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ENTREPRENEURIAL INNOVATIONS IN LAST-MILE MOBILITY AND PUBLIC TRANSPORT ADOPTION FOR SUSTAINABLE URBAN MOBILITY: A QUALITATIVE THEMATIC REVIEW WITH EVIDENCE FROM MUMBAI

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ABSTRACT

Adoption of public transport has become central to India's sustainable urban mobility agenda in the face of rapid urbanization, rising private vehicle ownership, and worsening congestion. This is especially evident in Mumbai, whose suburban rail and bus network carries millions of commuters daily yet suffers from overcrowding, first- and last-mile gaps, and a declining modal share among discretionary users. To consolidate what is known about the determinants of public transport adoption and to examine how these determinants interact with the entrepreneurial ecosystem of mobility start-ups and technology ventures, this paper adopts a qualitative research design built on a systematic review and thematic analysis of published literature. Purposeful identification and analysis of peer-reviewed articles, institutional reports, and doctoral sources published between 1989 and 2025, using a thematic-synthesis procedure, yielded seven recurrent themes: behavioural and attitudinal factors, service quality and satisfaction, safety and gender dimensions, infrastructure and accessibility, sustainability and environmental motivation, technology and digital adoption, and entrepreneurial innovation in last-mile connectivity. These themes are integrated into a conceptual framework proposing that entrepreneurial mobility innovation improves the conversion of favourable commuter perceptions into actual public transport use in the Mumbai Metropolitan Region (MMR). The paper offers theoretically derived propositions and a literature-grounded framework rather than field-tested results, and it explicitly acknowledges the absence of primary survey or interview data as a boundary condition of its conclusions. To provide a preliminary empirical cross-check on this literature-derived framework, the paper additionally reports a supplementary structured survey of 100 Mumbai commuters, whose descriptive and correlational results are broadly consistent with the proposed propositions, particularly the role of entrepreneurial last-mile ventures in supporting public transport use. With implications for mobility entrepreneurs, transit agencies, and policymakers, the paper concludes by outlining how the proposed framework can be empirically validated in future research using quantitative, survey-based methods such as structural equation modelling

Keywords: Public Transport Adoption; Sustainable Urban Mobility; Mobility Entrepreneurship; Last-Mile Connectivity; Thematic Analysis

Introduction

Mumbai, India's financial capital, is served by one of the world's most heavily used suburban train systems, alongside a large municipal bus network (BEST), a growing Metro, and an extensive fleet of auto-rickshaws and taxis. Together, these modes carry a population whose transport needs have

historically outpaced the expansion of infrastructure (Shaban & Sattar, 2023). Even so, rising incomes, growing two-wheeler and automobile ownership, and persistent perceptions of overcrowding, unreliability, and inadequate last-mile connectivity have eroded the discretionary appeal of public transit for a widening segment of commuters who have a genuine choice of mode. Because a modal shift away from private vehicles is widely regarded as the most cost-effective lever for reducing congestion, emissions, and transport-related inequity in dense, rapidly growing cities, reversing this trend is central to Mumbai's and India's sustainable urban mobility agenda (Banister, 2008).

Adoption of public transportation has traditionally been studied through the lenses of infrastructure development, socio-economic profile, and transport-behaviour theory. A phenomenon that has received comparatively less attention in this literature, yet is directly relevant to entrepreneurship scholarship, is the emergence over the past decade of a vibrant ecosystem of mobility start-ups, digital ticketing platforms, and last-mile connectivity ventures that have entered Indian cities specifically to address the access and convenience problems that discourage transit use (Kanuri et al., 2019). In a public-service market, firms and platforms that resolve first- and last-mile gaps, provide real-time information, and integrate payments are, in effect, entrepreneurial interventions whose success or failure has a direct bearing on whether commuters adopt and continue to use public transportation. This study frames public transport adoption in Mumbai as a phenomenon jointly shaped by passenger psychology, namely attitude, perceived control, and habit, and by the entrepreneurial mobility ecosystem that surrounds the formal transit network.

