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Evaluating Smart Mobility Ecosystems: Citizen Perspectives from Four Global Cities

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Abstract **Smart mobility has become a critical component of urban competitiveness and sustainable urban development. While smart city rankings frequently assess infrastructure and governance capacity, less attention has been paid to citizens' perceptions of mobility-related innovations. Drawing on survey data from Hamburg, Los Angeles, Shanghai, and Dubai (N = 955), this study examines how residents evaluate digital mobility services, including car sharing, parking guidance, bike sharing, digital ticketing, and real time traffic information. The findings reveal substantial cross regional differences. Shanghai records the strongest smart mobility index (1.78), followed by Dubai (1.91), Los Angeles (2.36), and Hamburg (2.83). Public transport t-ticketing receives the most positive evaluation in Hamburg and Los Angeles, while real-time road traffic information receives the most positive evaluation in Shanghai; both services are rated equally favourably in Dubai. The results suggest that smart mobility serves not only as a transport policy instrument but also as a visible indicator of urban innovation, quality of life, and competitiveness.**

Keywords: smart mobility, digital mobility services, citizen perceptions, smart cities, urban mobility, cross-city comparison

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I. Introduction

Cities increasingly face the challenge of adapting urban development to growing sustainability demands, technological change, and citizens' expectations regarding quality of life [1]. Smart city research highlights that digital infrastructures need to be complemented by human and social capabilities to improve urban performance [1], [9]. Within this broader context, mobility represents a particularly relevant smart city dimension because citizens experience transport infrastructure and digital mobility services directly through their everyday travel. Smart mobility connects intelligent transport systems, shared mobility, public transport e-ticketing, and real-time road traffic information to improve urban movement [2], [3]. Smart city literature examines these developments from both system-oriented and citizen-centred perspectives. Lyons [4] emphasizes the need to align technological innovation with broader sustainable mobility objectives, while Savastano et al. [5] demonstrate that the digitalization of shared and public mobility services can improve service quality, accessibility, and perceived value, particularly when applications are efficient and user-friendly. Angarita-Lozano et al. [6] further show that combining objective performance indicators with citizens' subjective perceptions can reveal implementation gaps that remain hidden in conventional assessments. Because mobility services are frequently used in everyday life, they constitute a highly tangible manifestation of smart city development and can influence citizens' perceptions of urban quality and performance [3],[7]. Citizens therefore evaluate urban innovation not only through policy initiatives or official rankings but also through their everyday mobility experiences. International comparative research also demonstrates that citizen roles and interactions in smart city initiatives vary across institutional and governance contexts and evolve over time [8]. Taken together, these studies indicate that the effectiveness of digital urban services cannot be assessed independently of citizens' everyday experiences and their specific urban contexts. Building on this perspective, the present study examines how citizens in four international cities evaluate digital mobility ecosystems.

II. Data and Method

The empirical analysis is based on a harmonized citizen survey from Hamburg, Los Angeles, Shanghai, and Dubai. The combined sample includes 955 respondents: Hamburg n = 352, Los Angeles n = 201, Shanghai n = 194, and Dubai n = 208.

Participants were recruited through the authors' academic networks and degree programmes in the four study locations. The study therefore employed a pragmatic convenience-sampling approach rather than probability-based sampling. Participation was voluntary and limited to residents of Hamburg, Los Angeles, Shanghai, and Dubai.

The structured questionnaire was administered online between October 2021 and June 2023. It was available in English and Chinese, with the Chinese version used to facilitate participation in Shanghai. At the beginning of the survey, respondents received standardized written information about the purpose of the study, the voluntary and anonymous nature of participation, and the procedure for completing the questionnaire. Participants completed the survey independently and were instructed to evaluate the statements using a five-point Likert scale, with lower values indicating more favourable assessments.

To reduce the likelihood of duplicate submissions, the survey platform permitted only one completed response per IP address. No names or contact details were collected. Survey responses were stored securely and were accessible only to the authors.

The underlying survey was originally designed to capture citizens' perceptions of multiple smart city dimensions. In addition to smart mobility, respondents evaluated smart governance, smart environment, smart living, smart economy, and digital public services. The survey therefore reflects a comprehensive understanding of smart city development.

Previous analyses using ordered logistic regression across all dimensions indicate that smart mobility, smart environment, and smart governance are among the most significant predictors of overall city ratings and citizens' perceptions of urban smartness [10]. Given the central role of mobility in shaping broader smart city perceptions, this paper focuses specifically on the mobility dimension. Overall perceived smart mobility status refers to respondents' general assessment of their city's mobility system in terms of accessibility, multimodality, sustainability, and the integration of digital technologies. In contrast, the Smart Mobility Index represents the arithmetic mean of five separately evaluated digital mobility services: car-sharing applications, parking guidance applications, bike-sharing services, public transport e-ticketing, and real-time road traffic information. Public transport e-ticketing refers to digital public transport services that provide timetable and journey-planning information and enable users to purchase or use public transport tickets through mobile applications or online platforms. It excludes parking tickets and parking payment services. Real-time road traffic Information refers to mobile information about road conditions, including congestion, incidents, disruptions, and route conditions; it does not include public transport timetable updates.

