



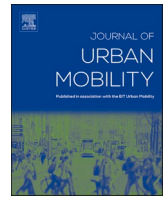
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Crowdshipping participation among private vehicle users

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ABSTRACT

This study investigates the determinants of willingness to participate in crowd shipping (WTP-CS) for the working population within the Mumbai Metropolitan Region. It explores socioeconomic factors, personality traits, and travel correlates to WTP-CS by testing an integrated choice and latent variable (ICLV) modeling framework. Four conclusions are drawn. First, longer travel times and higher costs diminish WTP-CS, while economic incentives (e.g., free Wi-Fi services) are positively associated with WTP-CS. Second, lower-income individuals are positively inclined toward crowd shipping, while females and older individuals display less inclination toward crowd shipping. Third, increasing the number of services offered by crowd shippers negatively affects WTP-CS. Fourth, individuals with higher levels of the openness personality trait exhibit a positive inclination toward WTP-CS, whereas those with higher conscientiousness tend to exhibit a more reserved attitude toward WTP-CS. The findings emphasize the role of individual traits in shaping participation behaviors in crowd shipping initiatives, and in contrast to most existing crowd shipping studies that focus on users or developed-country contexts, provide new evidence on supply-side participation among working commuters in emerging markets in a less-studied region.

1. Introduction

Crowd shipping has emerged as an emerging solution to the rapid growth of e-commerce (Punel et al., 2018). It utilizes the unused space in vehicles of regular travelers to deliver goods (Koh et al., 2024), turns ordinary travelers into temporary delivery workers, and creates a more flexible and dynamic workforce. This is deemed an appealing delivery mechanism to increase delivery speed and flexibility, enhance scalability, reduce environmental impacts, expand geographic reach, and provide employment opportunities and community engagement (Alharbi et al., 2022). However, the willingness to participate in crowd shipping (WTP-CS) remains an issue, influenced by socioeconomic characteristics, personality traits, and travel factors (Punel et al., 2018).

Much of the previous research examining the demand side (willingness to use) and the supply side (willingness to drive) has acknowledged that the success of crowd shipping in developing countries relies on the supply side. However, understanding how socioeconomic and

demographic factors (e.g., vehicle ownership, level of income), personality traits (e.g., conscientiousness, openness to new experiences), and travel characteristics (e.g., trip distance, travel time) influence the willingness to drive for crowd shipping services remains scarce in emerging markets like India, where transport infrastructure and patterns differ from those in developed nations (Mittal et al., 2022). The scarcity of research extends to (i) how gender influences the willingness to drive for crowd shipping services; (ii) how travel costs, mode choice for work trips, and travel time for return trips home affect crowd shipping adoption; (iii) how personality traits (conscientiousness and openness) to new experiences affect the willingness to drive for crowd shipping services; and (iv) how financial incentives can be tailored to encourage participation in crowd shipping.

In developed markets, the adoption of crowd shipping is often supported by established institutional mechanisms, including robust legal frameworks, platform-based reputation systems, and standardized service guarantees. These mechanisms provide a baseline of formal trust

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between platforms, customers, and crowd shippers. By contrast, in emerging economies such as India, these institutional arrangements are typically nascent, uneven, or fragmented. Participation in informal, peer-to-peer logistics arrangements, therefore, depends more strongly on intrinsic individual characteristics, such as willingness to engage with strangers, tolerance for uncertainty, and comfort with informal work, than on formal system-level assurances. Moreover, gig-economy activities in such contexts are frequently perceived as insecure or socially stigmatized, rather than as mainstream employment options. As a result, only individuals with specific psychological predispositions (e.g., higher openness to new experiences or greater flexibility in work attitudes) may be willing to participate in crowd shipping. This makes the explicit modelling of personality traits particularly relevant in developing-country settings, where structural and cultural barriers to adoption are more pronounced.

The current study is a natural continuation of research on understanding the willingness of workers to participate in crowd shipping with two contributions. First, by integrating socioeconomic factors, personality traits, and travel characteristics, this study provides a holistic view of the determinants influencing WTP-CS, addressing the fragmented approach observed in previous research. Second, by focusing on the Indian market, this study contributes contextual insights into the unique demographic, cultural, and economic factors affecting crowd shipping participation in emerging markets, which are under-represented in the existing literature. The findings provide insights into designing targeted incentives, optimizing financial incentives, and developing regulatory frameworks that encourage worker participation. Understanding the influence of travel costs, mode choice, and return trip characteristics can inform transport planning strategies that align crowd shipping with broader mobility policies, promoting cost-effective and environmentally sustainable solutions. By emphasizing industry and policy benefits, the analysis offers actionable recommendations for establishing crowd shipping as a scalable and inclusive urban freight model in developing economies. In the present study, participating as a crowd-shipper refers to receiving payment for delivering items to other individuals.

The remaining is structured as follows. First, the existing literature is

synthesized to discuss specific research gaps. Second, the research framework (conceptual framework, the design of the experiment, and the modeling approach) is outlined. Third, the study area and data collection are discussed. Fourth, the results and discussions are presented. Fifth, the conclusions and policy implications are presented along with the limitations of the research.

2. Literature review

This section reviews existing research on both the demand and the supply side of crowd shipping to identify key factors influencing the adoption and participation in crowd shipping services. [Table 1](#) provides an overview of the existing research.

2.1. Socioeconomic and demographic correlates

Socioeconomic and demographic factors influence the adoption of crowd shipping services for users. Younger individuals are more likely to use these services, indicating a negative correlation between age and adoption rates ([Punel et al., 2018](#)). Higher-income levels also positively affect the willingness to use crowd shipping due to the convenience and speed offered ([Punel et al., 2018](#)). Urban residents show higher adoption rates, likely due to greater availability and convenience in densely populated areas. Higher education levels positively influence participation in the sharing economy, suggesting that more educated individuals are open to innovative service models like crowd shipping ([Böcker & Meelen, 2017](#)). Additional studies support these findings. Trust is crucial in adopting crowd shipping services, influenced by income and urban residence ([Cebeci et al., 2023](#)). Younger individuals, especially students, show a higher intention to participate in crowd shipping ([Fessler et al., 2024](#)).

Socioeconomic and demographic factors also influence the adoption of crowd shipping services for couriers. Younger individuals are more likely to participate as crowd shippers, showing a negative correlation between age and willingness to drive ([Devari et al., 2017](#)). Lower-income individuals show higher participation rates, possibly due to the financial incentives offered by crowd shipping platforms.

Table 1
Literature review on demand and supply sides of crowd shipping.

Category	Study	Variable	Effect	Area
<i>Users</i>				
Socioeconomic	Punel et al. (2018)	Age	Younger people are more likely to use crowd shipping	United States
		Income	Higher-income individuals are more willing to use the service	United States
		Urban residence	Urban dwellers show higher adoption rates	United States
Travel	Böcker and Meelen (2017) Yildiz and Savelsbergh (2019) Punel et al. (2018)	Education level	Higher-educated individuals are more likely to participate in sharing economy	Netherlands
		Delivery speed	Faster delivery times increase willingness to use	Theoretical
		Package size	Smaller packages increase willingness to use	United States
Personality	Aleml et al. (2019) Le et al. (2019) Hamari et al. (2016)	Travel frequency	Frequent travelers are more likely to use ride-hailing services	United States
		Environmental concern	Environmentally conscious individuals are more likely to use crowd shipping	Global
		Price sensitivity	Price-sensitive users are less likely to adopt	Global
Couriers	Devari et al. (2017) Le et al. (2019) Hall and Krueger (2018) Aleml et al. (2018)	Enjoyment	Users who enjoy the experience are more likely to participate in sharing economy	International
		Age	Younger individuals are more likely to participate	United States
		Income	Lower-income individuals show higher participation	United States
Travel	Ermagun and Stathopoulos (2018) Le et al. (2019) Aleml et al. (2018)	Employment status	Unemployed individuals are more likely to participate	Global
		Flexibility needs	Individuals seeking flexible work arrangements are more likely to participate	United States
		Vehicle ownership	Car owners are more likely to participate in ride-hailing as drivers	United States
Personality	Ermagun and Stathopoulos (2018) Le et al. (2019) Aleml et al. (2018)	Distance to delivery	Shorter distances increase willingness to participate	United States
		Time flexibility	More flexible schedules increase participation	United States
		Commute distance	Longer commutes increase willingness to participate	Global
Personality	Aleml et al. (2018) Buldeo Rai et al. (2017) Bucher et al. (2016)	Variety seeking attitude	Variety seekers are more likely to participate in ride-hailing as drivers	United States
		Environmental concern	Environmentally concerned people are more likely to participate in ride-hailing as drivers	United States
		Community engagement	Those more engaged in their community are more likely to participate	Global
		Monetary motivation	Individuals motivated by financial gains more likely to participate in sharing economy	Norway

Unemployed individuals are more likely to participate, as it provides a flexible income source (Le et al., 2019). Individuals seeking flexible work arrangements are more likely to participate in ride-sharing, which can be extrapolated to crowd shipping (Hall & Krueger, 2018). Motivational factors for participation include financial incentives and flexible work arrangements, which are significant for lower-income and unemployed individuals (Dietmann, 2020). Low-income individuals are also willing to take longer detours to deliver parcels (Cebeci et al., 2023). Recent reviews of crowdshipping supply and demand synthesize these socio-demographic patterns and highlight the central role of income, age, employment status, and flexibility in shaping participation decisions, while also pointing to limited evidence from emerging economies (Garcia-herrera et al., 2025; Le et al., 2019; Mohri et al., 2023; Pourrahmani & Jaller, 2021).