The urgency of this inquiry is amplified by the scale of Mumbai's daily commuting population and by national policy commitments to decarbonising urban transport. As municipal and state governments invest in Metro expansion and bus modernisation, an equally important but under-examined question is how private entrepreneurial activity around the formal network either reinforces or undermines these public investments. A framework that treats entrepreneurial ventures as complementary levers, rather than as peripheral or competitive actors, has the potential to reshape how transit agencies, investors, and policymakers evaluate the contribution of mobility start-ups to public outcomes.

This question also matters commercially. Mobility start-ups operating in the last-mile space compete for scarce venture capital, municipal partnerships, and regulatory goodwill, and their pitches typically foreground unit economics and user acquisition rather than any explicit link to public transport ridership. If, as this paper argues, the value such ventures create for the formal transit system is real but currently unmeasured, then both entrepreneurs and the agencies that might partner with them are operating with an incomplete picture of the ecosystem's overall contribution to sustainable mobility outcomes. Clarifying this link is therefore of practical, and not merely academic, significance.

This paper makes three contributions. First, it synthesises the literature on entrepreneurship and innovation diffusion with the literature on transportation adoption, two streams that have grown

substantially but largely in parallel. Second, it proposes an integrated conceptual framework and a set of testable propositions that connect entrepreneurial mobility innovation to public transport uptake. Third, it outlines a research design suited to empirically testing this framework in the Mumbai context, offering a template that may be adapted to other Indian metropolitan areas facing similar first- and last-mile challenges.

Literature Review

Adoption of public transport has been examined from several disciplinary vantage points, including transport planning, behavioural psychology, service marketing, and, more recently, entrepreneurship and technology-diffusion research. This section synthesises that body of work thematically, following the six-phase process described in the Research Methodology section, and culminates in the seven-theme structure summarised in Table 1.

Behaviour and Attitude Factors

Subjective and social standards usually have less of an impact on public transit use than attitude and perceived behavioral control, according to the Theory of Planned Behavior (Ajzen, 1991). In the reviewed literature, this is the theme that has been mentioned the most. Using Confirmatory Factor Analysis and Structural Equation Modeling, Shinde and Nadkarni (2024) showed that attitude and perceived behavioral control significantly increased public transport usage among Mumbai commuters, while subjective norms had a negligible effect. They concluded that accessibility, cost-effectiveness, and convenience were the practical levers most likely to shift adoption. When considered collectively, these results imply that persuasion or awareness-only interventions are unlikely to be successful unless they are combined with observable increases in convenience and perceived ease of use.

Commuters' Satisfaction and Service Quality

Customer satisfaction and repeat business are strongly correlated with aspects of service quality, such as dependability, waiting time, crowding, comfort, and fare. While Solanki, Meena, and Kumar (2022) created and validated a Travel Satisfaction Scale for Delhi Metro commuters, highlighting the significance of satisfaction constructs in retaining current riders, Saxena, Choudhury, and Das Gupta (2024) discovered that fare price, travel time, reliability, ease of use, and comfort significantly shaped Bus Rapid Transit users' satisfaction and usage in Bhopal. Waiting time and dependability consistently show up as the characteristics most strongly linked to satisfaction and sustained use across different investigations, indicating that operational consistency may be more important to retention than any particular amenity upgrade.

Gender and Safety Aspects

Personal safety as a factor influencing mode selection and the decision to travel, especially for female commuters, is a third and analytically unique theme. Verma, Manoj, Rodeja, and Verma

(2017) found distinct operational and infrastructural gaps impacting perceived safety both on board and at stops in a service-gap analysis of Bangalore's public buses with regard to women's safety. In a similar vein, Meena (2024) investigated the psychological elements influencing women's perceptions of safety on Jaipur's public buses and discovered that the most significant aspects were boarding-related safety concerns and infrastructure problems. This topic is especially important for any approach that aims to increase transit ridership instead of just redistributing it among modes, since perceptions of danger might completely prevent people from making trips rather than just rerouting them to another mode.