The mobility-item analysis is based on 818 respondents with valid responses to all five service items. Cases with missing values in the original dataset, were excluded from this analysis; most excluded cases were from Hamburg. Respondents evaluated each item on a five-point Likert scale, with lower values indicating stronger agreement and more positive assessments (1 = very advanced/strongly agree; 5 = very primitive/strongly disagree). Arithmetic means are used exclusively as descriptive summaries to facilitate comparisons across services and cities; no parametric inferential tests are applied to the individual items. Given the relatively large city-specific samples, the identical five-point response format across all items, and the exclusively descriptive purpose of the comparison, mean scores were considered appropriate for illustrating general patterns. Nevertheless, the results should be interpreted as descriptive differences in response patterns rather than as evidence of statistically significant group differences [11].

III. Results

The results indicate clear cross-city differences in the perceived quality of smart mobility systems, suggesting that citizens experience and evaluate digital mobility ecosystems in distinct ways. Figure 1 compares two complementary measures of smart mobility across the four cities.

Across all four cities, the Smart Mobility Status receives slightly more favourable evaluations than the Smart Mobility Index, suggesting that citizens tend to assess the broader mobility system more positively than individual digital mobility services.

The figure reveals substantial cross-city differences. Shanghai receives the best evaluation on both measures, recording a Smart Mobility Index of 1.78 and a Smart Mobility Status score of 1.56. Dubai follows closely with an index value of 1.91 and a status score of 1.76. In contrast, Los Angeles achieves more moderate evaluations, with a Smart Mobility Index of 2.36 and a Smart Mobility Status score of 2.29, while Hamburg receives the most critical assessments, with corresponding values of 2.83 and 2.42. The distance between Hamburg and Shanghai

exceeds one full scale point for the Smart Mobility Index, suggesting notable differences in the perceived maturity, visibility, and integration of digital mobility ecosystems. The parallel ordering of the four city samples across both measures suggests that more favourable evaluations of specific digital mobility services tend to coincide with more favourable assessments of overall perceived smart mobility status. As the present analysis is descriptive, this pattern should not be interpreted as evidence of an individual-level statistical relationship.

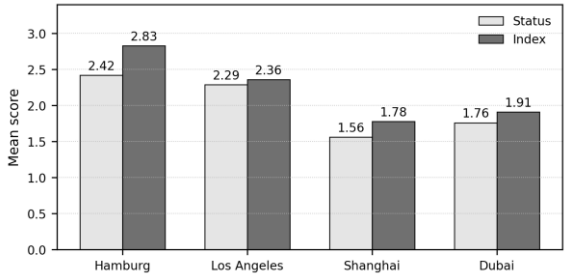


Fig. 1. Overall Perceived Smart Mobility Status and Smart Mobility Index by city. Lower values indicate more positive citizen evaluations. Source: Own figure.

A closer examination of the individual mobility indicators reveals differences in the composition of perceived mobility performance. While Shanghai and Dubai consistently achieve favorable evaluations across all indicators, Hamburg and Los Angeles exhibit a more heterogeneous pattern. Hamburg performs comparatively better in public transport e-ticketing than in parking guidance or car sharing applications, whereas Los Angeles receives relatively balanced evaluations across most mobility services. The consistently more favourable ratings of the Smart Mobility Status measure, which captures accessibility, multimodality, sustainability, and digital integration, compared with the five-item digital service index suggest that respondents distinguished their overall experience of the mobility system from their evaluations of specific digital services.

Figure 2 provides a detailed view of the five mobility service indicators. Public transport e-ticketing receives very positive evaluations across all four cities, indicating that citizens particularly value services that simplify public transport access and trip planning. Traffic information and parking guidance services exhibit the largest variation between cities. Shanghai records the strongest evaluation for real-time road traffic information (1.5), while Hamburg receives the weakest evaluation (2.9). Shared mobility services such as car sharing and bike sharing show greater heterogeneity, suggesting that local mobility cultures and policy frameworks influence user perceptions.

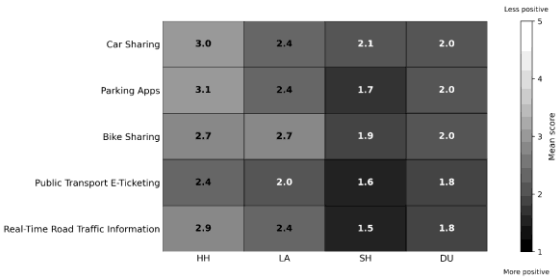


Fig. 2. Mean scores for the five digital mobility service indicators by city. Lower values and darker shading indicate more positive citizen evaluations. HH = Hamburg; LA = Los Angeles; SH = Shanghai; DU = Dubai. Source: Own figure.