Recent work on professional couriers in e-grocery delivery documents pronounced gender heterogeneity in mode choice and participation, indicating that women and men may respond differently to operational conditions and service attributes (Rossolov et al., 2026). However, the broader crowd shipping literature still lacks a detailed examination of gender's impact on the willingness of the general working population to act as crowd shippers, particularly in emerging-economy contexts. Understanding gender-specific preferences (e.g., female drivers being less likely to accept evening deliveries) could help tailor services (Miller et al., 2017).

2.2. Travel characteristics correlate

Travel characteristics impact the adoption of crowd shipping services for users. Faster delivery speeds positively influence willingness, as consumers prioritize quick delivery times (Yildiz & Savelsbergh, 2019). Smaller package sizes increase the likelihood of using crowd shipping due to easier handling and delivery (Punel et al., 2018). Frequent travelers are likelier to use ride-hailing services, suggesting a similar inclination towards crowd shipping due to familiarity with app-based service models (Alemi et al., 2019). Delivery speed and package size are critical factors influencing adoption (Mohri et al., 2023). Travel frequency and familiarity with app-based services significantly impact willingness to use crowd shipping (Cebeci et al., 2023). The presence of parcel lockers also positively impacts the willingness to be an occasional carrier by increasing delivery flexibility (Cebeci et al., 2023).

Travel characteristics impact the adoption of crowd shipping services for couriers. Shorter distances to delivery destinations increase the willingness to participate as crowd shippers (Ermagun & Stathopoulos, 2018). Flexible schedules positively influence participation, as individuals with flexible time can easily accommodate delivery tasks. Longer commute distances increase willingness to participate, as individuals can combine commutes with delivery tasks to earn extra income (Le et al., 2019). Vehicle ownership positively influences participation, as it is a prerequisite for delivery tasks (Alemi et al., 2018). Flexible schedules and vehicle ownership are significant motivators for participation (Dietmann, 2020). Low-income individuals are willing to take longer detours to deliver parcels, indicating the importance of travel characteristics such as detour willingness (Cebeci et al., 2023). These findings are consistent with recent systematic and narrative reviews of crowdshipping, which highlight travel time, acceptable detours, schedule flexibility, and perceived reliability as key levers for designing sustainable crowdshipping schemes (Fessler et al., 2024; Garcia-herrera et al., 2025; Mohri et al., 2023; Pourrahmani & Jaller, 2021).

The literature, however, lacks how travel costs, mode choice for work trips, and travel time for return home trips influence crowd shipping adoption. Additionally, there is a paucity of research that aims to assess the effect of personality traits on WTP-CS in the context of a developing country like India. Understanding these factors could provide deeper insights into economic and logistical considerations. While studies have begun exploring user preferences in public transport-based

crowd shipping, more detailed investigations are needed (Fessler et al., 2024).

2.3. Big five personality traits and their effect on travel behavior

The five-factor model (FFM) developed by McCrae and John (1992) is based on core personality qualities that are essential elements of human nature. The model comprises five fundamental personality traits: neuroticism, conscientiousness, extraversion, agreeableness, and openness to experience (Gosling et al., 2003; Roccas et al., 2002).

Neuroticism, which is linked to negative emotional states resulting in emotional instability, includes emotions of insecurity, sadness, guilt, wrath, melancholy, anxiety, and aggressiveness. Conscientiousness, in contrast, is associated with traits such as being focused on achieving goals, having a structured approach, being resolute, persistent, and committed. Extraversion is defined by traits such as being expressive, sociable, and outgoing, whereas openness to experience is linked to qualities like imagination, creativity, curiosity, and open-mindedness. Lastly, agreeableness is associated with attributes such as empathy, benevolence, magnanimity, reliance, and collaboration (Myers et al., 2010). Olson and Evans (1999) further developed the existing model by examining the effects of neuroticism and extraversion on emotions, as well as the influence of agreeableness, openness to experience, and conscientiousness on cognition (Olson & Evans, 1999).

Within the context of travel behavior studies, researchers have utilized the Big Five personality traits as psychometric variables to scrutinize their influence on travel behavior. Table 2 provides a comprehensive summary of these studies.

The existing literature suggests that a considerable body of research has been dedicated to investigating the influence of the Big Five personality traits on diverse domains of transportation planning. In the realm of travel behavior, researchers have consistently identified openness and conscientiousness as two traits that exert particularly strong and recurrent effects (Saxena et al., 2025). These traits have been widely recognized for their impact on individuals' travel preferences,

Table 2

Review of studies assessing the influence of big five personality traits on travel behavior.

Source	Study area	Study objective	Outcome
Pezenka et al. (2017)	Europe and Asia	To analyze the effect of big five traits on adoption of peer-to-peer travel services.	Openness trait had a significant and positive effect on the adoption of peer-to-peer travel services.
Antoniazzi and Klein (2019)	North America	To analyze the impact of big five traits on driving behavior	Conscientious riders pay attention to vehicle and environment-related cues and overall, are less risky riders. Openness to experience is inversely related to errors.
Niranjan et al. (2022)	USA	To investigate how personality traits contribute to distracted driving behavior.	Young adults who are extremely Conscientious are less prone to participate in distracted driving.
Irfan and Ahmad (2021)	China	To assess the effect of big five traits intention to purchase electric vehicles	Openness, conscientiousness, extraversion, and agreeableness positively impact EV purchase intentions.
Zhang et al. (2020)	China	To analyses the effect of technology acceptance model and big five personality trait on automated vehicle acceptance	Higher openness to experience increased trust in automated vehicles and adoption intentions.

risk attitudes, and willingness to use innovative mobility options. In the present study, we focus on openness and conscientiousness because they align closely with the main behavioral mechanisms underlying supply-side participation in crowd shipping. Openness to experience serves as a proxy for the willingness to adopt a novel, Information and communication technology (ICT)-enabled logistics concept and to engage with new social and operational arrangements. Conscientiousness, in turn, captures the extent to which individuals adhere to strict schedules, routines, and punctuality, thereby indicating their willingness, or reluctance, to accept additional detours and timing uncertainty associated with parcel deliveries. The current study, therefore, employs openness and conscientiousness to examine the intention towards WTP-CS, as behavioral proxies for innovation adoption and operational flexibility among potential crowd shippers. To keep both the survey instrument and the integrated choice and latent variable (ICLV) specification tractable, the psychometric battery was restricted to these two constructs; a pilot version including all five Big Five dimensions indicated longer completion times, visible response fatigue, and estimation instability, which would have compromised data quality and model identification.

2.4. Research gap and study contribution

The literature review highlights that while prior research has examined both demand (willingness to use) and supply (willingness to drive) factors, the success of crowd shipping in developing countries largely depends on the availability of willing drivers. However, existing studies have not adequately explored how socioeconomic factors (e.g., income levels, vehicle ownership), personality traits (e.g., conscientiousness, openness to new experiences), and travel characteristics (e.g., trip distance, travel time) influence workers' willingness to participate. This study addresses these gaps by focusing on the supply-side dynamics of crowd shipping in emerging markets like India. Specifically, it examines the role of gender, financial incentives, travel costs, work-trip mode choice, personality traits and return-trip travel time in shaping participation. By integrating these aspects within the unique socio-economic and infrastructural landscape of an emerging market, this

research provides valuable insights to advance both theoretical understanding and practical strategies for fostering inclusive and efficient crowd shipping models in urban logistics.

3. Data

This section outlines the rationale for selecting the survey location and respondents, the design of the survey questionnaire, and the data collection approach.

3.1. Study area and selection of respondents

This study is conducted in the Mumbai Metropolitan Region (MMR), India (Fig. 1). The MMR contributes over USD 15 billion to the state's GDP, accounting for approximately 40 % of the state's total economic output (MMRDA, 2021). It focuses on gathering data from working professionals in the MMR with a threefold rationale. First, the working population in MMR exhibits a higher trip rate, as they invariably undertake a return home trip daily. Second, due to their regular commute, working professionals are more attuned to the prevailing traffic conditions, providing them with better insights to make informed travel arrangements, including potential participation in crowd shipping initiatives. Third, the financial stability typically associated with working professionals enables them to weigh the trade-offs between travel time, travel costs, and the economic benefits crowd shipping programs offer more effectively.