Infrastructure and Accessibility

The sufficiency of physical transportation infrastructure in relation to urban expansion is the subject of a fourth theme. According to Shaban and Sattar (2023), the Mumbai Metropolitan Region's transportation infrastructure development has not kept up with population and vehicle growth, leading to congestion, exclusion, and a disjointed, poorly integrated network of modes—a structural constraint that individual-level behavioural models are unable to adequately capture. This theme suggests that behavioural treatments have a ceiling effect in situations when infrastructure is insufficient by framing adoption as limited by system-level capability and integration rather than just individual attitudes or preferences.

Environmental Motivation and Sustainable

Adoption of public transportation is positioned within the larger agenda for sustainable mobility policy as a fifth subject. Banister's (2008) sustainable mobility paradigm reframes the policy goal from fulfilling travel demand to managing and lowering the need for private motorized travel, placing accessibility above mobility in general. In line with this, Gopi et al. (2024) discovered that infrastructure and funding constraints are the main roadblocks to increasing the use of electric buses in Indian public transportation systems, demonstrating that ecosystem-level facilitators—rather than just commuter preferences—determine whether sustainability objectives result in increases in ridership.

Digital Adoption and Technology

As an additional layer of adoption determinants, a sixth theme focuses on digital ticketing, real-time information, and mobile app-based access. Perceived utility, usability, and social impact are significant indicators of technology adoption, according to fundamental technology-acceptance theory (Davis, 1989; Venkatesh, Morris, Davis, & Davis, 2003). Commuters' acceptance of app-based access to public transportation is influenced by factors such as simplicity of use, cost, trust, and habit, according to studies of mobile ticketing and rail-booking applications in Indian transit environments. This theme is important since last-mile businesses and mobility start-ups often create digital platforms, which directly relate to the review's seventh and main theme.

Last Mile Connectivity and Entrepreneurial Innovation

This paper's seventh and most important theme describes how mobility entrepreneurship has grown in response to the gaps found in the six themes that came before it. Kanuri et al. (2019) examined a last-mile connectivity pilot at a metro station in Bengaluru. They discovered that the intervention resulted in a quantifiable modal shift from private modes to shared mobility and generated significant perceived time savings, demonstrating that entrepreneurial endeavours can act as a lever on transit adoption rather than just as competitors. By expressly requesting citizen-led and entrepreneurial last-mile solutions to increase mass-transit ridership, the WRI India-led STAMP initiative expanded this rationale across many Indian cities (WRI India, 2020). In Indian cities, this entrepreneurial layer has grown quickly: aggregator-run auto-rickshaw and bike-taxi services, bike- and scooter-sharing companies, and app-based bus-tracking platforms now target the access, information, and convenience gaps noted in the previous themes (Frost & Sullivan, 2025). Diffusion of Innovation theory (Rogers, 2003) provides a lens through which to view the proliferation of such ventures: their relative advantage, compatibility with current commuting routines, and observability plausibly accelerate commuters' willingness to try and subsequently continue using public transit that these ventures connect to. When considered collectively, this theme reframes the previous six as a collection of frictions—behavioural, service-related, safety-related, infrastructural, environmental, and technological—that entrepreneurial endeavours are, in reality, trying to resolve piecemeal through targeted products rather than systemic reform. For this reason, their contribution has proven challenging for either transport-behaviour research or entrepreneurship research to capture on its own.

Table 1: Themes Emerging from the Qualitative Thematic Synthesis

Attitudinal/Behavioural	Attitude; perceived behavioural control	Ajzen (1991); Shinde & Nadkarni (2024)
Service Quality/Satisfaction	Reliability; waiting time; comfort; fare	Saxena et al. (2024); Solanki et al. (2022)
Safety/Gender	Personal safety; boarding/stop conditions	Verma et al. (2017); Meena (2024)
Infrastructure/Accessibility	Network adequacy; integration; congestion	Shaban & Sattar (2023)
Sustainability/Environment	Policy paradigm; emissions; financing	Banister (2008); Gopi et al. (2024)
Technology/Digital Adoption	Ease of use; usefulness; trust; habit	Davis (1989); Venkatesh et al. (2003)
Entrepreneurial Innovation	Last-mile ventures; MaaS; digital platforms	Kanuri et al. (2019); WRI India (2020); Rogers (2003)

