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Impact of the built environment on urban mobility patterns and advanced transport dynamics: a systematic review

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ABSTRACT

This systematic review explores the complex relationships between the built environment, transport systems, and travel behaviours, synthesising findings from 62 studies screened from the Scopus database. The review highlights how factors like infrastructure quality, transportation network connectivity, and land use diversity influence travel patterns. Key findings show that high-density bicycle networks and mixed-use urban developments promote active transportation, though their effectiveness varies by socio-economic and cultural contexts. Emerging mobility innovations, such as electric bicycles and dockless bike-sharing, further complicate these dynamics. The review also underscores the importance of subjective factors like perceived safety and comfort, alongside objective built environment attributes. Public transit systems, particularly rail networks, are crucial for facilitating multimodal travel and fostering urban development, but challenges related to equity and accessibility persist. Future research should focus on adaptive strategies that integrate advanced technologies, localised planning, and inclusive policies to enhance urban mobility, sustainability, and equity.

Introduction

In recent years, the dynamic relationship between transportation systems, the constructed environment, and travel behaviour has attracted significant attention as urban planners, policymakers, and researchers endeavour to establish sustainable and efficient urban environments (Cheng et al., 2020). It is essential to comprehend the interplay between these elements to address modern challenges, including the necessity for equitable access to transportation, environmental degradation, and traffic congestion. Many factors impact people's travel behaviour, which includes their choices in transportation, the frequency of their trips, and the places they visit (Mouratidis et al., 2019). The built environment, which includes things like infrastructure, urban planning, and homeland use patterns, is crucial to these. The layout of homes, businesses, and parks, as well as the accessibility of bike lanes, public transportation, and pedestrian walkways, all have an impact on how people travel (Ao et al., 2022). On the other side, transportation networks may have an impact on city planning, which can lead to a vicious cycle that only serves to further complicate matters.

Road crashes cause many injuries and deaths globally. The World Health Organisation (2018) estimates that 1.35 million people are killed annually in traffic collisions. Transportation is a noteworthy contributor to greenhouse gas emissions and simultaneously plays a central role in the economy and society (Golbabaei et al., 2020, Kamruzzaman et al., 2016). Autonomous driving solutions have been implemented in recent years as part of the wise and balanced transport agenda (Grindsted et al., 2022). Fully autonomous on-road vehicles have the potential to generate a miscellaneous exhibit of societal and environmental advantages, if they are powered by a pure propulsion system (Bathla et al., 2022). The fast progression of autonomous vehicle technology is set to induce substantial transformations in the transportation sector (Bagloee et al., 2016). Among the several uses of autonomous cars, shared autonomous vehicles emerge as a notably promising breakthrough. Shared Autonomous Vehicles (SAVs) integrate self-driving technology with shared mobility principles, presenting a novel paradigm for urban transportation that might improve efficiency, mitigate congestion, and diminish environmental concerns (Golbabaei et al., 2021).

Particularly in Southeast Asia, Latin America, West and East Africa, motorcycles are common in the developing world because they are comparatively less regulated, less expensive to purchase and run, and quicker than other means of transportation. But motorcycle usage is typified by disregard of traffic safety rules, congestion, criminality, environmental and noise pollution. Motorcycle taxis have expanded rapidly in developing cities in recent years as an indigenous response to

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the growing, unmet mobility needs and commercial opportunity presented by the failure of state-owned transport companies, according to claims, rather than as the outcome of a strategy or plan to meet the rising demand for transportation (Lisinge and van Dijk, 2022). With significant effects on the sustainability and development of the city, these phenomena might affect the general performance of public transport networks. Over time, researchers have demonstrated that the built environment plays a critical role in shaping individual travel choice, and a few factors, such as the spatial distribution of transit networks and the connectivity of road systems, strongly influence mode choice and travel behaviour. Similarly, urban density reflected in the concentration of jobs, housing, and mixed land uses affects accessibility and mobility patterns, ultimately guiding how people navigate their daily activities within cities (Harun and Yigitcanlar, 2025).

Moreover, broader elements of the living environment, including walkability, green spaces, and perceived safety, further mediate the relationship between urban form and transport behaviour, reinforcing the complexity of BE travel interactions. Few studies also highlight that the built environment not only influences daily travel choices but also interacts with socio-demographic factors and emerging mobility technologies, thereby shaping broader urban transport dynamics (Huang et al., 2024). Land-use and transportation policies aimed at modifying the built environment have gained traction as effective measures to mitigate urban growth challenges, such as energy consumption and greenhouse gas emissions (Chen and Costa, 2024). Some studies further examined the impact of location and built environment factors on activity participation and task distribution among household heads.

Hence, in this paper, a literature review was performed in a systematic manner. This review gives a detailed insight into the impact of the built environment on existing urban mobility patterns and advanced transport dynamics by bringing the multiple interrelated domains under a single umbrella, providing a better source of information. Advanced transport dynamics, such as the role of cycling, transit and multimodal integration and emerging transportation, were discussed. Besides, sustainability and urban development patterns were also reviewed in relation to urban planning and development. To extract the relevant articles, the Scopus database was taken into consideration to perform the systematic review processing. Although several review articles are available on travel behaviour and the built environment, this review differs by systematically assessing the literature further in-depth to give a future direction.

Methodology

The review methodology is established on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement, which has been adopted by several researchers (Musarat et al., 2022, Alaloul et al., 2022) to streamline the articles intended to conduct a review on specific topics. PRISMA helps in narrowing down the research area, which makes it easier and faster to conclude the findings. Besides, a future direction becomes clear to help the researchers resolve the problems. There are four phases of the PRISMA statement, starting with searching the data from a specific database based on the established keywords by applying the limitations. Then, moving to the second phase, the gathered data gets screened out based on the title and abstract of the articles, and any irrelevant information that is not related to the scope gets screened out. In the third phase of PRISMA, a full review of the remaining articles is made, and only those papers are selected that are relevant to the scope of the review. In the final phase interpretation of the remaining articles is made. Fig. 1 shows the screening flow based on the PRISMA statement, while further discussion has been made below.

Research strategy

Identification of articles

The scope of this review was narrowed down to “Travel Behaviour”, “Built Environment”, “Transport” and “Urban”. For this reason, the Scopus database was chosen to extract the articles. The search in the database was based on the following strings: (“Travel Behaviour” OR “Travel Behavior”) AND (“Built Environment”) AND (“Transport”) AND (“Urban”). The search was based on an algorithm suitable for the selected database, considering the scope of the review. The articles were considered from the year 2014 to early December 2024. Besides, a few more limitations were applied, such as: Articles in the English language only, Document type: Article, Conference Paper, Publication stage: Final and Source type: Journal, Conference proceedings. Based on this, 274 relevant articles were found that were considered for further assessment.

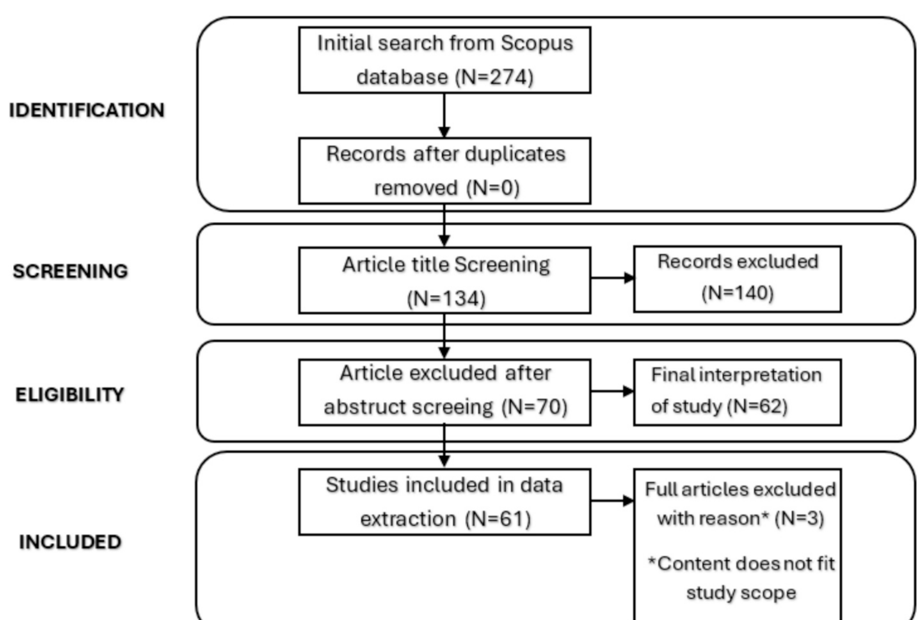

Fig. 1. PRISMA statement.