This study specifically examines the participation of the working population in crowd shipping, focusing on individuals with high mobile phone penetration, financial stability, and higher education levels, key factors enabling informed decision-making regarding travel costs, time, and economic benefits of WTP-CS. Hence, working professionals are selected from the Bandra-Kurla Complex (BKC) within MMR. BKC holds strategic significance as a central business district (CBD) and a prominent working zone within Mumbai. Renowned for its status as an economic hub, BKC hosts many corporate offices, financial institutions, and government establishments. According to the Mumbai Metropolitan Region Development Authority (MMRDA), BKC currently sustains

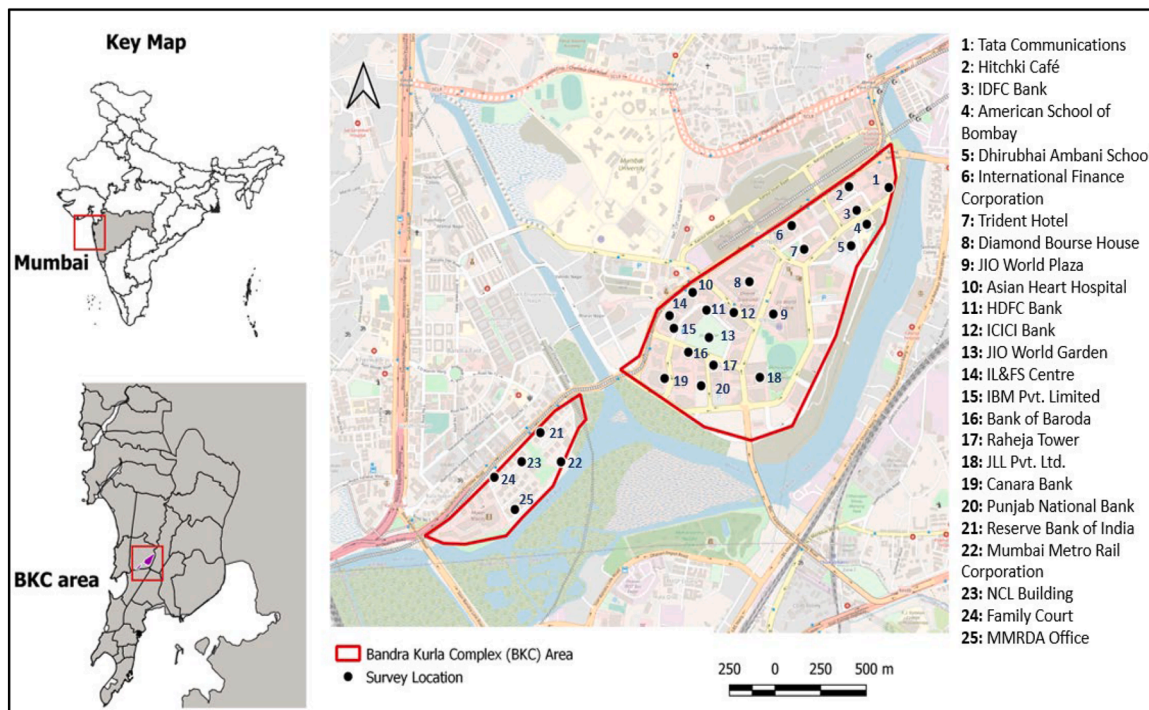


Fig. 1. Map of the study area and survey locations (workplace location of respondents).

employment opportunities for over 400,000 individuals. As BKC is dominated by corporate and institutional employers, the local workforce is predominantly highly educated, which is reflected in our sample composition.

3.2. Survey questionnaire and data collection

The survey questionnaire was organized into four separate sections: (i) socioeconomic and demographic backgrounds, (ii) personality traits, (iii) travel characteristics, and (iv) preferences for crowd shipping in nine hypothetical situations. Table 3 provides detailed information about the variables involved in the data collection process.

For primary data collection, surveyors targeted respondents from different offices of public and private sector employees. The data were collected from October 2023 to January 2024. This period corresponds to the post-monsoon and winter season in Mumbai, when commuting conditions are typically stable and not affected by the heavy rainfall and flooding that can occur during the monsoon months. As the survey focuses on routine home-work-home trips, which are highly habitual, seasonal effects on stated preferences for travel time and travel cost are therefore expected to be negligible. A random sampling method was employed to ensure representativeness and reproducibility of the self-administered survey. Two approaches were utilized: in-office surveys and surveys at food stalls and shopping malls within BKC, facilitating responses from a broad spectrum of individuals. Within office premises, employees present during lunch breaks and office closing hours were approached at random from the available staff in each workplace,

Table 3
Description of data collected through primary survey.

Variable	Levels	
Socioeconomic	Age of respondent (years)	1: 21–30; 2: 30–45; 3: 45–60
	Monthly income level (INR/month)	1: 0–50,000; 2: 50,000–1,00,000; 3: Above 1,00,000
	Gender of respondent	1: Male; 0: Female
	Education level	1: Graduate; 2: Post-graduate
Travel	Travel time for return home trip in minutes	Continuous
	Travel cost for return home trip in INR	Continuous
	Mode choice for work trip	1: Four-wheeler; 2: Two-wheeler
Personality trait (Conscientiousness)	I carefully plan my travel routes and schedules to ensure punctuality	1: completely disagree to 5: completely agree
	I prioritize sticking to predetermined travel arrangements and rarely deviate from them	
	I am conscientious about minimizing travel time and travel cost	
	I take responsibility for ensuring timely arrival at my destinations.	
	I enjoy exploring new travel routes and modes of transportation to enhance my travel experience	1: completely disagree to 5: completely agree
Personality trait (Openness)	I am open to trying alternative travel arrangements, even if they are unconventional, to reduce environmental impact	
	I actively seek out opportunities to engage with local cultures and communities during my travels.	

Note: INR is Indian Rupee.

independent of their interest in logistics or crowd shipping. In intercept locations such as food stalls, shopping malls, and informal retail areas, a systematic random intercept strategy was adopted, whereby every n-th passer-by at predefined high-footfall points was invited to participate, to minimise surveyor selection bias. Survey timings were strategically chosen during lunch breaks and office closing hours. Prior consent was obtained from higher authorities for in-office surveys, while verbal consent was obtained from respondents at food plazas and malls. A total of 564 samples were collected, of which 13 were discarded due to incomplete details, and 551 were utilized for data analysis. Of the samples collected, the majority (78 %) were from in-office surveys, and a significant proportion (56 %) of respondents belonged to private sector employment.

While BKC predominantly hosts a formal workforce, efforts were made to include responses from daily wage workers engaged in informal employment (e.g., watchmen, street vendors) to ensure a comprehensive representation of the working population. The target population comprised both government and private sector workers in BKC. To ensure a diverse and representative sample, data collection spanned various locations within BKC, including major food stalls, shopping malls, and informal retail establishments with high foot traffic. Surveys were conducted during peak hours (e.g., lunchtime, office closing hours) to maximize respondent engagement. A random sampling approach was employed, with efforts made to include individuals from different occupational domains (e.g., banking, healthcare, judiciary, urban development, business, hospitality, education, telecommunications). The survey encompassed 25 distinct office spaces and workplaces within BKC (Fig. 1). This method ensured broad occupational representation without limiting the survey to specific office spaces. To account for mode choice diversity, at least 100 respondents were sampled for each major transport mode.

Respondents were requested to review and validate their responses before submission to enhance accuracy and representation, facilitated using survey software (123formbuilder). Surveyors underwent training to proficiently administer the survey and accurately record responses using the software. Google API was integrated into the data collection process to verify respondents' workplace locations, ensuring spatial accuracy in the study. In-person surveys were conducted using smartphones to streamline data entry and enhance reliability. Approximately twelve minutes were taken by respondents to complete the survey questionnaire. To mitigate perception bias in self-reported travel characteristics, such as travel time and travel cost, respondents' inputs were cross-validated against real-time data obtained via Google API. Only responses that demonstrated consistency with actual travel estimates were retained for analysis, thereby improving the precision and validity of the dataset. To maintain data integrity and prevent duplicate participation during the four-month collection window, several safeguards were implemented. Technically, the 123formbuilder software was configured to restrict multiple submissions from the same IP address through digital fingerprinting and browser-based cookies. Logically, the integration of the Google API allowed for the spatial verification of respondents' workplace locations, enabling the identification and removal of redundant entries from identical office coordinates. Additionally, surveyors followed a strict field protocol in the distinct targeted workplaces and communal areas (food stalls/malls), involving a preliminary screening question to confirm that the respondent had not previously completed the survey. These measures ensured that the final dataset consisted of unique, high-quality responses. During the survey window, there were, to the best of our knowledge, no major policy changes, high-profile accidents, or large-scale commercial launches related to crowd-shipping services in Mumbai. Crowd shipping remains an emerging and relatively unfamiliar concept in this context. To ensure a consistent understanding of the concept, all respondents were first provided with a standardized, neutral description of crowd shipping within the questionnaire before answering the stated preference tasks, so their background information about the service was stable across the four-month

data collection period. However, because the survey window does not include the monsoon season itself, potential seasonal variation in commuting conditions and willingness to participate in crowd shipping under more disrupted travel conditions is not captured in this dataset.

3.3. Socioeconomic, travel, and personality characteristics of respondents

From the socioeconomic and demographic perspective, the majority of respondents falls within the younger age brackets, with 46.36 % aged between 21 and 30 years and 39.66 % falling between 30 and 45 years. A smaller proportion, 13.96 %, represents individuals aged 45 to 60 years. This age distribution reflects a significant representation of the younger working population. This aligns with the finding that in the Indian setting, young and middle-aged individuals are the age group most engaged in economic activity (Mahata et al., 2019). The male predominance in the sample (76.80 %) aligns with the broader trend of limited female participation in the formal workforce across major Indian cities (Ministry of Labour & Employment, 2022). A significant proportion of respondents also falls within the middle-income bracket, with 43.01 % earning between INR 50,000 and INR 1,00,000 monthly. Notably, 29.05 % report incomes below INR 50,000, while 27.93 % report incomes exceeding INR 1,00,000 monthly. This trend can be attributed to the prevalence of formal employment opportunities in locations like BKC, which typically require higher educational qualifications and higher pay than average. Most respondents hold post-graduate degrees or above (80.80 %), with only 19.20 % completing undergraduate studies. In the econometric analysis, education is therefore represented as a binary indicator distinguishing respondents with postgraduate degrees (post-graduate and above) from those without, as shown in Table 3.