Research Gap

Over time, research on entrepreneurship and transportation behavior has evolved independently. While research conducted in Mumbai and India explains public transportation use in terms of attitudes, infrastructure, safety, and service quality, it frequently ignores the impact of entrepreneurial innovations like digital ticketing solutions, Mobility-as-a-Service (MaaS) platforms, and last-mile services on public transportation adoption. In contrast, the research on entrepreneurship and innovation-diffusion studies the expansion, business strategies, and diffusion mechanisms of such endeavors, but it rarely links venture-level activity to formal public transportation ridership as a result of public interest and legislation.

There is a glaring research gap because there isn't a thorough framework specifically designed for Mumbai that looks at entrepreneurial mobility innovations as both a direct impact on the use of public transport and a factor that either increases or decreases the impact of important commuter-related determinants like attitude, perceived behavioural control, service quality, safety, and infrastructure. Additionally, previous research fails to identify the psychological mechanism that mediates entrepreneurial innovation's potential to increase passengers, such as perceived convenience and confidence in an integrated transport journey.

Research Objectives

1. To conduct a comprehensive review and thematic synthesis of the existing literature, including the entrepreneurial literature on mobility innovation, on the variables influencing the adoption of public transportation.
2. 2. To develop an integrated conceptual framework that suggests using entrepreneurial mobility innovation to control the association between Mumbai's public transport utilisation and commuter-level adoption determinants.
3. 3. To outline how primary quantitative data can be used to validate this framework established from the literature.

Research Methodology

This study has a qualitative design. Instead of collecting primary interview or survey data, its method of inquiry is a systematic literature review coupled with thematic analysis (Braun & Clarke, 2006). This is a tried-and-true method in management and entrepreneurship research for creating theory and conceptual frameworks from an existing corpus of published work, especially when the goal is to integrate literatures that have developed largely independently of one another—in this case, transport behavior and entrepreneurship.

Research Sources and Search Methods

Using Google Scholar, ScienceDirect, ResearchGate, SSRN, and Frontiers, the terms "public transport adoption," "sustainable urban mobility," "transit service quality," "commuter safety,"

"mobile ticketing adoption," "last-mile connectivity," and "mobility start-ups/entrepreneurship" were combined to find sources. To favour the Indian and, when accessible, Mumbai-specific context, a geographic filter was used. The search included reports from credible organisations like WRI India, conference proceedings, doctoral and working papers, and peer-reviewed journal articles published between 1989 and 2025. Sources that merely addressed engineering design or macroeconomics were removed; those that addressed the entrepreneurial or technical mobility ecosystem, or a determinant of public transportation use, satisfaction, or acceptance, whether experimentally or conceptually, were included.

The Process of Thematic Analysis

Each source was reviewed and open-coded to identify variables and constructs that affect transit acceptance or use. Using Braun and Clarke's (2006) six-phase thematic analysis—familiarisation, preliminary coding, theme creation, theme evaluation, theme description, and writing—the codes were sorted into candidate themes, checked for consistency and uniqueness, and refined into the seven themes discussed in the Literature Review. These themes formed the basis for the integrated conceptual framework in the Analysis and Discussion section. Since this is a qualitative, literature-based approach, the themes and framework represent an analytical summary of existing evidence, not new or field-tested findings. The Scope for Future Research section explains how these could be tested quantitatively in the future.

Analysis and Discussion

This framework builds on the seven themes from the Literature Review. It sees Public Transport Adoption—measured by behavioural intention and actual usage frequency—as the main outcome, influenced by two groups of factors. The first group, Commuter Adoption Determinants (Themes 1 to 4), includes attitude, perceived behavioural control, service quality, safety, and infrastructure accessibility. The second group, Entrepreneurial Mobility Innovation (Themes 6 and 7), covers exposure to and use of MaaS platforms, digital ticketing and information start-ups, and last-mile connectivity projects. The framework suggests that entrepreneurial mobility innovation not only directly affects adoption but also helps turn positive attitudes and perceived control into real transit use. It does this by addressing access, safety, and information issues found in Themes 1 to 4, which might otherwise prevent even willing commuters from using public transport.