Screening of articles

After getting the relevant articles, initially, it was checked for duplication within the same database as there are chance that an article gets repeated in the file. In this case, no article was found to be duplicated. Afterwards, screening based on the title was performed, where 140 irrelevant articles were removed. Then, screening based on the abstract was performed, where 70 irrelevant articles were removed. In the end, 64 articles were left for further assessment.

Eligibility and Inclusion of articles

The 64 articles were screened based on the full-text reading, and it was observed that the majority of the literature is relevant to the topic; hence, only 3 of the articles were screened out during this process. These 61 articles were considered for interpretation and further assessment.

Summary of articles

Distribution of articles

The distribution of the final gathered articles can be seen in Fig. 2. It can be observed that from the year 2014 to 2024, out of 61 articles, 58 were journal papers and 3 were conference papers. It is worth mentioning that during the selection of the type of articles, the review papers published in journals or conference proceedings were not considered due to the fact that the focus of this review was towards the technical findings directly stated by the authors.

Keyword and co-authorship analysis

Keyword co-occurrence. In articles, keywords are a fundamental aspect of valuable knowledge as they show the pattern of the research area. Keyword co-occurrence shows the connectivity between various studies based on the built-up connections. Hence, the keyword co-occurrence was performed via VOSviewer, where the minimum number of occurrences of a keyword was set as 5. Of the 575 keywords, 32 meet the threshold as demonstrated in Table 1. Fig. 3 presents the network visualisation of keyword co-occurrence, which shows the identified subsections in different clusters. Here, four clusters were formed, comprised of blue, green, yellow and red colours. Each cluster revolved around a set number of keywords showing the area of interest.

Co-authorship analysis. The co-authorship analysis was performed via VOSviewer, where the minimum number of documents for an author was set as 2. Of the 240 authors, 5 meet the threshold as demonstrated in Table 2. Fig. 4 shows the network visualisation of co-authorship, where it was observed that no connectivity or link strength was observed among the authors.

Table 1
Co-occurrence and Link of Keywords.

Rank	Keyword	Occurrences	Total Link Strength
1	travel behavior	48	261
2	built environment	44	236
3	urban transport	36	212
4	public tranport	20	121
5	china	20	117
6	cycle transport	15	100
7	land use	17	94
8	urban planning	12	73
9	united states	11	68
10	urban transportation	11	68
11	accessibility	10	64
12	transportation mode	9	58
13	neighborhood	9	56
14	metropolitan area	8	49
15	travel behaviour	11	48
16	bicycles	6	47
17	transportation planning	7	45
18	sustainable development	6	43
19	beijing [beijing (ads)]	5	43
20	beijing [china]	5	43
21	commuting	8	42
22	regression analysis	7	38
23	transportation system	6	37
24	transportation	6	36
25	travel demand	6	36
26	sustainability	6	34
27	carbon emission	5	31
28	urban design	5	30
29	walking	5	30
30	guangdong	5	29
31	mobility	5	28
32	urban development	5	21

Interpretation of articles

As mentioned in Table 3, the gathered articles were divided into specified sections based on their area of interest in urban mobility

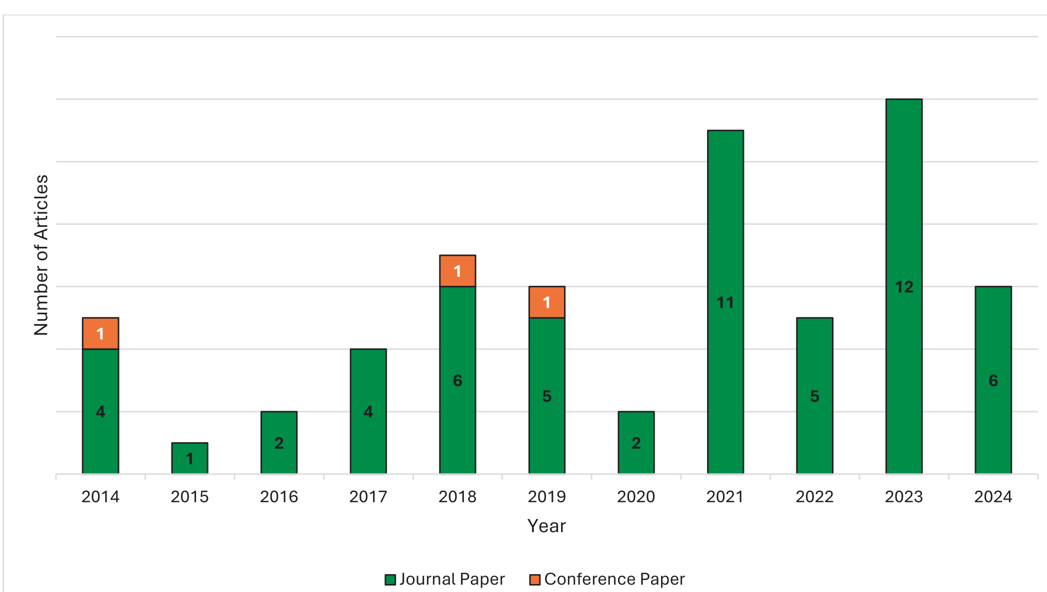

Fig. 2. Articles Distribution.

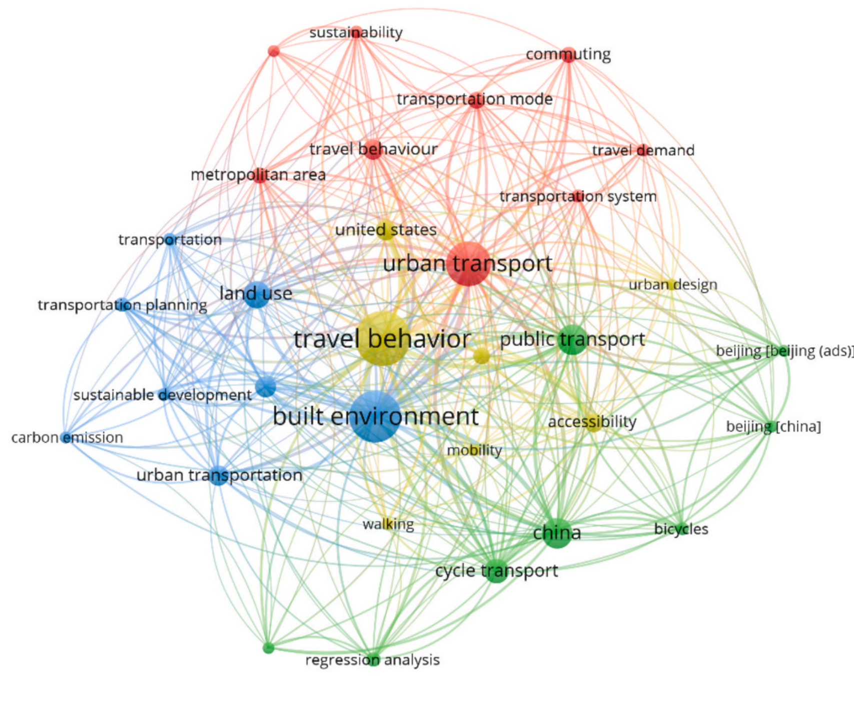

Fig. 3. Network visualisation of keywords co-occurrence.

Table 2
Co-authorship, Citations and Link Strength.

Author	Documents	Citations	Total Link Strength
marquet, oriol	2	32	0
park, keunhyun	2	121	0
tosa, cristian	2	26	0
wu, wei	2	43	0
zhao, pengjun	2	116	0

patterns and advanced transport dynamics. This further division helps in making the interpretation and review processing more efficient. Based on the articles' area of interest, the sections were categorised as Built Environment and Cycling, Transit and Multimodal Integration, Travel Behaviour and Mode Choice, Emerging Transportation Modes and Services, and Environmental Impact and Urban Planning.