From a travel perspective, two-wheeler usage is predominant. For the purposes of modelling the supply of potential crowd-shippers, the

commuting mode variable was restricted to private two-wheelers and four-wheelers, which are the modes operationally capable of carrying parcels in the Mumbai context; public transport, walking, and cycling users were not included in the mode-choice coding used in the ICLV model. The findings are consistent with official figures, which show that most transport preferences in the region are for two-wheelers, followed by four-wheelers, as a private mode of travel (MMRDA, 2021). The mean travel time for the respondents was around 68.1 min for a return home trip (workplace to home).

From the personality perspective, the mean ratings for the Likert scale related to conscientiousness and openness personality traits were 3.65 and 3.79, respectively. The distribution of ratings on a five-point scale is illustrated in Fig. 2. For conscientiousness-related items, most respondents (46.3 % to 58.4 %) generally agreed with statements about careful travel planning, adherence to predetermined arrangements, minimizing travel time and cost, and ensuring timely arrival at destinations. In contrast, for openness-related items, respondents exhibited greater variability in responses, with significant agreement (54.2 % to 55.3 %) toward enjoying exploring new travel experiences and being open to unconventional arrangements for environmental benefits. In addition, a notable proportion (25.9 %) strongly agreed with seeking opportunities to engage with local cultures during travels, indicating a high level of openness and cultural curiosity among respondents.

4. Method

This section deals with the conceptual framework, design of the stated preference survey, and empirical models used.

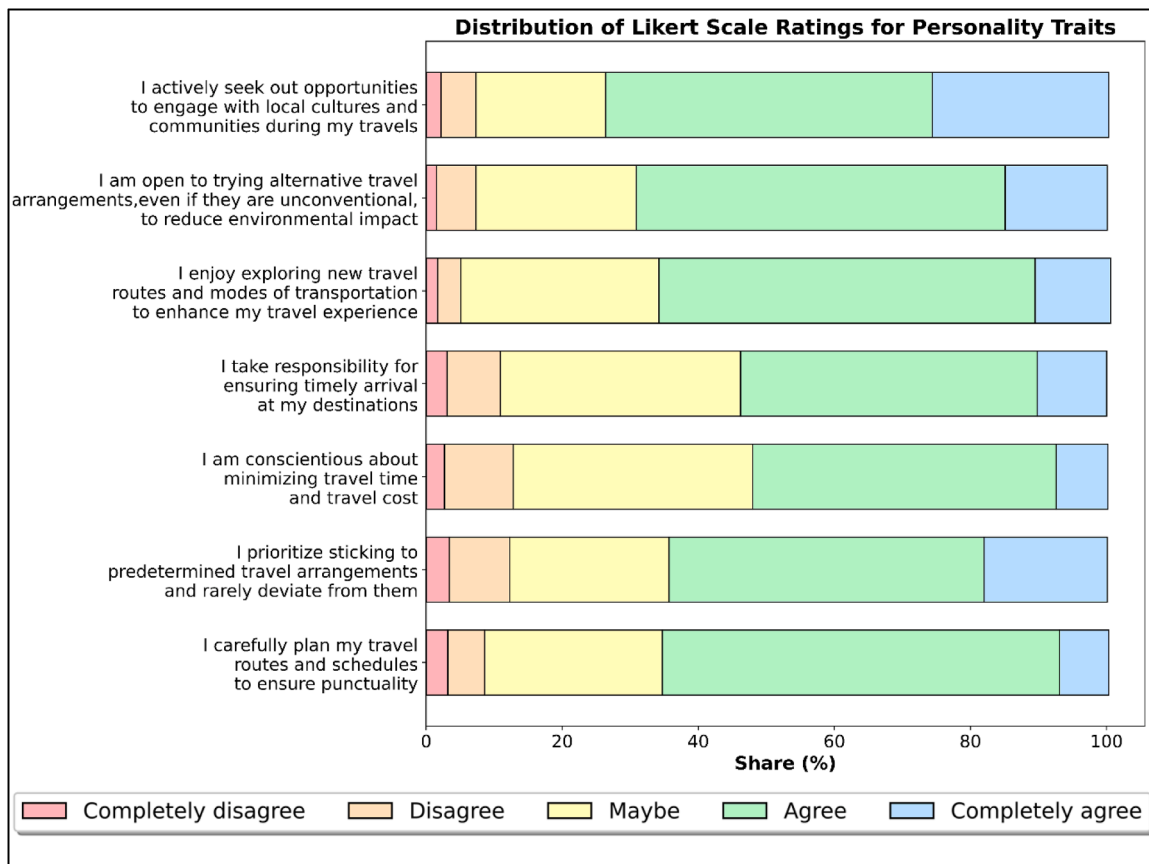


Fig. 2. Distribution of Likert scale rating for indicators representing latent variables (personality traits).

4.1. Conceptual framework

This study employs an Integrated Choice and Latent Variable (ICLV) model to examine the factors influencing respondents' WTP-CS (Fig. 3). The model comprises two main components: (i) the choice part, where the influence of exploratory variables (respondent's socioeconomic and demographic characteristics, travel characteristics, and personality traits as latent variables) on the utility equation for decision-making is assessed, and (ii) the structural part, which examines the effect of socioeconomic and demographic characteristics on latent variables (personality traits). This approach allows for a comprehensive understanding of the complex interplay between individual characteristics and the decision-making process regarding participation in crowd shipping.

4.2. Design of experiment

In designing the stated preference experiment, four attributes were considered: travel time, travel cost, frequency of services (refers to the number of times a participant has to work as a crowd shipper), and types of economic benefits offered by e-commerce companies to crowd shippers. Each attribute has three levels, as explained in Table 4. A full factorial design would result in 81 possible scenarios (3⁴). However, given the impracticality of presenting respondents with all 81 scenarios, the Taguchi orthogonal array method, precisely the L9 specification, was employed. This method allows for creating nine cards, significantly reducing the number of scenarios while still capturing the variability across the attribute levels. All nine scenarios were presented to the respondents. The Taguchi orthogonal array approach has been widely utilized in previous studies in travel behavior research for designing stated preference surveys, ensuring efficient and manageable data collection processes (Chen et al., 2023; Hsieh, 2020; Wang et al., 2022). Taguchi Orthogonal Design optimizes stated preference surveys by reducing the number of experimental combinations, ensuring efficient data collection and robust statistical analysis. It minimizes confounding effects, enhances model estimation, and offers a cost-effective approach to understanding preferences with multiple factors and levels.

The rationale for providing economic benefits rather than direct monetary benefits is demonstrated as providing attractive incentives such as complimentary shopping cards, Wireless Fidelity (Wi-Fi)

Table 4
Attributes and Levels for stated preference experiment.

Attributes	Levels
Travel time	Existing travel time + 15 min
	Existing travel time + 30 min
	Existing travel time + 45 min
Travel cost	Existing travel cost + Indian rupee (INR) 20
	Existing travel cost + INR 30
	Existing travel cost + INR 40
Service frequency	Once a week
	Twice a week
	Thrice a week
Economic benefits	Free shopping card of INR 5000 from e-commerce platform per month
	Free Wireless Fidelity (Wi-Fi) services at home and subscription to 3 favorite Over-The-Top (OTT) platforms
	Interest-free loan up to INR 1,00,000 for a year

subscriptions, or interest-free loans. This approach promotes sustainable travel and offers practical advantages while catering to broader economic and lifestyle requirements. These incentives aim to accommodate individuals' desire for additional perks, making sustainable travel behaviors more attractive and convenient. Integrating economic benefits into these schemes makes them more effective in motivating long-term participation and engagement in sustainable transport practices. The approach to providing economic benefits for shaping travel behavior and promoting sustainable mobility is widely researched and applied in various regions (Bresciani et al., 2016; Cellina et al., 2023; Tsimpa et al., 2019). In this study, the three economic incentives (shopping voucher, free home Wi-Fi with Over-The-Top (OTT) subscriptions, and an interest-free loan) were specified in the econometric model as separate dummy variables rather than as ordered levels of a single continuous attribute, allowing the model to capture their distinct behavioral effects. These incentive types were selected to represent different 'mental accounts' (consumption, digital access, and financial liquidity) in line with mental accounting theory (Thaler, 1999) and empirical evidence that reward-based and non-monetary incentives, delivered for example through apps, vouchers, or digital services, can effectively promote sustainable mobility and participation in sharing or ICT-enabled schemes (Arriagada, 2025; Bresciani et al., 2016; Cellina et al., 2023; Di Dio et al., 2020; Goetz et al., 2024; Tsimpa et al., 2019),