Table 2: Constructs of the Proposed Conceptual Framework

Commuter Adoption Determinants (independent)	Attitude; Perceived Behavioural Control; Service Quality/Accessibility; Safety; Cost
Entrepreneurial Mobility Innovation (independent/moderator)	Last-mile connectivity ventures; MaaS platforms; Digital ticketing and real-time information start-ups
Mediator	Perceived Convenience and Trust in the Integrated Transit Journey
Dependent Construct	Public Transport Adoption (behavioural intention and usage frequency)

The paper makes the following claims for empirical research based on this framework:

P1: There is a favorable correlation between commuter views on public transit and its uptake in the Mumbai Metropolitan Region.

P2: Perceived behavioral control and public transportation adoption are positively connected.

P3: Regardless of passenger sentiment, exposure to and use of entrepreneurial last-mile mobility enterprises are favorably connected with public transportation adoption.

P4: Entrepreneurial mobility innovation favorably moderates the connection between commuter attitude/perceived behavioral control and public transit uptake; this association is higher among commuters with access to MaaS platforms and last-mile efforts.

P5: Perceived convenience and trust in the integrated, formal-transit plus entrepreneurial last-mile experience influence the relationship between entrepreneurial mobility innovation and public transportation uptake.

These propositions collectively reposition entrepreneurial ventures from being marginal competitors to formal transit systems to becoming essential complements that can activate latent, attitude-driven demand. The framework proposes a testable sequence across seven themes: Themes 1 to 5 outline the psychological and practical factors influencing a commuter's willingness to use public transport; Theme 6 addresses the digital mechanisms through which this willingness is increasingly manifested; and Theme 7 focuses on the entrepreneurial actors who develop and manage the digital and physical last-mile services. In this interpretation, entrepreneurial mobility innovation is not simply an additional, eighth factor alongside the others but acts as a structural link connecting individual commuter willingness to overall system usage. This is why the framework identifies it both as a moderator and a mediated pathway rather than a straightforward predictor. The following Research Findings and Recommendations sections elaborate on the practical, policy, and entrepreneurial implications arising from this reframing.

Findings of the Research

Subjective social norms had a far smaller impact on public transport uptake than attitude and perceived behavioural control, according to the theme review. This implies that awareness programs by themselves are unlikely to boost ridership unless they simultaneously boost commuters' self-assurance and willingness to use public transit. Service quality, including dependability and wait times turns out to be the most crucial element for commuter pleasure and sustained use. Safety is more than just a consideration when choosing a method of transportation; it is a fundamental necessity for travel, particularly for women. Furthermore, poor infrastructure and network integration cannot be made up for by changes in individual conduct, underscoring the need for ongoing investment. Lastly, rather than serving as independent drivers, entrepreneurial

mobility innovations like digital ticketing, app-based services, and last-mile connectivity encourage the usage of public transportation by making travel more accessible, convenient, and user-friendly, and most crucial to this paper's contribution, entrepreneurial last-mile companies and MaaS platforms are found in the literature to generate measurable modal shift and perceived time savings, supporting their treatment as a special, additive lever on public transport adoption rather than as a substitute for or merely competitor to the official transit network. Together, the five propositions (P1 through P5) that incorporate these findings demonstrate how entrepreneurial mobility innovation both enhances and amplifies the impact of positive passenger attitudes on actual transit utilization, mediated by perceived convenience and trust in the combined journey experience.

When taken as a whole, the seven themes imply that the variables affecting the adoption of public transit are linked rather than separate. The willingness to utilize public transit is created by positive attitudes and safety, but whether or not that willingness can be turned into real use depends on the quality of the infrastructure and services provided. By increasing the accessibility and convenience of public transport, entrepreneurial innovations like digital ticketing and last-mile services help close this gap. This suggests that businesses and public organizations have complementary responsibilities in boosting ridership, emphasizing the necessity of coordinated cooperation rather than independent initiatives.

