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Effect of intra-urban logistics congestion on last-mile delivery efficiency of motorcycle dispatch services in Lagos State, South-West, Nigeria

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Abstract – Intra-urban logistics congestion has become a major barrier to last-mile delivery efficiency, particularly for motorcycle dispatch services that depend on rapid movement and frequent stop cycles to meet customer expectations. This study examined the effect of intra-urban logistics congestion on last-mile delivery efficiency of motorcycle dispatch services in Ikeja Community, Lagos State, South-West Nigeria. A quantitative cross-sectional survey design was adopted, and primary data were collected from 400 motorcycle dispatch riders using a structured questionnaire. Respondents were selected through purposive sampling of active riders and systematic selection across key dispatch clusters. Yamane's formula guided the sample size determination, while variables were measured on a 5-point Likert scale and analysed using multivariate multiple regression within the General Linear Model framework.

Findings showed that congestion exposure significantly increased delivery trip time ($B = 5.532$, $p < .001$) and failed drop-offs per week ($B = 0.900$, $p < .001$), while reducing deliveries completed per shift ($B = -1.897$, $p < .001$). Travel time variability pressure significantly increased delivery time variability ($B = 2.157$, $p < .001$), confirming that unpredictability is a major efficiency constraint. Curbside access difficulty significantly increased delivery re-attempt frequency ($B = 0.919$, $p < .001$), while stopping constraint significantly reduced deliveries per shift ($B = -0.672$, $p < .001$).

The study concludes that congestion reduces motorcycle dispatch efficiency through travel delay, time uncertainty, and access friction. It recommends improved curbside stopping spaces, congestion-aware dispatch planning, and operational support for safer stop management to enhance delivery reliability.

Key words – intra-urban logistics, congestion, last-mile delivery, motorcycle dispatch, delivery efficiency.

JEL Classification – R41, L90; L91, L92

Introduction

Urban freight movements increasingly shape city performance because last-mile delivery activity competes directly with passenger travel on limited road capacity and unstable street operations [1]. Intra-urban logistics refers to the planning and execution of goods movement within a city, including pickup, sorting, routing, and delivery processes that occur over short distances but under intense network pressure [2]. Congestion in this context means recurrent or non-recurrent traffic conditions where demand exceeds available road space, producing queueing, slower speeds, travel time variability, and higher stopping frequency that disrupt delivery flow [3]. Last-mile delivery efficiency can be defined as the ability to achieve timely, reliable, and cost-effective delivery outcomes using available resources, often reflected in delivery completion rate, punctuality, time per stop, and operational productivity [4]. Motorcycle dispatch services represent a last-mile mode that relies on two-wheeled mobility for fast, flexible deliveries, yet their performance still depends on the same road network, curb access conditions, and urban friction that influence other delivery operators [5]. This makes congestion not only a transport issue but also a logistics performance issue because it converts distance into delay and transforms routine trips into uncertain service outcomes.

Existing research has produced valuable insights on last-mile delivery design, urban freight sustainability, and operational efficiency, but it also reveals persistent limitations when urban conditions are highly disrupted and delivery work is time-sensitive [6]. Many last-mile models emphasize routing optimization and structured delivery tours, but real-world performance is often shaped by interruptions such as speed fluctuations, stop density, and unpredictable road interactions that reduce the stability of planned schedules [4]. Evidence also suggests that delivery impacts on traffic networks are not linear, because small disruptions around bottlenecks can trigger broader delay patterns that directly reduce delivery throughput and reliability [3]. In addition, planning and management of delivery bays and curb access remains a crucial operational factor, since inefficient loading conditions can increase dwell time, cause risky maneuvers, and intensify congestion spillovers [7]. These findings imply that the efficiency problem is not only about route choice but also about how street-level access and congestion interact to shape delivery completion.