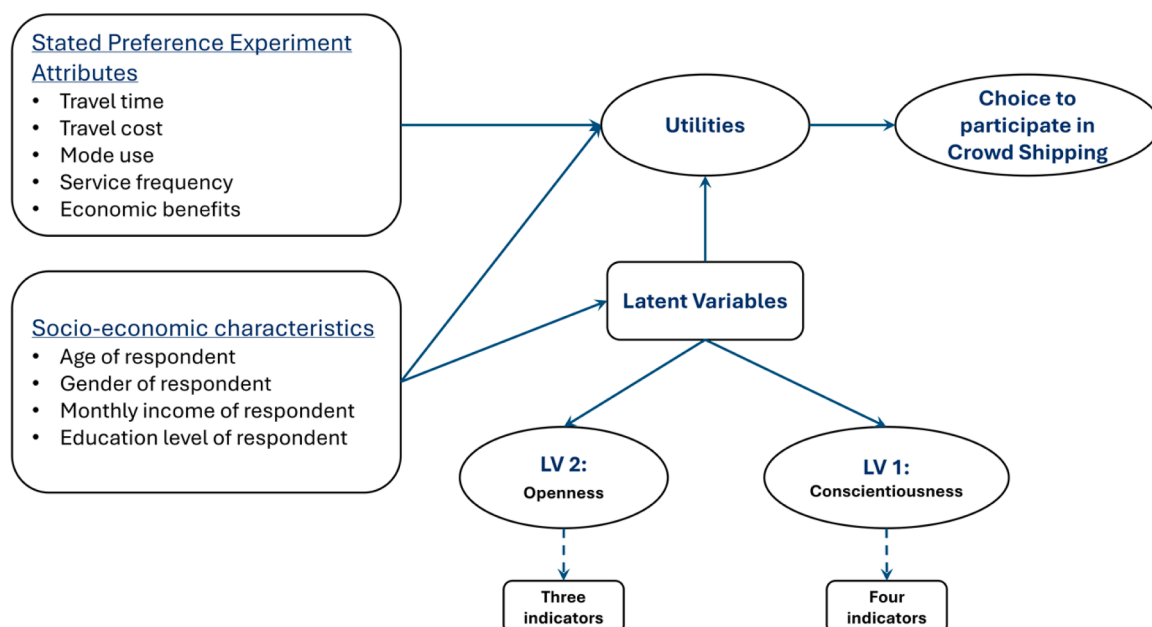


Fig. 3. Conceptual framework for analyzing the willingness to participate in crowd shipping.

and that cash and non-cash rewards are not behaviorally equivalent (Heyman & Ariely, 2004; Sittenthaler & Mohnen, 2020). Respondents were presented with a comparison of their current travel cost and time, and allowed to either participate in crowd shipping or stick with their current travel arrangements.

An example of a SP choice card presented to respondents is shown in Fig. 4. The card illustrates how the two alternatives, existing travel arrangement and participation in crowd shipping, were described in terms of travel time, travel cost, service frequency, and economic benefits.

4.3. ICLV modelling approach

A logit-kernel-based ICLV model is developed to effectively capture and analyze the interplay between individual characteristics, travel characteristics, and latent variables. People can accept crowd shipping or continue their existing travel arrangements (ETA). The analysis is based on two underlying variables represented by a structural equation. The utilities for different options in the discrete choice sub-models rely on observed and hidden variables linked to the decision-makers (Eq. (1)). The choice is determined by maximizing random utility (Eq. (4)).

Socioeconomic and demographic characteristics can impact decision-making through their direct effects on personal preferences and underlying factors that may not be immediately apparent. The indirect effects are observed through Eq. (2), in which the exogenous characteristics of the respondents determine each latent variable. Eq. (3) describes the measurement equation, which captures the influence of hidden variables through a set of 7 indicator variables derived from the survey’s measurement scales. Respondents provide feedback on their level of agreement or disagreement with statements that reflect their opinions or attitudes. The indicators provide supplementary data that aids in the identification and understanding of the underlying variables. The decisions regarding the number of latent factors and the specification of the structural and measurement equations are made based on the findings of the CFA. Determining the final model specification relies on statistical testing and inference, utilizing estimates of potential ICLV models.

Eq. (2) and Eq. (3) show a connection between unobserved latent variables and observed socioeconomic and demographic indicators. These latent variables contain information about personality traits of individuals. Therefore, the estimated model parameters provide valuable insights into behavior. The utility equation for the model is provided in Eq. (1). In the utility specification, the three economic incentive options (shopping voucher, free Wi-Fi with OTT subscription, and interest-free loan) enter as alternative-specific dummy variables for the crowd-shipping alternative, with the interest-free loan taken as the reference category:

$$u_{mnj} = B_m x_{nj} + \Gamma_m x_n^* + \epsilon_{mnj}, \epsilon_{mnj} \sim \text{i.i.d Gumbel} \tag{1}$$

The structural equation is as follows:

$$x_n^* = A s_n + v_n, v_n \sim N(0, \Phi) \tag{2}$$

The measurement equation can be written as:

$$i_n = D x_n^* + \eta_n, \eta_n \sim N(0, \Psi) \tag{3}$$

The choice equation is as follows:

$$y_{mnj} = \begin{cases} 1, & \text{if } u_{mnj} \geq u'_{mnj}, \forall j' \\ 0, & \text{otherwise} \end{cases} \tag{4}$$

Here, mnj represents the number of mutually exclusive alternatives $j(j = 1, \dots, J_n)$ that are available to individual n in choice situation m (i.e., accept to participate in crowd shipping or stick to current travel arrangements). The vector for latent variables (personality traits) for individual n are denoted by x_n^* . The vector for socioeconomic and demographic variables for individual n are represented by x_{nj} . The vector for the utility of alternative j for individual n is depicted by u_{nj} . B_m is a $(J \times X)$ matrix of unknown regression coefficients between each socioeconomic and demographic feature, travel characteristics for choice scenario m . The matrix for regression coefficients between each latent variable and choice alternatives m is denoted by Γ_m . The vector for random error for of unobserved components with Gumbel IID distribution is represented by ϵ_{mnj} .

In the structural equation, s_n is a $(K \times 1)$ vector for socio-economic

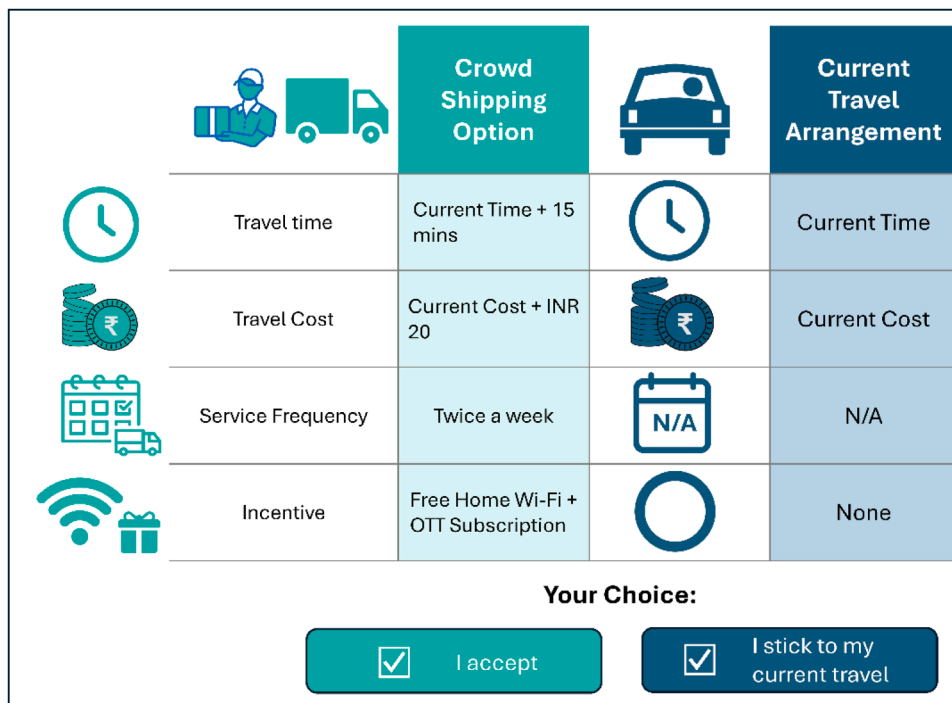


Fig. 4. Example of a Stated Preference (SP) Choice Card. The icons used in the figure are from flaticon.com.

character for individual n . A is a $(K \times M)$ matrix for the regression coefficient between socioeconomic and demographic character and latent variable. v_n is the error term normally distributed $N(0, \Phi)$, and Φ is a $(M \times M)$ variance-covariance matrix. In the measurement equation, the level of agreement to each item (indicators) is depicted by i_n . The $(R \times M)$ matrix for factor loading obtained through confirmatory factor analysis (CFA) indicating the relationship between each indicator and latent factor is denoted by D . The vector of measurement errors with normal distribution $N(0, \Psi)$ is represented by η_n . The diagonal matrix with variance terms is represented by Ψ . In the choice equation, y_{mnj} is the choice of individual n among alternatives j in choice situation m .

Since the utility function contains unobserved variables (x_n^*) which are themselves stochastic (distributed with error term v_n), the probability of individual n choosing alternative j is conditional on these latent constructs. Assuming the error term ϵ_{mnj} follows an i.i.d Gumbel distribution, the conditional probability $P_{mnj}(x_n^*)$ is given by the standard multinomial logit formulation:

$$P_{mnj}(x_n^*) = \frac{\exp(V_{mnj}(x_n^*))}{\sum_{k \in J_n} \exp(V_{mnk}(x_n^*))} \tag{5}$$

Where $V_{mnj}(x_n^*)$ is the systematic part of the utility function including the latent variable. However, because x_n^* is not observed, we cannot calculate this probability directly. Instead, we must integrate over the distribution of the latent variable's error term (v_n). The unconditional probability (likelihood contribution) for individual n is the integral of the conditional choice probability weighted by the density of latent variable:

$$L_n = \int_v P_{mnj}(x_n^*(v)) f(v) dv \tag{6}$$

This integral does not have a closed-form solution. Therefore, it is approximated using Maximum Simulated Likelihood (MSL) estimation, where the integral is evaluated numerically using Halton draws from the distribution $f(v)$. The ICLV model is estimated using a simultaneous (full-information) MSL approach, in which the choice model, structural equations, and measurement equations are jointly estimated within a single likelihood function (Eq. (5) and 6), using Halton draws to approximate the integrals over the distribution of the latent variables. The estimation of ICLV model was performed in the ‘‘Apollo’’ package in R (Hess & Palma, 2019). In addition to a complete ICLV model, two alternative models are estimated for model comparison: (i) a binary logit model without latent variables and (ii) a partial ICLV model that does not consider the relationship between socioeconomic and demographic factors and latent variables.