A burgeoning entrepreneurial mobility environment, adequate transit infrastructure, and commuter psychology all play a role in Mumbai's embrace of public transport. In order to understand why commuters choose or do not pick public transportation in a fast-changing urban mobility market, this article has proposed that transport-behaviour research and entrepreneurship/innovation research, which have primarily developed along distinct tracks, need to be combined. The mixed-method research design described in the Scope for Future Research section offers a practical route toward empirical validation, and the conceptual framework and propositions developed here, based on a methodical thematic synthesis of the published literature, provide a basis for such integration. If confirmed, the paradigm would suggest that attaining sustainable urban mobility outcomes in Mumbai and similar cities throughout India requires developing a strong mobility-entrepreneurship ecosystem.

Primary Survey Analysis: Empirical Evidence from Mumbai Commuters

To move beyond the literature-derived propositions of the preceding sections, this study supplements its qualitative thematic synthesis with a primary structured survey of 100 public transport commuters across the Mumbai Metropolitan Region. The self-administered questionnaire captured respondent demographics, frequency of public transport use, time spent and challenges faced on the last-mile leg of the journey, familiarity with and use of app-based last-mile mobility services (e.g., Rapido, shuttle vans, e-rickshaws, and shared-mobility platforms), the perceived effect of such services on public transport use, the importance attached to specific last-mile attributes, satisfaction with existing last-mile options, and priorities for improving public

transport use. Respondents were drawn through a convenience sample residing or working across the Central, Western, and Harbour railway corridors as well as Thane and Navi Mumbai, and responses were collected online. This sample is not probability-based and does not, by itself, permit the structural equation modelling envisaged in the Scope for Future Research section; it is offered here as a preliminary empirical cross-check of the seven-theme framework and the P1-P5 propositions developed above, operationalising in a small way the quantitative validation this paper had earlier flagged as absent.

Table 3: Demographic and Commuting Profile of Respondents (n = 100)

Characteristic	**Category**	**% of Respondents**
Age group	26-35 years	37%
	36-45 years	25%
	18-25 years	16%
	46-60 years	15%
	60 years and above	7%
Gender	Male	72%
	Female	28%
Occupation	Salaried employee	47%
	Retired	15%
	Student	13%
	Self-employed / business owner	12%
	Homemaker	11%
	Unemployed	2%
Residence corridor	Central Line	34%
	Navi Mumbai	20%
	Thane	19%
	Harbour Line	15%
	Western Line	12%
Frequency of public transport use	Daily	37%
	4-6 days a week	23%
	Rarely	17%
	2-3 days a week	15%
	Occasionally	8%

Consistent with the Infrastructure and Accessibility theme (Theme 4), the last-mile leg of the journey is a material time cost for most respondents: 42% reported spending 21-30 minutes daily

on last-mile connectivity, 25% reported 31-45 minutes, and a further 17% reported more than 45 minutes, so that a large majority spend over 20 minutes each day simply reaching or leaving the formal transit network. When asked to identify the specific challenges they face, respondents most frequently cited overcrowding, followed by poor road and footpath conditions and difficulty finding transport during peak hours, as summarized in Table 4.

Table 4: Reported Challenges in Last-Mile Connectivity (multi-select; % of respondents citing each)

Challenge	% of Respondents Citing It
Overcrowding	69%
Poor road conditions	43%
Inadequate footpath infrastructure	34%
Difficulty finding transport during peak hours	28%
Safety concerns	27%
Long waiting time	25%
Unpredictable availability	14%
High cost	14%
Lack of integration between services	9%
Poor lighting at night	7%
Weather-related issues	5%

Awareness and use of app-based last-mile mobility services is already widespread: 34% of respondents reported using such services regularly and 47% reported being aware of and using them occasionally, against only 11% who were aware but had never used them and 8% who were not aware of them at all. Reflecting this penetration, 57% of respondents said the availability of these services had increased their public transport use (7% significantly, 50% slightly), 23% reported no change, and only 3% reported a decrease. At the same time, satisfaction with existing last-mile options remains low: 46% described themselves as dissatisfied and a further 4% as very dissatisfied, against only 11% who were satisfied and none who were very satisfied, indicating a substantial gap between the demonstrated demand for last-mile solutions and commuters' evaluation of what is currently on offer -- precisely the gap this paper positions entrepreneurial mobility ventures to close. When asked what would most encourage more frequent public transport use, 30% of respondents pointed to better last-mile connectivity, ahead of better infrastructure (22%), higher service frequency (21%), increased safety (14%), faster travel (9%), and lower cost (4%), placing last-mile connectivity above every other single lever, including cost.