The problem is that while the literature recognizes congestion and curb competition as important constraints, mode-specific evidence on how intra-urban congestion reduces the operational efficiency of motorcycle dispatch services remains limited and fragmented across contexts [8-12]. Research on e-commerce delivery growth often highlights increased urban delivery traffic, yet it can understate the behavioral and operational realities of rapid-response dispatch services that depend on high trip frequency and short service windows [8]. Studies on sustainable city logistics commonly generalize across freight actors, which can hide the distinct exposure of motorcycle dispatch to mixed traffic interactions, informal stopping, and safety-sensitive maneuvers under congestion [9]. Work on curb optimization indicates that better curb management can reduce delivery impacts, but this does not automatically explain how congestion-driven delays translate into missed deliveries, re-attempts, and service unreliability for motorcycles [10]. Empirical evidence that commercial vehicles cruise for parking shows that access and search time can be major delay sources, yet the same access logic is rarely tested as a central efficiency constraint in motorcycle-based last-mile delivery [11]. Although loading-zone studies model arrivals and parking durations, they often focus on formal freight bays rather than the informal, high-turnover pickup and drop-off environment that characterizes dispatch operations [12].

Against this background, this study assesses the effect of intra-urban logistics congestion on last-mile delivery efficiency of motorcycle dispatch services in Ikeja Community, Lagos State, South-West Nigeria. The objectives of the study are to:

- examine how congestion exposure affects motorcycle dispatch delivery trip time and overall delivery productivity per shift
- assess the influence of congestion on delivery completion performance, particularly failed drop-offs among motorcycle dispatch riders
- evaluate how travel time variability pressure contributes to delivery time unpredictability and efficiency constraints in dispatch operations
- determine how curbside access difficulty affects delivery re-attempt frequency among motorcycle dispatch services
- analyse how stopping constraints under congested conditions reduce the number of deliveries completed per shift by dispatch riders.

RESEARCH HYPOTHESES

The study tested the following alternative hypotheses:

H_1: Congestion exposure significantly increases motorcycle dispatch delivery trip time and significantly reduces deliveries completed per shift.

H_2: Congestion exposure significantly increases failed drop-offs among motorcycle dispatch riders.

H_3: Travel time variability pressure significantly increases delivery time variability in motorcycle dispatch operations.

H_4: Curbside access difficulty significantly increases delivery re-attempt frequency among motorcycle dispatch services.

H_5: Stopping constraints under congested conditions significantly reduce the number of deliveries completed per shift.

1. LITERATURE REVIEW

The conceptualization of urban freight systems is becoming more and more networked socio-technical systems in which the efficiency of delivery is not only determined by route optimization, but also by road capacity constraints, high-density activity, and contested public spaces [1, 6, 9]. Although the last-mile delivery has been extensively modeled, the existing frameworks fail to capture micro-level disruptions and frictions associated with stops that create significant service variability [3-4, 13]. It has been shown that repeated interruptions can be experienced in short urban trips, which can be difficult to measure using classical distance- or cost-based performance measures [4-5, 14]. As a result, efficiency must be considered as multidimensional, which combines reliability in the case of uncertainty, limited access, and curbside space competition [2, 15-16]. The congestion as a homogenous background factor assumption is becoming more and more disputed, and intra-urban logistics studies should explicitly connect congestion states to the results of deliveries [1, 17-18].

The impact of congestion is not only through the decrease in the average speed but also through time variability, network spillovers, and service instability [3, 8-9]. Most analyses tend to presume linear effects of congestion, ignoring contextual moderators of operations, including stop density, task urgency, and street design, which can have a very divergent operational effect [1, 19-20]. High-frequency stops in last-mile delivery enhance variability, necessitating time buffers, decreasing the number of completed deliveries, and increasing the rate of re-attempts [3-5]. Additionally, the congestion is often viewed as an externality in city logistics studies, as opposed to an emergent outcome of delivery behavior, curb conflicts, and inefficient access [9, 21-22]. These views suggest that the efficiency losses due to congestion are structural, and they occur due to the interaction of travel and stop delays, and not individual travel-time penalties [1, 3, 23].