Interpretation of built environment and cycling-related studies

The studies related to the built environment and cycling were further explored and summarised, the details of which can be seen in Table 4.

Beck et al. (2023) explored the relationship between built environment characteristics and biking through novel urban biking typologies

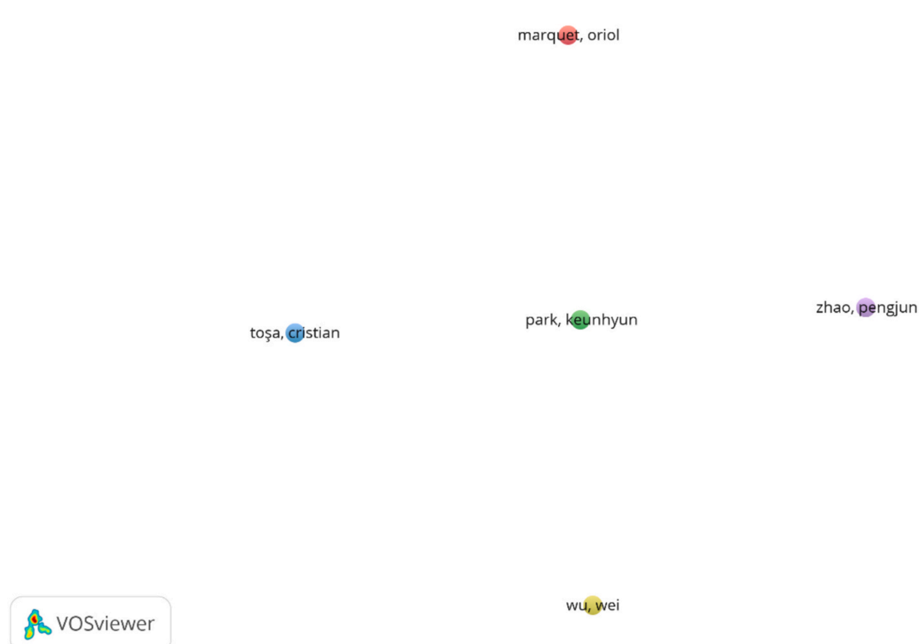

Fig. 4. Network visualisation of Co-authorship.

Table 3
Articles Summary.

S. No	Category	Authors	Focus / Key Theme
1	Built Environment and Cycling	Beck et al. (2023); Wang et al. (2023); Hardinghaus et al. (2021); Rui and Xu (2024); Zare et al. (2024); Zhao et al. (2022); Blitz (2021); Zhou et al. (2024); Cubells et al. (2023); Wei et al. (2021); Yu et al. (2022); Rahman et al. (2023); Shkera and Vaishali (2024); Liu et al. (2022); Wu et al. (2021); Lin et al. (2018); Liu et al. (2023a)	Bicycle infrastructure, bike-sharing systems, cycling behaviour, and active transportation
2	Transit and Multimodal Integration	Liu et al. (2023b); Park et al. (2021); Kimpton (2021); Lei et al. (2024); Merlin et al. (2021); Gascon et al. (2020); Xiao and Wei (2023); Park et al. (2018)	Public transit systems, intermodal connections, and transit-oriented development
3	Travel Behaviour and Mode Choice	Yang et al. (2023); Liu et al. (2021); Næss et al. (2018); Kim et al. (2018); Milakis et al. (2017); Wang and Lin (2014); Zhu et al. (2023); Bruns and Matthes (2019); Jin (2019); Feng et al. (2017); Toşa et al. (2018); TOŞA and Mitrea (2018); Wang et al. (2014); Munshi (2016); Ramezani et al. (2021); Yu et al. (2018)	Factors influencing travel decisions, mode selection, and behavioural changes
4	Emerging Transportation Modes and Services	Zheng et al. (2022); Malik et al. (2021); Bi et al. (2020); Hu et al. (2021); Chiu (2023); Wu and Zhuo (2018); Ho and Yamamoto (2011); Zhang et al. (2014)	New mobility options, vehicle ownership, and their relationship with the built environment
5	Environmental Impact and Urban Planning	Lu (2023); Wu et al. (2023); Wu et al. (2019); Rahman and Idris (2017); Li et al. (2017); Tiwari et al. (2016); Cheng et al. (2024); Tennøy et al. (2022); Nasri and Zhang (2019); Piatkowski and Marshall (2014); Aston et al. (2019); Etminani-Ghasrodashti and Ardeshiri (2015)	Emissions, sustainability, and urban development patterns

using unsupervised machine learning. The study analysed travel surveys, bicycle infrastructure, and population/land use characteristics in Greater Melbourne using k-medoid clustering, revealing 5 distinct clusters. Notable findings included areas with high bicycle network density accounting for 12 % of the population but 57 % of bike trips (Cluster 1), and areas with extensive off-road and on-road bicycle networks but low bike trip proportions (Cluster 4, 23 % of population, 13 % of trips). This approach provided insights into bicycling behaviour interactions with infrastructure and population characteristics. Wang et al. (2023) employed geographical detector models to analyse the relationship between the built environment and bike-sharing usage, using data from 6.5 million bike-sharing orders. The research found that street network centrality and proximity to key facilities (supermarkets, libraries) had the strongest independent and interactive effects. Notably, streetscape elements, including sky view and building frontage, showed significant explanatory power when combined with other factors or street network features. The findings emphasised the importance of considering factor combinations in urban design for promoting cycling.

Hardinghaus et al. (2021) developed a methodology for calculating bikeability using open data, combining qualitative and quantitative methods. Through literature review and expert surveys, the study identified key categories affecting bike-ability, ranking them by importance: biking facilities along main streets, street connectivity, neighbourhood streets prevalence, green pathways, and cycling facilities. The approach used OpenStreetMap data and showed that route bike-ability significantly influenced mode choice, providing a transferable method for assessing urban bike-friendliness. Rui and Xu [6] investigated how streetscape perceptions influence bicycle-sharing volume, using shared cycling data and improved classification of subjective streetscape perception. The research employed k-means clustering and XGBoost prediction methods, revealing that greenery, vivid street-front facades, and diverse street facilities promoted bicycle-sharing volume. The study proposed targeted strategies for different districts, including incentives for high-income groups in central areas and increased bicycle supply in suburban industrial areas. Zare et al. (2024) developed an Agent-Based Model (ABM) to simulate bicyclist movements. Using the GAMA platform and calibrated with Strava and Riderlog data, the model incorporated built environment characteristics, including infrastructure type, tree canopy, slope, land use mix, and vehicle traffic. These factors were used to compute rider comfort and safety levels. The study suggested potential model refinements, including aesthetic preferences and inter-modal interactions.

Zhao et al. (2022) examined determinants of public bicycle use as a metro feeder mode using survey data and binary logit modelling. Results showed middle-aged and medium-income commuters were more likely to use public bicycles as feeders. Route directness was important for most cyclists, while high-income and educated cyclists prioritised comfort and safety. Most trips were within 2 km, with longer distances correlating to higher public bicycle use probability. Blitz (2021) investigated how perceived local environment characteristics influence cycling behaviour, using a household survey (n = 701). The study analysed 21 perception items alongside socio-demographics and travel attitudes. Results showed an interrelation between built and non-built environment perceptions. Safe infrastructure, cycling as common practice, and the absence of negative factors (vandalism, dirt, high car pressure) encouraged bicycle use and positive attitudes. Zhou, et al. [10] examined spatial and temporal disparities in the relationship between the built environment and dockless bike-sharing (DBS) usage using 250 m grid-level data. The study employed multi-scale geographically weighted regression, finding positive correlations between population/employment density and bike usage. Metro stations showed both competitive and complementary effects on DBS usage depending on location. Bus coverage negatively affected bike usage. Mixed land use attracted more weekday usage, while residential and commercial areas generated more demand in urban centres and inner suburbs.

