of awareness (26.4 %) are the barriers. EV adoption is held back by purchase and charging costs and consumer participation faces obstacles at once.
- A combination of route optimisation, EVs and eco-friendly packaging is preferred by 56.4 % of respondents over any measure.
- None of the five hypotheses received support: H1 ($p = 0.191$) H2 ($p = 0.685$) H3 ($p = 0.963$) H4 ($p = 0.465$) and H5 ($p = 0.203$) so H01–H05 are not rejected.
- Attitudinal means of 3.14–3.33 out of 4 show generally positive support, for sustainability and technology-based improvements.

10. Suggestions

1. Focus on route optimization and AI forecasting to reduce delivery distances avoid trips and lower inventory waste.
2. Gradually introduce two-wheelers supported by shared charging stations and battery-swapping systems.

3. Switch to sized, recyclable or reusable packaging to cut down on plastic waste and make recycling easier.
4. Improve energy efficiency in stores by upgrading lighting, refrigeration and using renewable energy sources.
5. Use IoT and real-time tracking for vehicles and inventory. Add blockchain technology when transparency is important.
6. Increase customer awareness by sending in-app messages offering green delivery options and giving rewards for choices.
7. Combine green practices and monitor key metrics like emissions packaging waste and cost per order.
8. Look for government and industry support such, as electric vehicle incentives, better charging infrastructure and shared sustainability standards.

11. Conclusion

This study "Green Supply Chain Optimization in 10-Minute Delivery Models: A Study of Urban Quick Commerce " looked into the problems caused by ultra-fast delivery and the sustainable ways to fix them.

People who took part in the study said carbon emissions and packaging waste are the issues. They also think route optimization, electric vehicles, AI-based demand forecasting and eco-friendly packaging are steps toward being more sustainable. They also pointed out that high tech costs and low awareness make it hard to adopt green practices.

Even though people have attitudes toward sustainability the statistical tests didn't show strong enough evidence to support any of the five hypotheses. That means the study couldn't confirm the connections between the variables it looked at.

The findings show that improving performance, without slowing down delivery speed needs teamwork. Technology, green transport, smart packaging and customer involvement all have to work together.

Overall, a full green supply chain plan can help quick-commerce companies lower their harm use resources more wisely and stay sustainable in the long run. Future studies could look at green technologies and test how they perform in different city markets.

12. Limitations and Scope for Future Research

12.1 Limitations

The study is limited by its sample of 110 respondents, which may not represent different consumers of quick-commerce services across urban India. The findings rest on respondents' perceptions and may differ from the actual environmental performance of quick-commerce businesses. The study also concentrates on a few green supply chain practices, namely route optimization, electric vehicles, eco-friendly packaging and technology adoption, while other factors may also influence sustainability.

12.2 Scope for Future Research

Future research could use a larger and more varied sample drawn from different cities to make the findings easier to generalize. Data collected directly from quick-commerce companies would allow actual carbon emissions, packaging waste, delivery distances and energy use to be measured. Comparative studies across platforms could show which sustainability strategies work best, and further work could examine the long-term cost-effectiveness of electric vehicles, AI-based demand forecasting and reusable packaging.

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