Curb-related delays are always found to be a significant part of the inefficiency of deliveries [11, 24-25]. Parking search, access competition, and long dwell times have a direct negative impact on service reliability, but numerous studies focus on travel-time measures and do not sufficiently address the dynamics of stops [10-11, 13, 26]. The current body of curb-management studies shows that the inefficiencies are exacerbated by the crashes between the delivery and passenger parking [21, 27-28]. Nevertheless, the majority of empirical studies focus on trucks and vans, and there is a significant gap in the literature on motorcycle dispatch operations with shorter and more frequent stops and often informal [7, 11, 13]. This points to a serious gap in measurement mode-specific stop dynamics are not well studied as compared to traditional freight.

The research on infrastructure and enforcement shows that the provision of facilities is not enough, and behavioral compliance is a key factor in whether access can lead to efficiency gains [7, 28-29]. In places where there is formal availability of delivery bays, lax enforcement promotes rational shortcuts that can enhance individual productivity but systemic congestion [10, 27, 29]. The assumption of policy modeling that opportunistic delivery behavior is statically compliant underestimates the variability of opportunistic delivery behavior [19, 21, 28]. Thus, studies that combine enforcement, reliability of curb access, and delivery results are required to produce results with operational significance [12, 29-30].

Peak congestion can be alleviated with temporal strategies like off-hour delivery and receiver-led scheduling, but their applicability is limited by business practices, security, and client preparedness [31-32]. Temporal interventions are not adequate in high-frequency, on-demand settings such as motorcycle dispatch because customer demands on responsiveness cannot be met when access constraints remain [4-5, 33]. In this way, the temporal exposure and the reliability of stop-level access should be included in the study of the effects of congestion [3, 10, 17].

The efficiency metrics currently in use tend to simplify the concept of efficiency by focusing on reducing travel time or distance instead of operational performance outcomes, including completion rates or variability [4-5, 16]. Productivity is mediated by behavioral aspects, such as reactions to congestion, the lack of stops, and network instability, and further complicates the transferability of traditional metrics [11, 24, 26]. The literature has been demonstrated to be disjointed, focusing on formal parcel systems and mature urban settings, and a poor representation of semi-formal or informal delivery ecosystems [6, 14, 18]. As a result, the results of traditional freight research might not be applicable to the context of different enforcement, curb utilization, and traffic dynamics, which highlights the importance of mode-specific, context-based analysis [1, 9, 21].

Congestion mechanism synthesis Network delay, curb access uncertainty, and governance-driven stopping behavior are synthesized to show that these are recognized in the literature, but evidence is mostly vehicle-based and does not consider high Feedback loops at the system level increase inefficiencies: congestion increases stopping conflicts, which increases disruption, and generates compounding losses to rapid delivery modes [1, 10, 23]. Thus, a serious gap exists in the testing of the congestion-efficiency relationship based on the operational outcomes that can be measured and reflect the reality of motorcycle dispatch in high-density urban corridors. This gap is filled in the current study in Ikeja Community, Lagos State, South-West Nigeria, where mixed traffic pressures, informal stopping behavior, and high-frequency deliveries exacerbate the visibility and relevance of these mechanisms.

2. METHODOLOGY

The study was carried out in Ikeja Community, Lagos State, Nigeria. This is a high-activity urban corridor where commercial trips, commuting traffic, and frequent delivery stops create persistent intra-urban logistics congestion. The study population was the residents and economic actors within Ikeja Local Government Area, estimated at 470,200 persons [34]. Sample [35] size formula was used, using 5% precision, produced an estimated sample of 399.7, which was approximated to 400 respondents for field administration. Primary data were collected through a structured questionnaire administered to motorcycle dispatch riders using a purposive sampling technique to target only active riders, followed by systematic selection at major dispatch clusters, parks, and pickup points across Ikeja to reduce selection bias. The instrument contained close-ended items measured on a 5-point Likert scale capturing perceived congestion exposure, delivery time variability, curbside access difficulty, stopping constraints, and delivery efficiency outcomes such as timely completion, failed drop-offs, and repeat attempts. Data were analysed using multivariate regression analysis to test the combined influence of congestion-related factors on delivery efficiency outcomes. The model was specified as:

The multivariate regression model is specified as:

$$Y = B_0 + B_1CONG_1 + B_2TVAR_2 + B_3CURB_3 + B_4STOP_4 + e \quad (1)$$

Where:

Y = vector of dependent variables (delivery efficiency outcomes), such as:
Y_1 = delivery travel time;
Y_2 = delivery time variability;
Y_3 = delivery completion success (including failed drop-offs/re-attempts);
Y_4 = delivery productivity (deliveries completed per shift);
Y_5 = service responsiveness;
CONG = congestion exposure/intensity;
TVAR = congestion-related travel time variability;
CURB = curbside access difficulty;
STOP = stopping constraint under congestion;
B_0 = intercept matrix, B_1-B_4 = coefficient matrices;
e = multivariate error term.

MODEL DIAGNOSTICS

In order to comply with the requirements of regression-based inference methodology, the interpretation of the model entailed diagnostic checks concerning linearity, independent observations, normally distributed residuals, homoscedasticity, and multicollinearity. Multicollinearity is checked by tolerance and variance inflation factor (VIF) indicators, with a high tolerance level higher than 0.20 and VIF lower than 5 being a sufficient condition for independent predictors within social science research.

The adequacy of the model was not assumed based solely on the value of R^2. The analysis included such indicators as Pillai's Trace for multivariate significance, F-values, p-value, R^2, adjusted R^2, partial eta squared, direction of the coefficient, and meaningfulness of unstandardized coefficients. Being a cross-sectional study with survey data utilized, the coefficients are viewed as correlations rather than causations.

3. RESULT

3.1. SOCIO-ECONOMIC CHARACTERISTICS OF THE RESPONDENTS

Table 1 and Figure 1 present the socio-economic profile of the motorcycle dispatch riders that participated in the study. For age, 99 respondents, or 24.8%, were 18-24 years old, showing that a significant number of the riders sampled in this study were young people starting out in motorcycle dispatch operations. Moreover, 241 respondents, or 60.2%, were aged 25-34 years, showing that most of the riders sampled in this study were active youth. 58 respondents, or 14.5%, were aged 35-44 years, suggesting that a smaller number of the riders sampled were older adults who were still actively engaged in dispatch work. Only 2 respondents, or 0.5%, were 45 years and older, showing that very few older riders were sampled in this study.

In terms of riding experience, 183 respondents, or 45.8%, had 0-1 year of experience, showing that the majority of the riders sampled in this study were new to dispatch riding. 158 respondents, representing 39.5%, had 2-3 years of experience, indicating that another large proportion of respondents had short to moderate experience in dispatch riding. 42 respondents, representing 10.5%, had 4-5 years of experience, showing that only a small proportion of riders sampled had longer experience. 17 respondents, representing 4.2%, had 6 years and above riding experience, indicating that only a few respondents in the study had long experience in dispatch riding.

For average hours of work per shift, 67 respondents, or 16.8%, worked less than 8 hours per shift, showing that a minority of riders sampled in this study had shorter daily exposure to intra-urban delivery conditions. 203 respondents (50.7%) worked 8-10 hours per shift, indicating that most of the respondents in this study had long hours of dispatch work. 130 respondents, representing 32.5%, worked more than 10 hours per shift, showing that a significant proportion of respondents had very long exposure to traffic congestion and delivery pressure.

In essence, the socio-economic characteristics of the sample show that the study mainly surveyed young, less-experienced motorcycle dispatch riders working long hours, making the respondents appropriate for the study of the impact of intra-urban logistics congestion on last-mile delivery efficiency.