IV. Discussion

The findings support the view that smart mobility constitutes a strategic component of smart city development. Across all four cities, respondents evaluated overall perceived smart mobility status more positively than the individual mobility services. This difference suggests that their overall assessments may reflect not only experiences with specific digital technologies but also broader perceptions of accessibility, connectivity, and transport quality. However, the present descriptive analysis cannot determine which factors shaped these broader assessments.

Mobility also occupies a distinctive position among smart city dimensions because transport infrastructure and mobility services are encountered directly through citizens' everyday travel. Smart mobility therefore represents a particularly tangible and frequently experienced aspect of smart city development. This interpretation is consistent with Benevolo, Dameri, and D'Auria [2], who conceptualize smart mobility as a citizen-facing domain in which ICT-supported services can contribute to quality of life and public value.

The findings are consistent with Lyons [4], who argues that smart mobility should be assessed beyond technological innovation and aligned with broader sustainable mobility objectives. They also relate to the governance perspective of Docherty et al. [3], who emphasize that realizing the potential benefits of smart mobility requires effective coordination among technologies, services, public authorities, private providers, and other urban actors. The particularly positive evaluation of public transport e-ticketing further supports the findings of Savastano et al. [5], who highlight the importance of accessible and user-friendly digital mobility services.

The four city samples followed the same ordering for both overall perceived smart mobility status and the Smart Mobility Index. At the aggregate city level, more favourable evaluations of individual digital mobility services therefore coincided with more favourable assessments of overall smart mobility development. However, this parallel ordering is descriptive and should not be interpreted as evidence of an individual-level statistical relationship or a causal effect of particular mobility services on overall perceptions.

The findings should also be interpreted considering the pragmatic sampling approach. Recruitment through academic networks and degree programmes resulted in an overrepresentation of younger and highly educated respondents. The results therefore describe the surveyed samples and should not be interpreted as population-representative estimates for the four cities. In addition, the exclusion of incomplete mobility responses, most of which originated from Hamburg, may have affected the city-level comparisons.

The observed cross-city differences should be interpreted cautiously because they may reflect not only differences in local mobility ecosystems but also cultural and linguistic measurement effects. Respondents in Los Angeles and Shanghai, for example, may apply different culturally shaped reference standards when evaluating accessibility, service quality, and technological development. Cross-national research has identified differences in acquiescence, midpoint, and extreme response styles, while the language in which a questionnaire is administered can also influence the use of response categories [12],[13]. Differences in mean scores may therefore partly reflect how respondents interpret and use the Likert scale rather than differences in mobility services alone. Because the present study did not test measurement invariance or employ anchoring vignettes, it cannot fully distinguish substantive differences between the city samples from cultural and linguistic response effects.

Against this background, Hamburg's comparatively fewer positive results should not be interpreted as direct evidence of insufficient mobility innovation. Instead, they may indicate potential limitations in the visibility, usability, or integration of existing services among the respondents surveyed. The comparatively less favourable evaluations of car-sharing applications and real-time road traffic information point to possible opportunities to improve the everyday user experience and increase the perceived value of these mobility offerings. These interpretations nevertheless require confirmation through representative samples and complementary objective indicators of local mobility performance.

V. CONCLUSION

This study provides comparative evidence on how citizens perceive smart mobility as a visible dimension of smart city development. Across the four cities, citizens evaluate digital mobility services differently, with the most positive assessments observed in Shanghai and Dubai. Public transport e-ticketing and real-time road information emerge as particularly important components of smart mobility because they reduce friction in everyday travel and improve the user experience. For policymakers, the findings suggest that mobility strategies should focus not only on technological deployment but also on usability, integration, and perceived citizen value. Reliable and accessible digital services that are seamlessly integrated into everyday life can improve citizens' mobility experiences.The individual indicators reveal a consistent pattern across the four cities. Shanghai and Dubai achieve favourable evaluations across all mobility services, while Hamburg and Los Angeles receive more moderate ratings. Public transport e-ticketing receives the most favourable evaluation in Hamburg and Los Angeles, while real-time road traffic Information is rated most favourably in Shanghai and shares the best rating with public transport e-ticketing in Dubai. This pattern suggests that citizens particularly value digital services that facilitate public transport access and provide timely information for everyday travel. In contrast, car sharing applications, parking guidance systems, and traffic information display the largest cross-city differences. Hamburg receives substantially fewer promising evaluations for car sharing applications (3) and real-time road traffic information services (2.9) than Shanghai (2.1 and 1.5, respectively). For policymakers, the results imply that mobility strategies should focus not only on technological deployment but also on usability, integration, and perceived citizen value. In particular, the comparatively weaker evaluations of car sharing applications and traffic information services in Hamburg indicate that improving the visibility and user experience of digital mobility services may contribute to stronger citizen perceptions of mobility performance.

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