Table 5: Importance of Last-Mile Travel Attributes (rated 1-5, n = 100)

Attribute	Mean Rating	Std. Deviation
Travel time	4.53	0.56
Availability	4.45	0.61
Reliability	4.44	0.54
Safety	4.35	0.61
Comfort	4.31	0.66
Cost	4.25	0.76

Time-related and convenience attributes (travel time, availability, reliability) were rated marginally higher, on average, than cost, suggesting that the perceived-convenience mechanism proposed as the mediator in the conceptual framework (P5) is, in respondents' own account, at least as salient as price in last-mile decision-making.

Statistical Tests of the Proposed Propositions

To examine whether these descriptive patterns are consistent with the propositions advanced in the Analysis and Discussion section, Spearman rank correlations and chi-square tests of association were computed between ordinally coded survey items. The results are summarized in Table 6.

Table 6: Correlation and Association Tests Relevant to the Proposed Framework

Relationship Tested	Statistic	Result	Relevant Proposition
Frequency of last-mile app use vs. frequency of public transport use	Spearman rho	0.735, p < .001	P3
Frequency of last-mile app use vs. frequency of public transport use	Chi-square	chi2 = 107.94, df = 16, p < .001	P3
Familiarity with last-mile apps vs. perceived change in public transport use	Spearman rho	0.564, p < .001	P3 / P4
Familiarity with last-mile apps vs. perceived change in public transport use	Chi-square	chi2 = 53.26, df = 12, p < .001	P3 / P4
Frequency of last-mile app use vs. perceived change in public transport use	Spearman rho	0.547, p < .001	P4
Familiarity with last-mile apps vs. frequency of public transport use	Spearman rho	0.523, p < .001	P3
Satisfaction with last-mile options vs. frequency of public transport use	Spearman rho	-0.108, p = .284 (n.s.)	P1 (nuance)
Satisfaction with last-mile options vs. perceived change in public transport use	Spearman rho	-0.065, p = .524 (n.s.)	P1 (nuance)

These results offer converging, though preliminary, support for the entrepreneurial-innovation propositions at the core of this paper. The frequency with which commuters use app-based last-mile services is very strongly and significantly associated with how often they use public transport (rho = 0.735), and both familiarity with and frequency of use of these services are significantly

associated with commuters' own reports of increased public transport use (rho = 0.564 and 0.547 respectively), directly corroborating P3 and, more tentatively, the moderating logic of P4: among respondents who use last-mile apps daily, roughly two in three also use public transport daily, whereas among those who never use such apps, the large majority use public transport only rarely. Because the survey did not include a validated multi-item scale for attitude or perceived behavioural control, P2 could not be directly tested and remains an open item for the SEM-based validation recommended later in this paper. Notably, satisfaction with last-mile options was not significantly correlated with either frequency of public transport use or perceived change in use, which nuances rather than contradicts P1: in Mumbai's high-density, high-necessity commuting context, many respondents appear to keep using public transport regardless of how satisfied they are with last-mile options, consistent with this paper's broader argument that convenience-based interventions, not attitude-shaping alone, are what move usage. The comparatively high importance ratings for travel time, availability, and reliability (Table 5) are consistent with the hypothesised mediating role of perceived convenience and trust (P5), though, again, mediation in the strict statistical sense was not tested here.

A further pattern with policy relevance emerged along gender lines: only 18% of female respondents (5 of 28) reported regular use of app-based last-mile services, compared with 40% of male respondents (29 of 72), even though safety was rated as the second most important last-mile attribute overall (mean 4.35). This gap is consistent with the Safety and Gender theme (Theme 3) identified in the Literature Review and suggests that safety perceptions may be constraining women's uptake of otherwise beneficial entrepreneurial last-mile options -- a boundary condition that mobility entrepreneurs and transit agencies should treat as a design priority rather than an afterthought.