Table 1: Socio-economic characteristics of respondents

Characteristic	Category	Frequency (n)	Percentage (%)
Age group (years)	18-24	99	24.8
	25-34	241	60.2
	35-44	58	14.5
	45+	2	0.5
Riding experience (years)	0-1 year	183	45.8
	2-3 years	158	39.5
	4-5 years	42	10.5
	6+ years	17	4.2
Average work hours per shift	Less than 8 hours	67	16.8
	8-10 hours	203	50.7
	Above 10 hours	130	32.5

Source: Field Survey (2025)

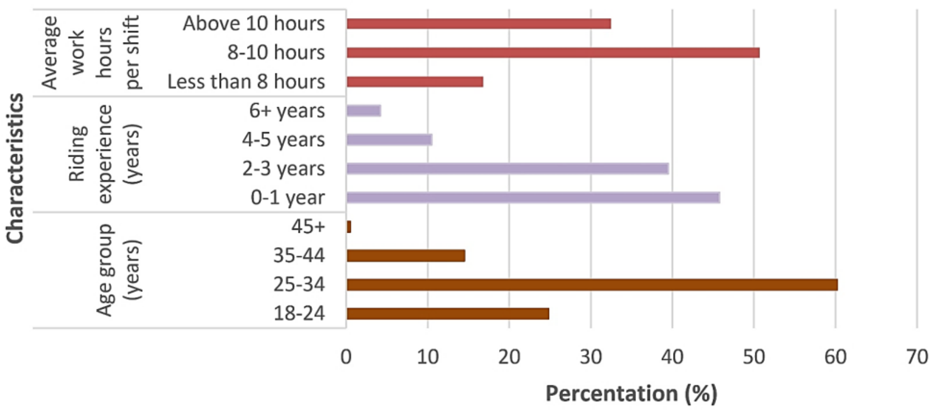

Fig. 1. Socio-economic characteristics of the respondents

3.2. MULTIVARIATE TESTS OF OVERALL MODEL SIGNIFICANCE

Table 2 confirms that congestion-related factors have a statistically significant joint effect on the combined delivery efficiency outcomes. In practical terms, congestion exposure (CONG_SC) produced the strongest multivariate influence (Pillai = .360), followed by travel time variability (TVAR_SC) (Pillai = .301). This pattern is consistent with the argument that urban delivery performance is shaped not only by slow movement but by unstable travel conditions that disrupt delivery scheduling and stop sequencing, as discussed in the network-performance and last-mile operational perspectives [3, 8]. The results also corroborate the view that last-mile efficiency is a multidimensional systems outcome rather than a simple routing problem [1, 4]. Curbside access difficulty (CURB_SC) remained significant but smaller, which aligns with curb-competition evidence showing that access constraints matter, but their effects may be more visible on selected outcomes like re-attempts than on all outcomes at once [11, 27]. STOP_SC was significant but weakest, which suggests that stopping constraints contribute to efficiency losses, yet they may operate as a reinforcing factor under broader congestion pressure rather than the primary driver [7, 10].

Table 2: Multivariate Tests (Pillai's Trace)

Effect	Pillai's Trace	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
CONG_SC	.360	44.082	5	391	.000	.360
TVAR_SC	.301	33.662	5	391	.000	.301
CURB_SC	.093	7.983	5	391	.000	.093
STOP_SC	.048	3.912	5	391	.002	.048

As shown in Table 3, the model explains a large share of variance in trip time (R^2 = .545) and time variability (R^2 = .553). This supports the established position that congestion mainly damages last-mile delivery through time loss and unpredictability, which weakens operational planning and rider productivity even when trip distances are short [4-5]. In line with delivery systems research, stronger explanatory power for time outcomes suggests that congestion is most directly experienced as unstable travel conditions and repeated stop-start delays [1, 3].

However, the model explains relatively less variance for failed drop-offs (R^2 = .097) and re-attempts (R^2 = .159), indicating that service failure outcomes are shaped by additional factors beyond traffic conditions. This aligns with demand-management and receiver-side arguments which show that delivery failures can be driven by customer availability, access restrictions, and coordination limits, not only congestion [31-32]. For deliveries per shift, the model shows moderate explanatory power (R^2 = .367), reinforcing the productivity argument that congestion reduces throughput by increasing time per task and constraining the number of feasible job completions [10, 13].