To evaluate the comprehensive impact of socio-economic and demographic characteristics on the decision to participate in crowd shipping, we calculated the total effects by combining direct and indirect pathways. By substituting the structural equation (Eq. (2)) into the utility equation (Eq. (1)), the utility function can be re-expressed to explicitly show the mediation through latent variables:

$$U_{mnj} = (B_m + \Gamma_m A) s_n + \Gamma_m v_n + \epsilon_{mnj} \tag{7}$$

Where B_m represents the direct effect of the socio-economics vector s_n on the utility of alternative j . The term $\Gamma_m A s_n$ represents the indirect effect of socio-economic variables mediated through the vector of latent variables x_n^* .

Consequently, the Total Effect of a specific socio-economic variable k on the utility of crowd shipping is calculated as:

$$Total\ Effect_k = \beta_{k,direct} + \sum_{l=1}^L (\alpha_{k,l} \times \gamma_l) \tag{8}$$

Where $\beta_{k,direct}$ is the coefficient of variable k in the choice model (element of matrix B_m), $\alpha_{k,l}$ is the coefficient of the variable k on the latent variable l (element of matrix A), and γ_l is the coefficient of latent

variable l on the choice utility (element of matrix Γ_m). This formulation allows for the assessment of how personality traits amplify or dampen the influence of demographic factors.

5. Result and discussion

This section presents results from statistical analysis and offers a comprehensive discussion of the findings.

5.1. Confirmatory factor analysis

The study focuses on two personality traits (openness and conscientiousness) considered latent variables. Table 5 displays the estimated confirmatory factor analysis (CFA) results, which include Cronbach's α values and average variance extracted (AVE).

The reliability measures (Cronbach's α) for the two latent variables are above 0.7, suggesting a strong internal consistency of the constructs. The AVE values of the two constructs exceed 0.5, while the standardized loadings of their associated indicators surpass 0.6. These findings indicate that the measurement model demonstrates satisfactory convergent validity (Das & Mandal, 2021; Hair et al., 2014). In addition, it was found that all square roots of AVE were higher than the intercorrelation between the constructs, which confirms the strong discriminant validity. To further evaluate the model fit indices for the CFA model, the following cut-off values for goodness of fit statistics (GOF) are suggested: Comparative Fit Index (CFI): >0.9; Goodness of Fit Index (GFI): >0.9; Tucker Fitness Index (TFI): >0.9; Standardized root mean square

Table 5
Confirmatory factor analysis for respondent's personality traits.

Personality trait (Latent Variable)	Indicator	Standardized Estimate	Cronbach's Alpha	AVE
Conscientiousness	I carefully plan my travel routes and schedules to ensure punctuality	0.73***	0.84	0.56
	I prioritize sticking to predetermined travel arrangements and rarely deviate from them	0.82***		
	I am conscientious about minimizing travel time and travel cost	0.76***		
	I take responsibility for ensuring timely arrival at my destinations.	0.69***		
	I enjoy exploring new travel routes and modes of transportation to enhance my travel experience	0.78***		
Openness	I am open to trying alternative travel arrangements, even if they are unconventional, to reduce environmental impact	0.82***	0.79	0.60
	I actively seek out opportunities to engage with local cultures and communities during my travels.	0.73***		

Note: The significance levels, denoted by asterisks (***, **, *), signify statistical significance at 1 %, 5 %, and 10 %.

residual (SRMR): <0.08; and Root Mean Square Error of Approximation (RMSEA): <0.08 (Das & Mandal, 2021; Qu et al., 2021; Sánchez et al., 2018; Saxena et al., 2024; Saxena & Shrivastava, 2022). From the developed CFA model, the GOF values were as follows: CFI: 0.96; GFI: 0.98; TFI: 0.93; SRMR: 0.03; and RMSEA: 0.08. Based on the findings derived from the CFA model and the established criteria for model fit, it can be concluded that the selected indicators accurately reflect the underlying latent variables of personality traits.

5.2. ICLV model

The complete ICLV model comprises two components: a measurement part, choice equation and a structural equation. This subsection presents the outcomes derived from the estimated models.

5.2.1. Measurement part

In an ICLV model, the measurement part refers to the component that links the latent variables (personality traits in the case of this study) to observable indicators (typically obtained through attitudinal survey questions for each personality trait). The results obtained are depicted in Table 6.

Based on the results obtained from the measurement part of ICLV model, it is evident that each attitudinal item has significant and positive relations with respective latent variables. Similar findings were also observed from the confirmatory factor analysis model. Full estimation results for the structural and measurement components of the ICLV model, including robust standard errors, t-ratios, and the ordered thresholds for each Likert-scale indicator, are reported in Appendix Table A1.

5.2.2. Choice part

The choice component of the ICLV captures individuals' decision-making process in predicting their WTP-CS or sticking to ETA. The model incorporates latent variables, socio-economic factors, and travel characteristics. The results of the choice part of the ICLV model, along with a binary choice model and a partial ICLV model, are depicted in Table 7.

In the main specification, travel time and travel cost are entered into as alternative-specific coefficients for the existing travel arrangement (ETA) and crowd-shipping (WTP-CS) alternatives rather than as generic parameters. This allows the model to capture potential behavioral asymmetries between routine commuting time and cost, which are

Table 6
Measurement part of ICLV model.

Observable/Attitudinal Indicator	Personality trait (Latent Variable)	Estimate
I carefully plan my travel routes and schedules to ensure punctuality	Conscientiousness	1.79***
I prioritize sticking to predetermined travel arrangements and rarely deviate from them	Conscientiousness	1.49***
I am conscientious about minimizing travel time and travel cost	Conscientiousness	1.29***
I take responsibility for ensuring timely arrival at my destinations.	Conscientiousness	1.82***
I enjoy exploring new travel routes and modes of transportation to enhance my travel experience	Openness	3.2***
I am open to trying alternative travel arrangements, even if they are unconventional, to reduce environmental impact	Openness	2.75***
I actively seek out opportunities to engage with local cultures and communities during my travels.	Openness	3.02***

Note: The significance levels, denoted by asterisks (***, **, *), signify statistical significance at 1 %, 5 %, and 10 %.

perceived as part of the baseline trip, and the additional time and cost associated with undertaking parcel deliveries, which represent an active deviation from the usual commute and are evaluated relative to ETA as a reference. As a robustness check, we also estimated a model with generic time and cost coefficients constrained to be equal across alternatives; the resulting estimates (−0.0083 for travel time and −0.0071 for travel cost) are reported in the note below Table 7 and confirm that the main behavioral conclusions are not sensitive to this specification choice.

From Model 2 and Model 3, it is evident that including latent variables (personality traits) significantly impacts the model's effectiveness in analyzing the WTP-CS. In addition, the model's exploratory power is further enhanced by establishing relationships between the latest variable and the socioeconomic and demographic characteristics of respondents, as demonstrated in Model 1.

As shown in Model 1, in examining travel characteristics, it is logical that longer travel times, higher travel costs, and higher frequency of services (to be provided by crowd-shippers) would diminish the utility of respective transportation modes, as indicated by their negative effects on WTP-CS. Economic incentives such as free shopping cards and home Wi-Fi, along with preferred OTT subscriptions, exert a significant and positive influence on respondents' inclination towards crowd shipping. This aligns with consumer behavior theory, where individuals are drawn to options offering added benefits or cost savings (Fessler et al., 2024). Interpreting these results through the lens of mental accounting theory, the substantial disparity between the coefficients for "Free Wi-Fi and OTT" and the "Free Shopping Card" suggests a distinct psychological valuation of incentives among the young professionals working in the BKC. While shopping cards represent a fungible monetary substitute that is likely to be mentally integrated into a general expense account, connectivity-related incentives appear to be mentally earmarked within a separate hedonic or time-utilization account. For this demographic, such incentives are not perceived as marginal income but as non-fungible lifestyle facilitators that directly enhance leisure quality, digital engagement, and perceived time efficiency. In the context of Mumbai's demanding work environment, these benefits reduce the psychological cost of participation more effectively than generic monetary rewards, resulting in a substantially higher estimated utility. The negative impact of car usage for commuting on the WTP-CS can be ascribed to multiple underlying factors. Individuals relying on cars for their daily commute tend to be more economically stable, prioritizing the perceived value of time over potential economic incentives provided by crowd shipping. In addition, social influences may come into play, with their social circles possibly lacking endorsement or appreciation for adopting crowd shipping practices. This underscores the complex interplay of economic considerations, social norms, and lifestyle preferences in shaping decisions regarding participation in crowd shipping.