Cubells et al. (2023) examined route selection patterns of 115 e-scooter and bike-share users, comparing GPS-tracked trips to the shortest possible routes. Using multilevel modelling, the research found that users rarely chose the shortest paths, instead prioritising safety, accessibility, and aesthetic factors. Gender differences were observed in route preferences, with women generally taking shorter detours than men. The study revealed distinct preferences between cyclists and e-scooter riders regarding infrastructure elements. Wei et al. (2021) analysed spatial and temporal distribution patterns of sharing bicycle behaviours using one week's Mobike data. The study identified clear morning and evening peak usage patterns on both weekdays and weekends. Old urban areas with mixed functions, dense road networks, and cycling-friendly environments attracted the most shared bicycle

Table 4
Summary of Built Environment and Cycling-Related Studies.

S. No	Author	Study Location	Key Focus	Methodology	Main Findings
	Beck et al. (2023)	Melbourne, Australia	Urban biking typologies	K-medoid clustering, Travel surveys	Identified 5 clusters; 12 % of the population generated 57 % of bike trips in high-density network areas
	Wang et al. (2023)	Shanghai, China	Built environment impact on bike-sharing	Geographical detector models	Street network centrality and facilities (supermarkets, libraries) have the strongest effects; streetscape elements show significant interactive effects
	Hardinghaus et al. (2021)	Not specified	Bikeability assessment	Expert survey, OpenStreetMap data	Biking facilities, street connectivity, and green pathways are most important for bikeability
	Rui and Xu (2024)	Shenzhen, China	Streetscape impact on bike-sharing	XGBoost, K-means clustering	Greenery, vivid facades, and street facilities promote bike-sharing; effects vary by district
	Zare et al. (2024)	Penrith, Australia	Bicyclist movement simulation	Agent-Based Modeling	Built environment characteristics affect comfort and safety levels; tree canopy and infrastructure type influence route choice
	Zhao et al. (2022)	Beijing, China	Public bikes as metro feeder	Binary logit model, Cluster analysis	Middle-income users are more likely to use public bikes; most trips are within 2 km; route directness is important
	Blitz (2021)	Offenbach, Germany	Perceived environment impact	Household survey analysis	Safety perception and infrastructure quality significantly influence cycling behaviour
	Zhou et al. (2024)	Shenzhen, China	Dockless bike-sharing (DBS)	Multi-scale GWR	Population density positively affects usage; metro stations show both competitive and complementary effects
	Cubells et al. (2023)	Barcelona, Spain	Micromobility route preferences	GPS tracking, Multilevel modelling	Users rarely choose the shortest path; gender affects route choice; women take shorter detours
	Wei et al. (2021)	Guangzhou, China	Sharing bicycle patterns	GWR, Temporal analysis	Dense road networks and mixed-use areas attract more users; clear morning/evening peaks observed
	Yu et al. (2022)	Jinan, China	E-bike usage patterns	OLS and GWR models	Road density and public services positively affect e-bike use; open sky index and NDVI show a negative association
	Rahman et al. (2023)	Khulna, Bangladesh	Built environment impact on active transport	Structural Equation Modelling	Compactness and sidewalk conditions increase walking but decrease cycling; roadway infrastructure reduces both
	Shkera and Vaishali (2024)	Mumbai, India	Mode choice for shopping trips	Binary logistic regression	Car ownership, gender, and income significantly influence transport decisions
	Liu et al. (2022)	Beijing, China	Last-mile choice between bike-sharing and buses	Binomial logit model using transit card data, cycling records	Walking distance from the metro has a stronger effect than total distance; Evening rush hours show the highest bus preference; Bike lanes increase shared bike usage
	Wu et al. (2021)	China	Bicycle-metro integration	Analysis of 3 + million transfer cycling trips	Aggregate-points buffer outperforms traditional buffers; High spatial heterogeneity between urban/suburban areas; Population density and transit accessibility significantly affect transfer cycling
	Lin et al. (2018)	Beijing, Taipei, Tokyo	Public bike usage near metro stations	Logit and latent class models	Built environment associations with bike usage vary significantly between cities; Local empirical knowledge is critical for development
	Liu et al. (2023a)	Shenzhen, China	Integrated use of DBS and URT	Multi-buffer zone approach, OLS, GWR, MGWR models	Built environment factors influence DBS-URT integration; impact varies during peak periods and by access/egress

travel. POI density of public transport stations, functional mixing degree, and residential POI density significantly influenced travel behaviours. Yu, et al. [13] investigated the relationship between e-bike usage and built environment factors, using population-level travel survey data. Both macro and micro levels of the built environment were analysed using OLS and GWR models. The study found positive correlations between e-bike trips and eye-level greenery, building floor area, road density, and public service POIs. Negative associations were found with the open sky index and NDVI. The GWR model revealed significant spatial heterogeneity in these relationships, suggesting the need for tailored planning interventions. Rahman et al. (2023) examined built environment impacts on active transportation. Despite a built environment conducive to active travel, usage was limited by affordable motorised alternatives and other structural factors. Using Structural Equation Modelling, the study found that urban compactness and sidewalk conditions increased walking propensity while decreasing bicycling. Roadway infrastructure reduced both walking and bicycling due to motorised vehicle options. Travel distance and cost significantly impacted walking tendency. The study concluded that built environment factors more strongly influenced active transportation compared to socioeconomic factors. Shkera and Vaishali (2024) examined mode choice behaviour for shopping-related trips, focusing on sustainable travel options versus private vehicles. Using questionnaire survey data and binary logistic regression, the study analysed relationships between mode preferences and factors including car ownership, gender, income, age, walk score, and population density. Results showed the prominence of sustainable transportation modes and identified car ownership, gender, and income as significant determinants of transportation decisions.

In Beijing, a study by Liu et al. (2022) analyzed the mode choice between bike-sharing and buses as a last-mile connection to urban rails using a binomial logit model. The findings show that walking distance from the metro station has a stronger effect on users' mode choice than the total subchain distance. Longer travel time increases the preference for taking the bus. The existence of bike lanes increases the probability that people choose shared bikes. The impact of the built environment on transfer cycling behaviour around metro stations was explored using an aggregate-points buffer method by Wu et al. (2021). The findings indicate that this method outperforms traditional static buffers in predicting transfer cycling trips. There is a high level of spatial heterogeneity in the catchment area and transfer cycling density between urban and suburban areas. Residential and working population density, bus stop density, and metro station accessibility significantly affect bicycle-metro transfer cycling. A transnational comparison study by Lin et al. (2018) examined the associations of the built environment with public bike usage in three cities in eastern Asia, i.e., Beijing, Taipei and Tokyo. The results indicate that these associations vary across cities, and empirical knowledge of travel behaviour is critical for developing bike-friendly built environments. Another interesting innovation is Dockless bike-sharing (DBS), which offers a solution to the “first and last mile” problem in urban transportation. The study by Liu et al. (2023a) observes the integration of DBS with urban rail transit (URT) using various regression models to analyse the spatiotemporal heterogeneity of integrated use. The findings show that built environment factors such as catering, shopping, and residential buildings influence DBS-URT integration, with variations during peak periods. The study provides insights for promoting DBS-URT integration and improving urban transportation systems.

Interpretation of transit and multimodal integration

The studies related to transit and multimodal integration were further explored and summarised, the details of which can be seen in Table 5.

The rail transit system was developed in Chinese large cities to achieve more efficient and sustainable transport development. The study by Liu et al. (2023b) investigates the interrelations between trip stage characteristics, socio-demographic attributes, and the built environment using an XGBoost model. The outcomes reveal that separate trip stage characteristics have a greater impact than general trip characteristics. The non-linear effects revealed by the machine learning model show changing effects and thresholds of impact by trip stage characteristics on people's main mode choice of rail transit. A study conducted by Park et al. (2021) focused on how transit riders experience out-of-vehicle environments such as access, transfer, and egress. The findings indicate that out-of-vehicle environments influence customer satisfaction and loyalty more than in-vehicle factors. Safety and transfer experience are critical out-of-vehicle elements most in need of improvement.

The transition from the 'Predict and Provide' approach to the 'Demand Management' approach in urban planning ensures access to rapid public transport for all. The conceptual model developed from transport planning and social psychology literature strengthens the theoretical and empirical foundations for understanding travel behaviour and supports planning authorities in promoting sustainable transport behaviour Kimpton (2021). In Beijing, the cooperation between bus and metro in public transportation was analysed using an extreme gradient boosting algorithm applied to smart card data. The results reveal that the relative spatial relationship between bus and metro service facilities extensively influences their cooperation. The characteristics of the bus network hold the highest importance ranking in peripheral areas. Extensive nonlinear relationships and threshold effects exist between the built environment and intermodal transit demand (Lei et al., 2024).