Table 3: Tests of Between-Subjects Effects (Model Summary)

Dependent Variable	F	Sig.	R Squared	Adj. R Squared	Partial Eta Squared
TRIPTIME_MIN	118.163	.000	.545	.540	.545
TIMEVAR_MIN	122.147	.000	.553	.548	.553
FAILWK	10.626	.000	.097	.088	.097
REATTWK	18.621	.000	.159	.150	.159
DELIV_SHIFT	57.207	.000	.367	.360	.367

TEST OF HYPOTHESES

Table 4 provides the clearest evidence on which congestion mechanisms matter for specific delivery outcomes. First, congestion exposure (CONG_SC) significantly increased delivery trip time (B = 5.532, $p < .001$) and failed drop-offs per week (B = 0.900, $p < .001$), while also reducing deliveries completed per shift (B = -1.897, $p < .001$). This pattern supports the operational argument that congestion reduces productivity through time loss and service disruption, which is in line with network impact evidence linking traffic conditions to delivery performance decline [3] and the urban freight literature describing congestion as a primary last-mile cost driver [1]. It also corroborates the position that last-mile systems do not fail only on speed but on throughput and reliability, because longer trip times translate into fewer completed tasks [4-5].

Secondly, travel time variability (TVAR_SC) was the dominant predictor of the variability outcome itself

(TIMEVAR_MIN), with a strong positive effect (B = 2.157, $p < .001$). This finding strengthens the critical point made in urban freight studies that uncertainty is a separate performance problem from average delay, because variability makes delivery planning unstable and increases operational stress [8-9]. In terms of delivery operations, this aligns with the broader literature that highlights variability as a key barrier to reliable service promises in last-mile contexts [33].

Thirdly, curbside access difficulty (CURB_SC) significantly increased re-attempt frequency (REATTWK) (B = 0.919, $p < .001$). This is consistent with curbside competition and access constraint arguments showing that difficulty in stopping, locating safe access points, and managing customer-side entry conditions can directly trigger repeat visits, additional delay cycles, and inefficient task repetition [11, 27]. The result also reinforces the curb-management position that delivery inefficiency is often produced at the stopping point rather than only while moving through the network [10, 28].

Also, stopping constraint (STOP_SC) significantly reduced deliveries per shift (DELIV_SHIFT) (B = -0.672, $p < .001$), meaning that when riders struggle to stop safely or quickly under congested conditions, their shift productivity declines. This supports the view that delivery performance depends on curb operations and stop efficiency, not only route travel, which aligns with evidence that parking and dwell time inflation reduce last-mile output [13, 24-25]. The non-significant effects observed for some predictors across some outcomes indicate that congestion impacts are not uniform, which is a key critical insight for city logistics research that warns against one-size-fits-all assumptions in last-mile policy and operations [19, 21-22].

Thus, according to the estimated parameters, the five alternative hypotheses in the study were accepted. H_1 was accepted as congestion exposure significantly increased delivery trip time (B = 5.532, $p < .001$) and significantly reduced deliveries completed per shift (B = -1.897, $p < .001$). H_2 was accepted as congestion exposure significantly increased the number of failed drop-offs for motorcycle dispatch riders (B = 0.900, $p < .001$). H_3 was accepted as travel time variability pressure significantly increased delivery time variability (B = 2.157, $p < .001$). H_4 was accepted because difficulty in accessing the curb significantly increased the number of re-attempts (B = 0.919, $p < .001$). H_5 was also as because stopping restrictions in congested conditions significantly decreased deliveries completed per shift (B = -0.672, $p < .001$). In essence, the hypotheses test show that intra-urban logistics congestion significantly affects last-mile delivery efficiency of motorcycle dispatch services in the study, primarily by increasing trip time, failed drop-offs, delivery time variability, re-attempts and reducing the number of deliveries per shift.