Table 7 presents a comparative assessment of model fit across the three specifications. The Binary Logit model (Model 3) serves as the baseline, yielding a final log-likelihood of −2977.98 and an adjusted ρ^2 (observed share) of 0.111. The partial ICLV model (Model 2), which incorporates latent personality constructs without socio-economic structural equations, improves the fit to a log-likelihood of −2959.00 and an adjusted ρ^2 (observed share) of 0.116, indicating that accounting for unobserved heterogeneity via personality traits enhances explanatory power. The complete ICLV model (Model 1) achieves the best fit, with the highest (least negative) log-likelihood of −2940.03 and the largest adjusted ρ^2 (equal share) of 0.122, confirming that explicitly modelling the structural relationship between socio-demographics and personality provides the most reliable representation of crowd-shipping participation. Likelihood-ratio (LR) tests support these conclusions. The partial ICLV model significantly outperforms the binary logit model (LR = 37.96), and the complete ICLV specification significantly improves on the partial ICLV (LR = 37.94), both exceeding the relevant χ^2 critical values at the 5 % level. These results indicate that the additional complexity of the complete ICLV model is justified by statistically significant gains in model fit.

Table 7
Model estimation and goodness-of-fit statistics for WTP-CS (binary logit, partial ICLV, and complete ICLV).

Independent variable	Dependent variable	Model 1 (Complete ICLV) Estimate value	Model 2 (Partial ICLV) Estimate value	Model 3 (Binary Logit model) Estimate value
Alternate specific constant	ETA	0.170***	0.162***	0.229***
Alternate specific constant	WTP-CS	0 (Fixed)	0 (Fixed)	0 (Fixed)
Travel time	ETA	-0.009**	-0.009**	-0.009**
Travel time	WTP-CS	-0.008**	-0.008**	-0.008**
Travel cost	ETA	-0.014***	-0.013***	-0.013***
Travel cost	WTP-CS	-0.007***	-0.007***	-0.007***
Service frequency	WTP-CS	-0.410***	-0.414***	-0.411***
Free shopping card/voucher	WTP-CS	1.304***	1.304***	1.302***
No interest loan	WTP-CS	1 (Fixed)	1 (Fixed)	1 (Fixed)
Free Wi-Fi and OTT subscription	WTP-CS	2.350***	2.351***	2.342***
Mode use (Car)	WTP-CS	-0.240**	-0.230**	-0.193**
Gender (Female)	WTP-CS	-0.281**	-0.254**	-0.213**
21 to 30 years (Younger)	WTP-CS	0.222**	0.216**	0.204**
45 to 60 years (Elder)	WTP-CS	0.014	0.018	0.012
INR 0 to 50,000 (lower income)	WTP-CS	0.271***	0.269***	0.300***
INR Above 1,00,000 (higher income)	WTP-CS	-0.864***	-0.843***	-0.814***
Educated above UG	WTP-CS	-0.321***	-0.308***	-0.306***
Personality trait (Conscientiousness)	WTP-CS	-0.191**	-0.134**	NA
Personality trait (Openness)	WTP-CS	0.150**	0.165**	NA
Model fit parameter				
Adjusted rho square (equal share)	NA	0.261	0.212	0.182
Log-Likelihood (Final)		-2940.03	-2959.00	-2977.98
Log-Likelihood (Null)		-3349.98	-3349.98	-3349.98
Adjusted rho. square (observed share)		0.122	0.116	0.111

Note: The significance levels, denoted by asterisks (***, **, *), signify statistical significance at 1 %, 5 %, and 10 %. Additionally, the 'interest free loan' is taken as reference category and fixed at 1. Halton draws were utilized to estimate the ICLV models. Note: ETA means existing travel arrangements; WTP-CS means willingness of individuals to participate in crowd shipping; OTT means over the top services. Additionally, the generic coefficient for travel time and travel cost were -0.0083 and -0.0071 (estimated using a separate model with complete ICLV specification).

This finding is corroborated by other insights from Model 1, which reveal distinct patterns based on income and education levels. Specifically, individuals from lower income brackets are positively inclined towards crowd shipping participation, while their higher-income counterparts display a negative propensity. Another study performed by [Devari et al. \(2017\)](#) also found that lower income had more inclination to work as crowd-shippers. Those with education beyond undergraduate level demonstrate a decreased likelihood of participating in crowd shipping. This suggests that individuals with higher education levels may be more inclined towards car usage, possibly due to higher-paid job opportunities or personal preferences. The observed reluctance towards crowd shipping among car commuters aligns with broader socio-economic trends, wherein economic stability and social dynamics influence transportation choices. Other socioeconomic and demographic characteristics exerted significant effects on crowd shipping participation. Female respondents displayed a negative inclination towards participation, contrasting their male counterparts. Age emerged as a notable factor, with younger individuals exhibiting a positive effect on WTP-CS while older respondents displayed a negative inclination. These findings may be rationalized through several lenses. The gender discrepancy could stem from differences in risk perception, safety concerns, additional household responsibilities, or preferences for convenience and familiarity in transportation modes. Younger individuals may be more inclined towards adopting novel technologies and alternative transportation methods, while older respondents might prioritize reliability and comfort, potentially favoring traditional modes of transport over-crowd shipping. The findings pertain to the influence of socioeconomic and demographic factors on the desire to participate in crowd shipping aligns with previous research performed in developed countries ([Fessler et al., 2024](#); [Le & Ukkusuri, 2019](#); [Mohri et al., 2024](#); [Punel et al., 2018](#)).

These results are broadly in line with recent reviews and empirical studies, which also find that younger and lower-income individuals with flexible commutes are more likely to participate in crowdshipping, and that detour time and compensation are central drivers of supply ([Devari et al., 2017](#); [Garcia-herrera et al., 2025](#); [Le et al., 2019](#); [Mohri et al.,](#)

[2023](#); [Pourrahmani & Jaller, 2021](#)). At the same time, our findings differ from much of this literature in several ways. First, we identify particularly strong negative effects of higher education and car use on supply-side participation among working commuters in an emerging-market megacity, whereas existing studies often focus on students, professional couriers, or users in high-income countries. Second, we find sizeable gender penalties in WTP-CS for women, complementing but extending beyond the gender-based mode-choice heterogeneity reported for professional e-grocery couriers ([Rossolov et al., 2026](#)). Third, we show that non-cash digital incentives (free home Wi-Fi with OTT subscriptions) are valued more highly than shopping vouchers, adding nuance to the predominantly monetary incentive schemes discussed in prior reviews ([Mohri et al., 2023](#); [Pourrahmani & Jaller, 2021](#)). Finally, unlike most crowdshipping studies, our ICLV specification explicitly incorporates Big Five personality traits, revealing opposite effects of openness and conscientiousness on WTP-CS and underlining the importance of psychological heterogeneity on the supply side.

Personality traits also emerged as influential factors in crowd shipping participation. Individuals reporting higher levels of conscientiousness exhibited a negative effect on WTP-CS, whereas those with higher levels of openness displayed a positive inclination. This divergence in response could be attributed to the distinct characteristics of each personality trait. Conscientious individuals typically prioritize orderliness, reliability, and adherence to established routines. Thus, they may perceive crowd shipping as unreliable compared to their ETA. Conversely, individuals high in openness tend to embrace novelty, curiosity, and flexibility. For them, crowd shipping may represent an innovative and adaptable solution that aligns with their exploratory mindset. The consistent impact of conscientiousness and openness on travel behavior and decision-making aligns with findings from previous studies ([Dollinger & Orf, 1991](#); [George & Zhou, 2001](#); [Lopez-Carreiro et al., 2021](#); [Yazdanpanah & Hosseini, 2016](#)).

5.2.3. Structural part

The structural part of the complete ICLV discusses the intricate

relationships between latent variables (personality traits) and socio-economic factors. The results of the structural part of the complete ICLV (model 1 in the context of the present study) obtained are depicted in Table 8.

Conscientiousness appears to have a positive coefficient in relation to gender. This implies that females tend to display slightly higher conscientiousness levels than males. Previous studies have shown that women tend to achieve higher conscientiousness scores than men (Costa et al., 2001). The findings also indicate that females and individuals with higher education, as well as those with higher conscientiousness, had a negative impact on their WTP-CS. Individuals with higher education levels were also found to have higher conscientiousness. It may be because higher education has the potential to cultivate qualities like discipline and organization, which are often linked to conscientiousness.

5.3. Role of latent variables in the hybrid choice model

The overall effect of socio-economic variables on WTP-CS is depicted in Table 9. To estimate the overall effect, both the direct effect of each socio-economic and demographic variable (estimated directly through the ICLV) on the WTP-CS and the indirect effect (calculated by multiplying the coefficient of the latent variable for WTP-CS by the coefficient values of socio-economic variables to the latent variable) are summed.

“Gender (Female)” has the most substantial indirect effects through both Conscientiousness and Openness, resulting in the highest overall indirect effect of -0.073 . The variable “INR Above 1,00,000 (higher income)” exhibited the highest direct effect on WTP-CS. This variable also has the highest overall effect on WTP-CS. While “Gender (Female)” has the most substantial indirect impact through the latent variables, “INR Above 1,00,000 (higher income)” demonstrated the most significant direct and overall impact on WTP-CS.