In the USA, a study (Merlin et al., 2021) on transit accessibility and ridership in large urbanised areas found that transit service provision strongly influences both transit ridership per capita and job accessibility provided by transit. Population density results in higher transit accessibility directly by making destinations easier to reach and indirectly by increasing the amount of transit services provided. Another study by Gascon et al. (2020) explored the relationship between built environment characteristics and the frequency of public transport use in European cities. The results propose that dense urban environments, reliable and affordable public transport services, and limiting motorised vehicles in high-density areas promote public transport use. Individual values and attitudes towards public transport use also influence the frequency of use. A study in SLCo, Utah, by Xiao and Wei (2023) examined the impact of the built environment on walking and biking trip generation around transit stations using a regression tree method. The results indicate that the retail floor area ratio is the primary determinant of walking trip generation, while dwelling density is crucial to biking trip generation. Urban amenity accessibility is significant for improving walkability and bikability around transit stations. Besides, Transit-oriented development (TOD) focuses on creating dense, mixed-use, walkable, and transit-friendly environments near transit stations to reduce auto dependency and increase ridership. This study Park et al. (2018), conducted in eight U.S. metropolitan areas, uses advanced modelling techniques to analyse travel outcomes such as vehicle miles travelled (VMT), auto trips, transit trips, and walk trips. Findings indicate that automobile use is linked to land-use diversity and street network design, while transit use and walking are strongly associated with transit availability and land-use diversity. Density has the least influence among the factors studied.

Interpretation of travel behaviour and mode choice

The studies related to travel behaviour and mode choice were further explored and summarised, the details of which can be seen in Table 6.

The study by Yang et al. (2023) introduces a Random Forest classifier model to predict travel mode and duration probabilities, assessing the mobility impacts of urban design changes. The model uses predictor features measuring urban form, demographics, and service densities. Findings indicate that dense, mixed-use environments with good multimodal mobility network coverage promote active transportation and public transit use, while ultra-dense developments can increase travel time and vehicle use in urban peripheries. Liu et al. (2021) propose an activity-based model to simulate detailed decision-making in daily travel. The model addresses various activity types, plans, zones, time slots, and travel modes. It shows that compact design reduces vehicle miles travelled (VMT), but the influence mechanisms vary, impacting

Table 5
Summary of Transit and Multimodal Integration-Related Studies.

S. No	Author	Study Location	Key Focus	Methodology	Main Findings
	Liu et al. (2023b)	Chongqing, China	Rail transit integration in multimodal trips	XGBoost model analysis of Urban Resident Travel Survey (2014)	Trip stage characteristics have more impact than general trip characteristics; Non-linear effects show changing impacts of trip stages on rail transit choice
	Park et al. (2021)	Utah, USA	Out-of-vehicle transit environments	Survey (n = 445), Importance-Satisfaction analysis, path analysis	Driving is the most common first-mile mode (68.5 %); Safety and transfer experience influence satisfaction more than in-vehicle factors
	Kimpton (2021)	Not specified	Multimodal transport approach vs. traditional planning	Literature review, conceptual model development	Multimodalism provides a pragmatic alternative to strict auto-reduction; Park & Ride services ensure public transit access
	Lei et al. (2024)	Beijing, China	Bus-metro cooperation	XGBoost algorithm on smart card data, SHAP analysis	The spatial relationship between services affects cooperation; the Bus network is most important in peripheral areas; Nonlinear relationships exist with the built environment
	Merlin et al. (2021)	50 US urban areas	Transit accessibility and ridership	Structural equation modelling	Transit service provision strongly influences both ridership and job accessibility; Fixed-guideway transit has a larger effect on accessibility
	Gascon et al. (2020)	7 European cities	Public transport use factors	Population-based cross-sectional study (N = 9952), GIS analysis	High-density areas are associated with higher public transport use; Car/bike access reduces usage; Demographics and attitudes influence usage patterns
	Xiao and Wei (2023)	Salt Lake County, Utah	Active travel in transit-oriented development	Regression tree analysis	Retail floor area ratio is primary for walking trips; Dwelling density is crucial for biking trips; Urban amenity accessibility is important for both
	Park et al. (2018)	8 US metro areas	Travel outcomes in rail station areas	Two-stage hurdle models, multi-level modelling	Land-use diversity and street design affect auto use; Transit availability and diversity influence transit use; Density has the weakest influence

Table 6
Summary of Travel Behaviour and Mode Choice-Related Studies.

S. No	Author	Study Location	Key Focus	Methodology	Main Findings
	Yang et al. (2023)	Not Specified	Travel Mode and Duration Modelling	Random Forest Classifier	Dense, mixed-use environments promote active transport, but ultra-dense developments can increase travel time
	Liu et al. (2021)	Beijing, China	Activity-based Travel Behaviour	A simulation model with 8 activity types	Compact design reduces vehicle miles travelled through different mechanisms
	Næss et al. (2018)	Oslo and Stavanger, Norway	Urban-suburban Travel Differences	33 qualitative interviews	Built environment influences travel through an interplay with activity location choices
	Kim et al. (2018)	Cincinnati, USA	Social Influences on Travel	Spatial multivariate Tobit model	Social influences and built environment impact walking/ cycling preferences
	Milakis et al. (2017)	Greece-US Comparison	Built Environment Impact on Relocated Residents	Quasi-longitudinal design, 51 participants	Travel time to the centre affects car use; density affects bike use
	Wang and Lin (2014)	Urban China	Residential self-selection	Theoretical analysis	Housing source is crucial for residential choice in the Chinese context
	Zhu et al. (2023)	Hong Kong	Dense urban setting travel patterns	Mode choice analysis	The built environment affects public transport sub-mode choices differently
	Bruns and Matthes (2019)	Hamburg, Germany	Suburban-urban relocator behaviour	Qualitative interviews	Travel options are significant in suburban-urban relocation decisions
	Jin (2019)	Not Specified	Smart growth impact on travel	GS2SLS model	Jobs-housing balance and density reduce commuting time
	Feng et al. (2017)	Nanjing, China	Travel Behaviour Changes	Cross-sectional data analysis	Increasing car and public transport use at the expense of non-motorised modes
	Toşa et al. (2018)	Cluj-Napoca, Romania	Transport mode choice	Computer-assisted telephone survey	Demographic and built environment factors influence commuting patterns
	TOŞA and Mitrea (2018)	Cluj, Romania	Commuter travel behaviour	Online survey	Notable differences between private and state sector employees
	Wang et al. (2014)	Southeast Michigan, USA	Route environment impact	GPS data analysis, 46 drivers	No significant relationship between route environments and non-work travel
	Munshi (2016)	Rajkot, India	Built environment-mode choice	Personal interviews	Strong residential self-selection for non-motorised transport users
	Ramezani et al. (2021)	Helsinki, Finland	Relocation impact of travel	Online map-based survey	Built environment modifies travel attitudes and activity space
	Yu et al. (2018)	Urban Villages, China	Public transit choice	Multinomial logistic regression	Mixed land use shows an unexpected negative effect on transit choice

mode choice or multiple travel aspects. Næss et al. (2018) present insights from qualitative research, analysing interviews to explain differences in travel behaviour between inner-city and suburban residents in Norway. It finds that built environment characteristics influence travel through their interplay with inhabitants' rationales for activity locations and travel mode choice, with inner-city residents having more facility options within short distances compared to suburbanites. Kim et al. (2018) propose a model evaluating how individual travel behaviour is influenced by inter- and intra-household interactions. It concludes that social influences and the built environment significantly impact the willingness to walk and cycle. Milakis et al. (2017) investigate the causal links between the built environment, travel attitudes, and behaviour of Greeks who relocated from the US to Greece. It finds that longer travel time to city centres increases car use, while higher-density neighbourhoods and better access to amenities increase bike use and walking. Wang and Lin (2014) discuss the specificities of residential self-selection in urban China and its implications for the relationship between the built environment and travel behaviour. It highlights the importance of considering housing sources and travel-related attitudes in such studies.