Table 4: Parameter Estimates (Unstandardized B, Sig.)

Dependent Variable	Predictor	B	Sig.	Direction
TRIPTIME_MIN	CONG_SC	5.532	.000	Positive
	TVAR_SC	0.477	.159	Not significant
	CURB_SC	-0.146	.604	Not significant
	STOP_SC	-0.265	.313	Not significant
TIMEVAR_MIN	CONG_SC	0.306	.174	Not significant
	TVAR_SC	2.157	.000	Positive
	CURB_SC	0.227	.108	Not significant
	STOP_SC	-0.059	.651	Not significant
FAILWK	CONG_SC	0.900	.000	Positive
	TVAR_SC	-0.181	.307	Not significant
	CURB_SC	0.132	.371	Not significant
	STOP_SC	0.036	.794	Not significant
REATTWK	CONG_SC	0.218	.391	Not significant
	TVAR_SC	-0.004	.983	Not significant
	CURB_SC	0.919	.000	Positive
	STOP_SC	0.032	.830	Not significant
DELIV_SHIFT	CONG_SC	-1.897	.000	Negative
	TVAR_SC	0.127	.526	Not significant
	CURB_SC	0.114	.493	Not significant
	STOP_SC	-0.672	.000	Negative

3.3. DISCUSSION OF FINDINGS

The study findings confirm that intra urban logistics congestion has a significant impact on the efficiency of motorcycle dispatch delivery, but the impact is through multiple delivery channels rather than a general mechanism. The results of the multivariate analysis show that the effect of congestion exposure was the strongest overall on the combined delivery outcomes (Pillai's Trace = .360, F = 44.082, $p < .001$) followed by the effect of travel time variability pressure (Pillai's Trace = .301, F = 33.662, $p < .001$), while the effects of curbside access difficulty (Pillai's Trace = .093, F = 7.983, $p < .001$) and stopping constraints (Pillai's Trace = .048, F = 3.912, $p = .002$) were weaker but still significant. This suggests that motorcycle dispatch inefficiency is not just a congestion problem, but also a result of travel time variability, access difficulty and stopping constraints. This finding supports the argument that last mile delivery performance is a complex operational outcome, rather than a simple travel distance or speed issue [1, 4].

The model summary also indicates that the congestion related variables explained a fairly large share of the variance in delivery trip time ($R^2 = .545$) and delivery time variability ($R^2 = .553$), confirming that time loss and timing instability are the most impacted performance dimensions by congestion. This confirms that last mile inefficiency is caused by delay, frequent disruptions and unstable travel conditions, even for short delivery distances [1, 3, 5]. But the relatively low explanatory power for failed drop offs ($R^2 = .097$) and re attempt frequency ($R^2 = .159$) shows that service failure is only partially explained by congestion related factors. This is important as it demonstrates that failed drop offs and re attempts are not only influenced by travel delay, but may also be influenced by access, receiver availability and coordination factors, as per [32] and [33]. The explanatory power for deliveries per shift was moderate ($R^2 = .367$) which shows that congestion reduces rider productivity, but productivity is also affected by multiple operational factors.

The estimated parameters provide more evidence for the five hypotheses. Hypothesis 1 was confirmed because exposure to congestion significantly increased delivery trip time (B = 5.532, $p < .001$) and significantly decreased deliveries completed per shift (B = -1.897, $p < .001$). This shows that congestion reduces delivery efficiency by increasing trip time and decreasing the number of deliveries completed per shift, as found by [8], [9], [33]. Hypothesis 2 was also supported because congestion exposure significantly increased failed drop offs (B = 0.900, $p < .001$), which suggests that congestion not only increases travel time but also impacts service delivery. But congestion exposure did not significantly increase re attempts (B = 0.218, $p = .391$), which indicates that re attempts are not a continuation of congestion, but are more related to access level restrictions.