6. Conclusions and policy implications

This study investigated the factors influencing WTP-CS in an emerging market. The research provides some insights. First, offering free Wi-Fi services at home and subscriptions to three favorite OTT platforms were identified as the most influential factors positively associated with WTP-CS. Providing free shopping vouchers worth INR 5000 also enhanced WTP-CS. These findings align with consumer behavior theory, emphasizing the importance of added benefits and cost savings in influencing consumer decisions. The results also indicate that connectivity-based and lifestyle-oriented digital incentives, such as home Wi-Fi and OTT subscriptions, may be more attractive to professional commuters than generic shopping vouchers, so designers of crowdshipping schemes should consider these formats alongside direct monetary rewards. Second, increasing the number of services offered by crowd shippers negatively affected WTP-CS. Third, distinct trends are noticed among different demographic groups. Younger adults (aged 21 to 30 years) exhibited a strong positive inclination towards participating in WTP-CS. Low-income individuals showed a notable interest in crowd shipping due to financial incentives, while higher-income individuals and those with higher education levels demonstrated a decreased likelihood of participating. Fourth, individuals with higher levels of the openness personality trait exhibited a positive inclination toward WTP-

Table 8

Effects of socioeconomic and demographic factors on personality traits.

Socio-economic variables	Conscientiousness	Openness
Gender (Female)	0.07*	-0.40***
21 to 30 years (Younger)	-0.11	-0.02
INR Above 1,00,000 (higher income)	0.21*	-0.03
Educated above UG	0.15*	0.08

Note: The significance levels, denoted by asterisks (***, **, *), signify statistical significance at 1 %, 5 %, and 10 %. Note: UG means undergraduate.

CS. Conversely, those with higher conscientiousness tended to exhibit a more reserved attitude toward WTP-CS. These findings emphasize the role of individual traits in shaping participation behaviors in crowd shipping initiatives. Compared with previous crowd shipping research, which has largely examined users or professional couriers in high-income countries, this study contributes evidence on working commuters’ willingness to act as crowd shippers in an emerging economy and shows that non-cash digital incentives and Big Five personality traits are central to explaining supply-side participation.

Successfully implementing crowd shipping in a region requires a multi-faceted approach that leverages the area’s unique socioeconomic and cultural context. This study highlights several key strategies to achieve this. First, this study revealed that working professionals in MMR, particularly those in the younger age brackets (21–45 years), have higher trip rates due to their daily return home trips. Their financial stability allows them to effectively weigh the trade-offs between travel time, travel costs, and economic benefits. Focusing on this demographic, as seen in carpooling initiatives like “Quick Ride” and “Sride,” could potentially drive crowd shipping adoption. Second, the BKC was identified as a primary survey location as it is a central business district and economic hub hosting over 400,000 employees. Implementing bike-sharing programs like “Yulu Bikes” in BKC suggests that similar strategic location-based initiatives might thrive, providing a high concentration of potential crowd shipping participants. Third, public awareness campaigns are important for the success of crowd shipping initiatives. The findings on personality traits (e.g., conscientiousness, openness) indicate a need for targeted campaigns. The “Swachh Bharat Abhiyan” (Clean India Mission) utilized public awareness to drive behavioral change, suggesting that similar strategies could promote crowd shipping by emphasizing its benefits for reducing traffic congestion and environmental impact. Fourth, economic incentives (e.g., free shopping cards, home Wi-Fi, preferred OTT subscriptions) enhanced WTP-CS. Partnerships with telecom providers, OTT platforms, and retail chains can offer these incentives at a subsidized cost, potentially boosting participation rates. The use of “Paytm” cashback offers highlights the effectiveness of economic incentives in motivating behavior. Fifth, a regulatory framework that supports crowd shipping, including guidelines for safety, data privacy, and operational standards, is essential. The findings underscore the need for clear regulations. The regulatory framework for ride-sharing services like “Ola” and “Uber” in Mumbai has aimed to facilitate their integration into the city’s transportation system, ensuring safety and operational standards. Sixth, technology plays a crucial role in optimizing crowd shipping operations. The study emphasized the importance of mobile apps for real-time tracking and route optimization. The implementation of “Dunzo,” a hyper local delivery service in Mumbai, showcases the potential of technology in enhancing delivery efficiency.

7. Limitations and future research

The findings should be interpreted considering some limitations: the sample is drawn from a single central business district and is skewed towards highly educated workers using private motorised modes, so the results are most representative of a potential early-adopter segment rather than the entire urban working population. The assessment of model performance in this study is based on in-sample likelihood-based fit measures; future work could complement this with explicit out-of-sample validation when larger datasets become available. In addition, the data were collected only during the post-monsoon and winter months, so possible seasonal variation in commuting conditions and willingness to participate in crowd shipping during the monsoon period is not captured; future research could explicitly compare WTP-CS across seasons, including extreme-weather conditions such as heavy rainfall and flooding. This study has opened further exploration and research avenues. First, while this study focused on the influence of two personality traits (conscientiousness and openness), selected because they

Table 9
Combined effect of socio-economic variables on WTP-CS.

Socioeconomic variables	Direct	Indirect through LV 1 (Conscientiousness)	Indirect through LV 2 (Openness)	Combined effect of LVs	Overall effect on WTP-CS
Gender (Female)	-0.281	-0.013	-0.06	-0.073	-0.354
21 to 30 years (Younger)	0.222	-	-	-	0.222
Income above INR 1,00,000	-0.864	-0.04	-	-0.04	-0.904
Educated above UG	-0.321	-0.029	-	-0.029	-0.35

Note: The sign (-) represents an insignificant effect. Note: UG means undergraduate.

align most directly with innovation adoption and willingness to deviate from routine and to keep the survey and ICLV specification parsimonious, there is an opportunity to extend the framework to include the remaining Big Five dimensions. Future work could explicitly examine how neuroticism (e.g., safety and anxiety concerns), extraversion (e.g., preference for social interaction during handovers), and agreeableness (e.g., prosocial or community-oriented motives) shape participation in crowd shipping, particularly in developing-country contexts where trust and perceived risk may play an outsized role. Second, examining the regulatory frameworks surrounding crowd shipping is essential for its sustainable growth. Future studies can analyze legal and regulatory challenges, including liability, insurance, and privacy concerns, and propose frameworks that foster innovation while ensuring compliance and safety for the Indian context. Third, expanding the scope beyond work trips to include other trip purposes, like leisure or shopping, can provide a more comprehensive understanding of crowd shipping’s potential applications and limitations across various contexts. Fourth, conducting in-depth environmental impact assessments can shed light on the sustainability of crowd shipping compared to traditional delivery methods. Evaluating factors such as carbon emissions, congestion, and resource consumption can guide the development of eco-friendly logistics practices.

Data statement

The anonymous base data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Appendix

Table A1
Structural and measurement parameter estimates for the ICLV model (latent variables: Conscientiousness and Openness).

Parameter Type	Variable / Indicator	Estimate	Robust Std. Err.	t-ratio
Structural Eq.	Effect on Conscientiousness (C)			
	Gender (Female)	0.07	0.04	1.80
	Age (21–30 years)	-0.11	0.11	-1.00
	Income > INR 1,00,000	0.21	0.12	1.82
	Education (Post-graduate)	0.15	0.08	1.81
Structural Eq.	Effect on Openness (O)			
	Gender (Female)	-0.40	0.14	-2.96
	Age (21–30 years)	-0.02	0.13	-0.12
	Income > INR 1,00,000	-0.03	0.15	-0.20
	Education (Post-graduate)	0.08	0.14	0.60
Measurement Eq.	Factor Loadings (ζ)			
	ζ(C,a) (Plan routes)	1.79	0.30	6.02
	ζ(C,b) (Stick to arrangement)	1.49	0.39	3.84
	ζ(C,c) (Minimize travel time)	1.29	0.19	6.77
	ζ(C,d) (Timely arrival)	1.82	0.62	2.93
	ζ(O,a) (Explore new routes)	3.20	0.48	6.68
	ζ(O,b) (Unconventional modes)	2.75	0.30	9.11
	ζ(O,c) (Local culture)	3.02	0.59	5.08

(continued on next page)

Ethical approval

This study involved human participants in the form of a questionnaire survey. Informed consent was obtained from all participants.

CRediT authorship contribution statement

Aditya Saxena: Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Deepjyoti Das:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Conceptualization. **Alireza Ermagun:** Writing – review & editing, Writing – original draft, Validation, Supervision, Conceptualization. **David Levinson:** Writing – review & editing, Visualization, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Table A1 (continued)

Parameter Type	Variable / Indicator	Estimate	Robust Std. Err.	t-ratio
Thresholds (τ)	Conscientiousness Indicators			
	$\tau(C,a)$ (Levels 1–4)	−5.75, −4.13, −0.99, 3.84	0.24–0.69	All signif.
	$\tau(C,b)$ (Levels 1–4)	−5.29, −2.65, −0.71, 2.06	0.21–0.58	All signif.
	$\tau(C,c)$ (Levels 1–4)	−4.67, −2.41, −0.03, 2.95	0.18–0.43	All signif.
Thresholds (τ)	Openness Indicators			
	$\tau(O,a)$ (Levels 1–4)	−7.61, −6.12, −1.42, 4.46	0.38–0.76	All signif.
	$\tau(O,b)$ (Levels 1–4)	−8.07, −3.51, −1.84, 2.91	0.37–0.68	All signif.
	$\tau(O,c)$ (Levels 1–4)	−6.87, −4.96, −2.07, 2.26	0.44–1.06	All signif.

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