Using Hong Kong as a case study, the study by Zhu et al. (2023) addresses the challenges of studying built environment impacts in dense urban settings. It finds that built environment characteristics influence choices among public transport sub-modes more than between public transport and cars, with generational differences in susceptibility to these attributes. Besides, the travel-related aspects significantly impact relocation decisions, with the absence of good transport options being a dominant reason for leaving suburban environments Bruns and Matthes (2019). The study by Jin (2019) uses a generalised spatial two-stage least square estimator to investigate the effects of land use on travel behaviour, controlling for self-selection and spatial autocorrelation. It was revealed that higher job-housing balance, retail and service jobs, density, and walker-friendly environments reduce commuting time and car use. A study by Feng et al. (2017) examines changes in travel behaviour, where it was revealed that urban form and transport system changes lead to longer travel distances and increased use of private cars and public transport, with a widening gap in travel behaviour between low-income and higher-income groups. The study by Toşa et al. (2018) analyses transportation mode choice in Cluj-Napoca, Romania, using survey data. It concludes that demographic, socioeconomic, and attitudinal characteristics, along with transport supply and built environment, influence commuting patterns, with generational differences impacting travel behaviour. Another study in Romania by TOŞA and Mitrea (2018) examines travel behaviour among morning commuters, finding significant differences between private and state sector employees. It calls for a paradigm shift in transport policies to address personal comfort and current development patterns. Wang et al. (2014) present a methodology to examine the correlation between the built environment along commuting routes and vehicle miles travelled (VMT) and fuel consumption for nonwork travel, using GPS data from southeast Michigan. It suggests refining travel behaviour modelling along commuting routes. Munshi (2016) investigated the relationship between the built environment and mode choice, and it suggests focusing land use policy on accessibility and mixing diverse uses to support non-motorised and public transport travel. The study by Ramezani et al. (2021) examines the influence of residential relocation on travel behaviour, using a map-based survey tool. It finds reciprocal influences between changes in car and bike ownership, travel attitudes, and behaviour, supporting the effectiveness of nudging approaches to encourage sustainable travel behaviour. Yu et al. (2018) explore how built environment factors affect public transit choice behaviour, finding that mixed land use has an adverse effect on public transit choice. It suggests measures to efficiently satisfy public transit demand and provide new perspectives for urban regeneration.

Interpretation of ride-hailing and other services

The studies related to emerging transportation modes and services were further explored and summarised, the details of which can be seen in Table 7.

The explosive growth of ride-hailing services has significantly altered residential travel patterns. The study (Zheng et al., 2022), based on GPS and Web map data from Chengdu, China, constructs spatio-temporal entropy indicators to analyse the impact of the built environment on ride-hailing travel behaviour. The outcomes show that building density and education facilities inhibit ride-hailing usage, while mixed land use, house prices, and proximity to transit increase it. Ride-hailing has become a mainstream mobility option, influenced by various factors, including the built environment. Vibrant, walkable neighbourhoods have a higher ride-hailing mode share, potentially substituting active modes. Besides, there is a need for policymakers to consider these factors when making built-environment and regulatory decisions related to ride-hailing Malik et al. (2021). Optimising transit systems requires understanding the relationship between ridership and the built environment. Bi et al. (2020) use point of interest (POI) data and geographic weighted regression (GWR) analysis to study online car-hailing ridership. The outcome reveals that the built environment significantly influences ridership patterns, with different factors affecting ridership during various periods. Another study by Hu et al. (2021) employs gradient boosting decision tree (GBDT) and ordinary least squares (OLS) models to explore the factors influencing electric vehicle (EV) usage intensity. The assessment shows that charging time, charging pile density, and proximity to business districts are significant factors affecting EV usage. The GBDT model outperforms the OLS model in accuracy, highlighting the importance of advanced modelling techniques in understanding EV travel behaviour and informing infrastructure development.

The relationship between the built environment and motorcycle travel behaviour was explored by Chiu (2023). It was observed that higher population density, distance from central business districts, and lower job density are associated with higher motorcycle ownership and usage. The findings challenge existing hypotheses about motorcycle travel and suggest that transportation and land use policies should focus on expanding mass transit and developing suburban employment centres near metro stations to reduce motorcycle dependence.

Encouraging a shift from automobiles to bicycles for short-distance travel can also alleviate urban congestion and improve environmental quality. Wu and Zhuo (2018) analyze the impact of the built environment on short-distance taxi travel using multiple regression models. The results indicate that urban design can influence travel behaviour, and planners should consider spatial settings to discourage short-distance motorised travel and promote sustainable transportation modes. In another study by Ho and Yamamoto (2011) the influence of residential self-selection on travel behaviour was examined using generalised nested logit models to analyse the effects of attitudes, public transport service, and land use on multiple vehicle ownership. The outcome proposes that both subjective and objective dimensions of the built environment are important, with modest effects of self-selection. The study highlights the need for comprehensive planning that considers both individual preferences and built environment characteristics. Zhang et al. (2014) investigated built environment factors that influence vehicle use. Using negative binomial regression models, the study shows that denser land use, better transit service, and less connective street networks reduce car and motorcycle trips. The results provide insights for planners to develop high-density land use, slow street network expansion, and improve access to public transportation to shape vehicle use and promote sustainable urban mobility.

Interpretation of environmental impact and urban planning

The studies related to environmental impact and urban planning were further explored and summarised, the details of which can be further seen in Table 8.

Urban travel is a significant component of urban transport, and controlling the carbon emissions from residents' travel can effectively reduce the total carbon emissions of urban transport. The study by Lu (2023), based on questionnaire data from various residential areas in Guangzhou, analyses residents' daily travel behaviour and calculates their travel carbon emissions (CO_2). It identifies three categories of influencing factors: individual socio-economic factors, the built environment, and travel behaviour. Using a structural equation model, the study finds significant differences in travel carbon emissions across different types of municipalities, with the built environment having a more pronounced impact than individual socio-economic factors. Travel distance and mode are the direct factors affecting travel carbon emissions, leading to proposals for reducing these emissions. The built environment significantly influences residents' travel modes and energy consumption, which is crucial for urban sustainability. The study by Wu et al. (2023), using data from Ningbo, China, establishes a regression

Table 7
Summary of Emerging Transportation Modes and Services Related Studies.

S. No	Author	Study Location	Key Focus	Methodology	Main Findings
	Zheng et al. (2022)	Chengdu, China	Impact of built environment on ride-hailing services	GPS data, Web map big data, global and local regression models	Built environment significantly influences ride-hailing travel patterns; mixed land use has the strongest promoting effect
	Malik et al. (2021)	California, USA	Built environment's effect on ride-hailing for non-work trips	Integrated choice and latent variable (ICLV) model, travel survey data	Built environment influences ride-hailing mode share; vibrant, walkable neighbourhoods have higher ride-hailing mode share
	Bi et al. (2020)	Chengdu, China	Relation between ridership and built environment	Point of interest (POI) data, Voronoi cells, geographic weighted regression (GWR) analysis	Built environment influences online car-hailing ridership; significant POI factors vary by ridership pattern.
	Hu et al. (2021)	Chongqing, China	Influencing factors on EV use intensity	Gradient boosting decision tree (GBDT) and ordinary least squares (OLS) models	Charging time, charging pile density, and distance to business districts significantly influence EV use intensity.
	Chiu (2023)	Taipei, Taiwan	Relationship between the built environment and motorcycle travel	Multinomial logistic and tobit regression models, household travel surveys	Higher population density and distance from CBD/ metro stations correlate with higher motorcycle ownership and usage
	Wu and Zhuo (2018)	Shanghai, China	Spatial impact of the built environment on short-distance taxi travel	Taxi trajectory data, demographic data, POI data, multiple regression model	Built environment influences short-distance taxi travel; recommendations for reducing motorised travel
	Ho and Yamamoto (2011)	Ho Chi Minh, Vietnam	Effects of attitudes and public transport service on vehicle ownership	Generalised Nested Logit models, household interview survey data	Both subjective and objective built environment factors influence vehicle ownership behaviour
	Zhang et al. (2014)	Zhongshan, China	Relationship between the built environment and vehicle use	Negative binomial regression models, household socio-demographic data	Denser land use, better transit service, and less connective street networks reduce car and motorcycle trips

Table 8
Summary of Environmental Impact and Urban Planning-Related Studies.