Hypothesis 3 was also supported because travel time variability pressure significantly increased delivery time variability (B = 2.157, $p < .001$). This is significant because it distinguishes between delay and variability. That is, travel time variability is different from travel time. This finding is consistent with [1], [3-5], who claim that reliability failure is a significant problem in last mile delivery. Hypothesis 4 was supported because curbside access problem significantly increased the number of delivery re attempts (B = 0.919, $p < .001$), showing that repeated deliveries are highly correlated with access problems at the stopping point, rather than traffic delay in general. This finding is consistent with [10-11], [27-28], who stress that curbside competition and access problems lead to inefficiency at the stopping point. Hypothesis 5 was also supported because stopping constraints significantly decreased the number of deliveries per shift (B = -0.672, $p < .001$), demonstrating that the inability to stop safely, quickly, or conveniently during congestion reduces the number of deliveries.

LIMITATIONS OF THE STUDY

The results should be interpreted with care as:

- the study was based solely on subjective survey data from motorcycle dispatch riders. The survey responses reflect riders' subjective views of congestion exposure, access difficulty, failed drop-offs, and productivity, but they were not verified with objective GPS traces, dispatch platform logs, timestamp data, or customer delivery data.
- Purposive sampling was necessary to access active dispatch riders, but it restricts the generalisation of the results to other clusters in Ikeja. Selection bias may also be present if the riders available at parks, pickup points and dispatch clusters were different from those who were unavailable or connected to closed dispatch platforms.
- The regression findings report statistically significant effects, but they should not be considered definitive causal effects. The cross-sectional nature of the study does not support temporal precedence, and the study did not use a full causal modelling approach such as structural equation modelling.

Conclusions

This study established that intra-urban logistics congestion significantly reduces the last-mile delivery efficiency of motorcycle dispatch services. Congestion exposure was found to increase delivery trip time and reduce the number of deliveries completed per shift, showing that traffic delay directly weakens rider productivity and service capacity. Travel time variability also emerged as a major constraint, confirming that uncertainty in movement conditions affects delivery reliability beyond average delay. In addition, the study showed that delivery outcomes are not driven by congestion alone, because curbside access difficulty significantly increased delivery re-attempts, indicating that inefficiency is also created at pickup and drop-off points where stopping and access are contested. Overall, the findings confirm that motorcycle dispatch efficiency is shaped by a combined mechanism of travel delay, time unpredictability, and access constraints, which together reduce timely delivery, increase failed drop-offs, and limit rider responsiveness to delivery requests.

Recommendations

Based on the study objectives and findings, the following are recommended to improve motorcycle dispatch delivery efficiency under congestion:

- **Improve curbside access for deliveries:** designate and enforce short-stay stopping points around major pickup and delivery clusters to reduce re-attempts linked to access difficulty.
- **Manage congestion exposure during peak periods:** encourage operational scheduling that reduces reliance on the most congested corridors during peak traffic windows where possible, to lower travel time inflation.
- **Strengthen dispatch routing support:** promote real-time route guidance and rider communication systems that help riders adjust to time variability and avoid delay hotspots.
- **Support safer and faster stop operations:** provide operational guidelines and collaboration with local traffic control to reduce unsafe stopping constraints that limit deliveries per shift.

Recommendations for further research

Future studies should extend the analysis by integrating objective GPS data, dispatch system logs, app-based timestamps, and delivery completion records. This would reduce perceptual error, support stronger validation of travel delay and re-attempt measures, and make it possible to test causal pathways through structural equation modelling or longitudinal designs.

Author Contributions

- title finalization, A.E. (Adeolu Emmanuel Gbadgesin);
- idea conceptual, F.A. (Frank Adekunle Mensah);
- literature review methodology, J. O. (Jonathan Olaniyi Ojo);
- methodology, F.A.;
- analysis, A.E.;
- findings and report, A.E.;
- conclusion and recommendation, J.O.;
- proof-reading and editing, F.A.

All authors have read and agreed to the published version of the manuscript

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