Taken together, this convenience-sample survey cannot substitute for the structural-equation-modelling validation recommended in the Scope for Future Research section, and it leaves P2 untested; but it provides converging preliminary evidence for the paper's central contribution -- that exposure to and use of entrepreneurial last-mile mobility ventures is strongly and significantly associated with public transport usage (P3) and with commuters' own reports of increased usage (P4), that commuter-rated importance of time, availability, and reliability is consistent with the hypothesised mediating role of perceived convenience and trust (P5), and that attitudinal satisfaction alone does not explain usage frequency in this sample, which nuances P1 and reinforces the paper's core argument for entrepreneurial mobility innovation as a structural lever on public transport adoption rather than a peripheral input.

Recommendation

Instead of competing with public transport systems, entrepreneurs and investors should concentrate on mobility solutions that enhance them. They should assess projects according to their capacity to boost public transport adoption as well as their financial viability. In addition to ongoing infrastructure expenditures and public awareness campaigns, transit agencies and

legislators should fortify their alliances with mobility start-ups to enhance last-mile connectivity. The results also emphasise the necessity of supporting mobility start-ups with incentives and policies that promote integration with official transit networks in order to acknowledge them as important contributors to sustainable urban transportation. Additionally, industry associations can use this framework to encourage stronger collaboration between start-ups and public transport agencies, ultimately creating a more integrated and sustainable urban mobility ecosystem. Educational institutions and entrepreneurship development programs should prepare future mobility entrepreneurs by incorporating practical insights into behavioural and infrastructure challenges.

Scope of the future research

It is best to think of the ideas and framework presented in this paper as hypotheses that need to be tested empirically rather than as established connections. To test the suggested direct, moderating, and mediating relationships among commuter adoption determinants, entrepreneurial mobility innovation, perceived convenience and trust, and public transport usage among a representative sample of Mumbai commuters, future research should use quantitative, survey-based methodologies, such as structural equation modelling. Additionally, longitudinal designs would enable researchers to see whether exposure to entrepreneurial last-mile endeavours results in long-term, sustainable changes in transit usage rather than a transient novelty effect. To determine the framework's boundary conditions and determine whether the suggested moderating role of entrepreneurial innovation extends beyond Mumbai's unique transport and start-up ecosystem, comparative studies across other Indian metropolitan areas with varying infrastructure maturity and start-up density, such as Delhi, Bengaluru, and Pune, would be helpful. In order to ascertain whether each type of venture contributes similarly to the suggested moderating and mediating effects, future research may also break down the entrepreneurial mobility innovation construct into its component venture types, such as MaaS aggregators, bike and scooter sharing operators, and digital ticketing platforms. To supplement the quantitative validation, qualitative interviews with venture operators and transit officials may be included.

Limitation of the Study

This study's primary drawback is directly related to its design: as a qualitative synthesis of published secondary literature, its themes, framework, and propositions are analytical and interpretive rather than field-tested. Mumbai commuters and mobility-venture operators were not the subjects of any primary surveys, interviews, or observational data. The seven themes and the resulting framework should be seen as hypotheses generated from the literature rather than as established correlations because a literature review alone cannot determine the exact amount, direction, or even presence of the proposed moderating impact (P4). Additionally, given the methodology is specific to Mumbai's transport and start-up ecosystem, its applicability to other Indian metropolitan centres with varying infrastructure maturity and start-up density should be considered an open empirical topic.

A supplementary primary survey of 100 Mumbai commuters, reported in the Primary Survey Analysis section, provides preliminary empirical corroboration for several of the propositions advanced above, particularly P3 and P4. However, that survey relied on convenience rather than probability sampling, is cross-sectional, did not include a validated scale for perceived behavioural control (P2), and does not support formal moderation or mediation testing or causal inference. It therefore complements, but does not replace, the structural-equation-modelling-based validation recommended in the Scope for Future Research section.

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