S. No	Author	Study Location	Key Focus	Methodology	Main Findings
	Lu (2023)	Guangzhou, China	Impact of built environment on travel carbon emissions	Questionnaire data, structural equation model	Built environment significantly influences travel carbon emissions; travel distance and mode are key factors
	Wu et al. (2023)	Ningbo, China	Relationship between the built environment and energy consumption	Survey data, regression analysis model	Population density and mixed land use reduce energy consumption; the built environment impacts transportation trips more than residential buildings
	Wu et al. (2019)	Minneapolis-St. Paul, USA	Built environment determinants of CO2 emissions	Gradient boosting decision trees	Distance to transit stop, job density, and land use diversity are critical factors; threshold effects of built environment elements
	Rahman and Idris (2017)	Various	Impacts of planning policies on travel behaviour and GHG emissions	Trip-Based Urban Transportation Emissions (TRIBUTE) model	Mode choice and emissions forecasting models help evaluate policy scenarios for GHG emission targets
	Li et al. (2017)	Shenyang, China	Factors associated with shopping travel CO_2 emissions	Survey data, multinomial logistic regression model	Private car trips generate high emissions; built environment and socio-economic characteristics influence emissions
	Tiwari et al. (2016)	Udaipur, Rajkot, Vishakhapatnam, India	Impact of infrastructure on travel mode shares and emissions	Scenario analysis	Improving both NMT and PT infrastructure reduces CO2 emissions and improves safety; NMT infrastructure is crucial
	Cheng et al. (2024)	Shanghai, China	Enhancing street vitality in HSR station areas	GPS and POI data, machine learning algorithms, GIS tools	Walking accessibility and built environment influence passengers' stay time; synergistic effects inform spatial planning
	Tennøy et al. (2022)	Various	Built environment effects on travel behaviour	Empirical and theoretical analysis	Proximity to the city centre increases the competitiveness of sustainable modes; dense mixed-use zones outside the inner-city increase car usage
	Nasri and Zhang (2019)	USA	Increasing transit mode share through urban design	Seemingly Unrelated Regression (SUR) modeling	Urban form at local and regional levels influences commuting patterns; transit accessibility and job density are key factors
	Piatkowski and Marshall (2014)	Various	Transportation goals of New Urbanist developments	Mode choice models	Distance to work and parking availability predict travel behaviour; New Urbanist communities support parking policy reforms
	Aston et al. (2019)	Various	Relationship between the built environment and transit use	Meta-analysis	Density, diversity, and accessibility weakly correlated with transit ridership; study design impacts results
	Etminani-Ghasrodashti and Ardeshiri (2015)	Shiraz, Iran	Factors influencing travel behaviour	Structural equation model	Lifestyle patterns significantly affect non-working trips; the built environment's impact is smaller compared to lifestyle

analysis model to examine the relationship between the built environment and domestic energy consumption. The outcome shows that social and economic conditions are the main factors affecting traffic energy consumption. Understanding the association between built environment features and travel-related CO_2 emissions is essential for promoting environmentally sustainable travel. The study by Wu et al. (2019), using data from the Minneapolis-St. Paul metropolitan area applies gradient boosting decision trees to identify critical built environment determinants of CO_2 emissions and illustrate threshold effects. The findings reveal that distance to the nearest transit stop, job density, and land use diversity are the strongest influences on CO_2 emissions, with built environment variables being effective only within certain ranges. These findings provide valuable implications for planners to achieve environmental benefits efficiently. A Trip-Based Urban Transportation Emissions (TRIBUTE) model was developed by Rahman and Idris (2017) to explore the impacts of transportation and land use planning policies on travel behaviour and greenhouse gas (GHG) emissions. Using household travel surveys and emissions inventories, TRIBUTE estimates modal shares of alternative travel modes and translates them into vehicle kilometres travelled and GHG emissions. This macroscopic model assists municipalities in evaluating and selecting transportation and land use policy scenarios to meet future GHG emission targets, as demonstrated in a case study. Promoting active travel behaviour and reducing transport-related CO2 emissions are priorities in Chinese cities experiencing rapid urban sprawl and greater automobile dependence. The study by Li et al. (2017), based on a survey of shoppers in Shenyang, China, estimates shopping-related travel CO_2 emissions and examines the contributions of the built environment and individual socio-economic characteristics. The findings reveal that private car trips generate significantly higher carbon emissions than public transport trips, with built environment features such as population density and public transport stations negatively correlating with CO_2 emissions. These results have important policy implications for sustainable urban transportation.

In Indian cities, the modal share favours non-motorised transport (NMT) and public transport (PT), but poor infrastructure quality poses risks and may lead to a shift towards personal motorised vehicles (PMV). Tiwari et al. (2016) analyse travel behaviour in Udaipur, Rajkot, and Vishakhapatnam, and examine the impact of improving NMT and PT infrastructure on travel mode shares, fuel consumption, emission levels, and traffic safety. The scenario analysis shows that improving both NMT and PT infrastructure yields the maximum reduction in CO_2 emissions and enhances traffic safety, emphasising the crucial role of NMT infrastructure in maintaining sustainable travel modes. Another mode of transport having a significant impact on the environment and urban planning is High-speed railway (HSR) development, which significantly influences individuals' lifestyles and travel behaviours, enhancing urban growth and transport efficiency. Cheng et al. (2024) focus on Shanghai Hongqiao station, analysing the impact of walking accessibility and the built environment on street vitality using GPS and point-of-interest (POI) data. The outcomes show that passengers are more likely to stay within areas accessible by a short walk from the station, with synergistic effects of walking accessibility and the built environment informing spatial planning. These insights are valuable for urban planners aiming to enhance HSR station areas' development and efficiency.

Tennøy et al. (2022) examine how built environment characteristics affect travel behaviour in small and medium-sized cities compared to larger cities. It was observed that sustainable modes of transport are more competitive and commuting distances are shorter with proximity to city centres, although the tendencies are weaker than in larger cities.

The study concludes that small and medium-sized cities can improve the competitiveness of sustainable modes by steering new urban development towards central areas and avoiding development in outer areas, following similar strategies as larger cities. Transit-friendly development aims to increase transit mode share by enhancing residential and job densities, walkability, and mixed-use development around major transit stations. Nasri and Zhang (2019) analyze commute mode share across U.S. rail transit stations, using a Seemingly Unrelated Regression (SUR) model to examine the influence of urban form at both neighbourhood and regional levels. The findings suggest that factors such as population and employment densities, walkability, and transit accessibility significantly influence commuting patterns, with job accessibility via transit being a crucial factor in encouraging transit ridership. New Urbanist development, characterised by higher densities and mixed land uses, aims to support increased transportation options beyond automobiles. Piatkowski and Marshall (2014) compare travel behaviour in New Urbanist and old urbanist neighbourhoods, finding that distance to work and availability of free parking at work significantly predict mode choice. Despite being further from central business districts, New Urbanist neighbourhoods show similar average work distances, suggesting decentralised employment locations. The study concludes that New Urbanist communities can support parking policy reforms and transit investments to prioritise sustainable travel modes.

Many studies have demonstrated the relationship between public transport ridership and built environment variables such as density, diversity, and accessibility. This *meta*-analysis synthesises evidence on these relationships, finding that transit-friendly urban design indicators are weakly correlated with increased transit ridership. The study highlights the importance of geographic context and consistent study design in understanding the built environment's impact on transit use, suggesting that future research should adopt a consistent approach across different locations to identify contextual sources of variability (Aston et al., 2019). In developing countries, individuals' travel behaviour is influenced by multiple factors, including lifestyle and built environment. Etminani-Ghasrodashti and Ardeshiri (2015) explore non-working trip frequencies by different modes. The structural equation model results indicate that lifestyle patterns significantly affect non-working trips, while the built environment has a smaller impact. The findings emphasise the need to consider lifestyle orientations in travel studies alongside objective factors such as land use attributes to promote sustainable travel behaviour.

Discussion

The research emphasises the complex and diverse relationship between the built environment and travel behaviours, drawing on studies undertaken in a variety of global contexts, including Australia, China, Bangladesh, Spain, Germany, and India. To investigate this relationship, a range of analytical methodologies were used, including modern methods such as machine learning and agent-based modelling, as well as standard statistical techniques. The core findings emphasise that certain built-environment elements, such as infrastructure quality, transportation network connectedness, and land use variety, have a major impact on travel patterns. However, the quantity and form of these impacts vary greatly depending on the geographical, cultural, and socioeconomic situations. For example, well-designed, high-density bicycle networks and mixed-use urban projects encourage cycling and other modes of active transportation. However, the usefulness of such features is frequently influenced by variables such as wealth, gender, and access to private automobiles. The introduction of current mobility technologies, such as electric bicycles and dockless bike-sharing systems, has complicated the interplay between built environments and traditional forms of transportation, offering both complementary and competing advantages. Importantly, the research demonstrates that focusing exclusively on quantifiable or objective aspects of the built environment is inadequate. Perceived safety, visual attractiveness, and general comfort are all important considerations when making travel selections. Furthermore, different user groups, such as commuters, leisure bikers, and shoppers, have distinct preferences and sensitivities to various built-environment features, emphasising the significance of developing context-specific and user-centric mobility solutions.

In addition, the literature emphasises the transformational influence of public transport systems, particularly rail networks, on urban mobility and growth. These systems promote multimodal travel by allowing for seamless transitions between modes of transportation, with features like walking distance to metro stations and the presence of bike lanes greatly impacting consumer choices. Out-of-vehicle experiences, such as transfer safety and transit hub convenience, have been found to have a major impact on consumer happiness and utilisation. Rail systems also benefit urban development by improving employment access, boosting economic output, and making better use of underground areas. However, issues exist, notably in terms of equality and accessibility, as certain communities may be underserved.

The findings also emphasise the crucial interplay between dense urban settings, dependable public transit, and policies targeted at reducing motorised vehicle dependency in high-density neighbourhoods. Transit-Oriented Developments (TODs) are emerging as key concepts for improving urban quality of life and supporting sustainable transportation. However, concerns such as ultra-dense projects that may increase commute times in peripheral metropolitan regions highlight the need for balanced planning. Active travel behaviours such as walking and cycling are especially sensitive to both the physical qualities of the built environment and the larger social context, with residential self-selection and age variations playing critical roles in determining mobility patterns. Furthermore, the literature emphasises the importance of geographical and temporal elements in optimising transit systems, as well as the complex dynamics brought about by new forms of mobility such as ride-hailing and electric automobiles. Simplistic transit planning techniques are insufficient to handle the complex linkages between urban design and mobility options. Instead, comprehensive methods are required, which incorporate both subjective and objective aspects of the built environment while aligning them with socioeconomic realities and personal lifestyle choices. The study emphasises the need for comprehensive, evidence-based urban planning and policy frameworks that promote justice, sustainability, and accessibility while lowering travel-related carbon emissions and encouraging more environmentally conscious mobility behaviours. Based on the critical evaluation, a conceptual framework was developed, as presented in Fig. 5.

Future direction

Future research in cycling and built environment studies should adopt adaptive, multifaceted approaches to address urban mobility's evolving challenges. Advanced methodologies that combine surveys with technology, such as GPS monitoring and machine learning, are critical for analysing traffic patterns and infrastructure utilisation. There is a need to prioritise marginalised populations, eliminate gender inequities, and improve accessibility. Cycling's economic effect, as well as its integration with other modes of transportation, should be studied in order to increase first/last-mile connectivity and transit satisfaction. Tailored solutions based on empirical data can help to promote sustainable urban development by emphasising transit-oriented architecture, active transportation, and reduced reliance on automobiles. Preparing for trends such as Mobility-as-a-Service (MaaS), ride-sharing, and electric mobility necessitates adaptable planning, but social fairness and carbon emissions reduction remain critical. A thorough, evidence-based framework stabilising infrastructure needs and societal factors will enable inclusive, sustainable urban transit systems.

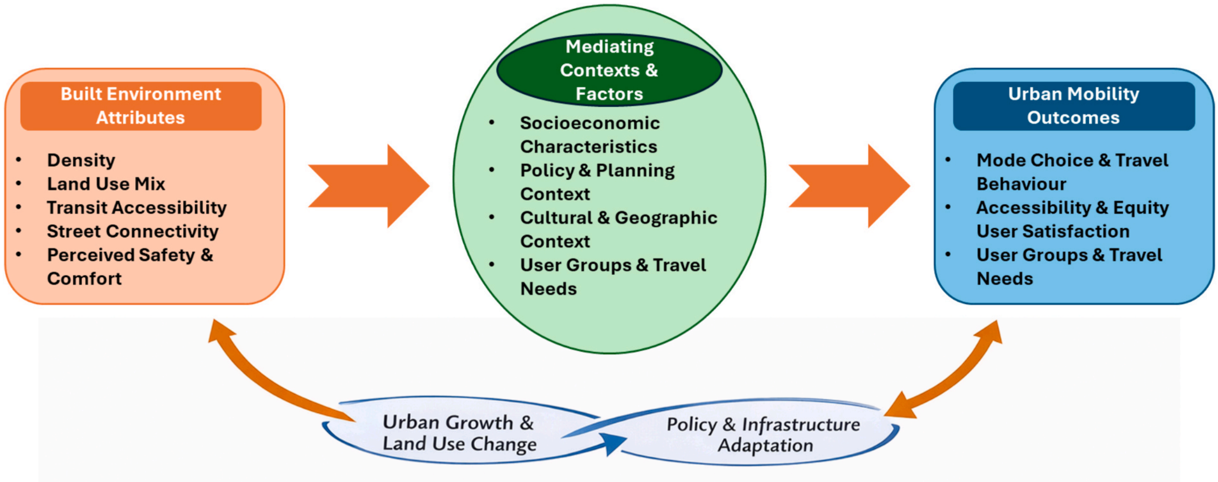

Fig. 5. Conceptual Framework.

Conclusion

This systematic review explains the complex relationship between built environments and travel behaviours, reflecting the diversity of global urban perspectives. The outcomes establish that infrastructure quality, connectivity, and mixed land use are crucial for advancing active and sustainable mobility. High-density bicycle networks and transit-oriented developments (TODs) promote walking, cycling, and public transit use, yet their success is often mediated by socio-demographic factors, including income, gender, and vehicle ownership. Furthermore, the advent of mobility innovations like e-bikes and dockless bike-sharing systems heads both prospects and confronts traditional transportation modes. Public transport systems, particularly rail networks, emerge as revolutionary in terms of urban mobility and growth. These solutions not only enable multimodal transport but also boost employment opportunities, increase productivity, and optimise urban area use. However, ongoing difficulties with social equality, accessibility, and the unintended effects of ultra-dense urban areas demand a balanced approach to design. Active travel habits are especially sensitive to the physical and social surroundings, emphasising the need for context-specific, data-driven initiatives. Future urban planning and research must take an adaptable, comprehensive strategy that uses modern technologies like GPS monitoring and machine learning to analyse complicated mobility behaviours. Addressing gender gaps, increasing accessibility for marginalised populations, and integrating cycling with other means of transportation are significant concerns. Preparing for trends like Mobility-as-a-Service (MaaS) and self-driving cars necessitates adaptable policies and infrastructure expenditures. A comprehensive and inclusive framework that matches physical infrastructure with socioeconomic realities and human choices is critical for boosting long-term urban mobility, lowering carbon emissions, and promoting fair access. The assessment in this review assists in deploying this framework by recognising the key built environment, behavioural, and policy factors that must be unified to attain sustainable and equitable urban mobility. This integrated strategy will allow cities to satisfy the changing requirements of their residents while also enhancing sustainability and quality of life.

CRediT authorship contribution statement

Saba Ayub: Writing – review & editing, Writing – original draft, Visualization, Methodology, Conceptualization. **Yuting Hou:** Writing – review & editing, Supervision, Resources, Conceptualization.

Declaration of competing interest

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Data availability

Data will be made available on request.

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