EXPLORING THE LINK BETWEEN TRAVEL BEHAVIOUR AND SUSTAINABLE MOBILITY

HODA POURRAMAZANI & JOSE LUIS MIRALLES-GARCIA
Department of Urbanism, Polytechnic University of Valencia, Spain

ABSTRACT
Today's society, which is built and developed based on time and access, seeks to consider these values in different modes of transportation. But what influences these values is the behaviour of users and the pattern they choose. The present study seeks to reveal the factors affecting the behaviour and travel pattern of transportation users and their changes over time by reviewing the relevant literature. Finding and recognizing these changes is critical to finding user behaviour patterns because transportation network performance, policies, planning, and sustainable mobility goals result from these behaviours and changing user patterns over the years and the interactions between them. On the other hand, we know that behavioural patterns are due to users' needs and are different in different population groups. Their preferences and choices will be very different in different situations. Thus, unstable economic, demographic, cultural conditions, existing or lacking infrastructure, mobility habits, technology, and shared mobility can change users' behaviour or lead to an urgent need to change the pattern. This principle can appear in different countries and under different policies and facilities. Therefore, understanding the behaviour of users in sustainable transportation life is extremely important.
Keywords: travel behaviour, urban form, mode choice, sustainable mobility, social-economic factor.

1 INTRODUCTION

We live in a time of change that affects every part of our lives, including our movement patterns. Mobility in today's world is increasingly a guarantee of health and a sign of society's present and future well-being, so despite emerging trends such as self-driving cars, alternative energy sources, and environmentally friendly travel modes (such as cycling and walking), moves towards higher stability. While particular attention is paid to mobility, the search for sustainable transport policies to reduce the adverse environmental effects caused by the increase is also clearly visible. The mobility pattern as an essential part of transportation has a vital role in the efficiency of a city, which in combination with travel behaviour, can provide the conditions and requirements of communication and the surrounding space.

The population in a country shapes their daily activities based on mobility, manifested in travel behaviour according to their particular conditions and needs. Users' behaviour can follow a regular pattern or be irregular due to various factors. It should be noted that with the growth of urban areas, more fundamental challenges arise, which has caused the behaviour cycle of users to undergo many changes, which at first glance is deeply influenced by individual factors and socioeconomic conditions, and urban form. This means that each population segment is considered by factors such as gender, age, education, or income. Each demographic group has its own travel needs and has different time and financial resources available that can change their behaviour. Therefore, it becomes more necessary to find the relationship between these factors and their effect on this cycle.

It is obvious that mobility and gender are influenced by each other. On the other hand, the travel pattern depends on the life cycle to a large extent, which shows the impact of age on the travel behaviour of users [1]. Because the travel needs of young people, middle-aged people, and the elderly change with age, they change and reduce their ability to move and access the transportation system [2]. On the other hand, there is a strong correlation between

poverty and transportation deprivation, i.e., lack of access to transportation and full social participation [1]. Therefore, along with rapid socio-economic development, the choice of travel mode due to travel behaviour changes drastically, and it is accepted that research on travel behaviour is of great importance.

It is noteworthy that urban form and the built environment influence user behaviour cycle changes. Since cities differ in internal components such as spatial design, socio-economic distribution, spatial structure, and infrastructure, investigating the relationship between the built environment and travel behaviour provides essential knowledge to inform land use and travel-related environmental policies. It also provides for sustainability purposes, doubling this issue's attractiveness. We have seen extensive theoretical and experimental contributions in this field in recent years. How the environment affects travel behaviour and how people's decisions in space and time are compatible with the surrounding environment.

2 METHODOLOGY OF THE LITERATURE REVIEW APPROACH

A systematic literature review was used to complete this article concerning the most cited papers on travel behaviour, followed by a corresponding overview of the obtained results. This selection of bibliographic sources is based on authoritative publications such as Chang et al. [3], Yang et al. [4] and Maciejewska et al. [1]. From the key concepts (travel behaviour, choice of travel mode, sustainable mobility) based on the subject, research was done in Google Scholar, Researcher Gate, Scopus, or Academia.edu to obtain the necessary information. The search was limited to collecting about 102 publications (e.g., articles, books, theses). The selected publications mainly focus on documents published since 2010 (Fig. 1).

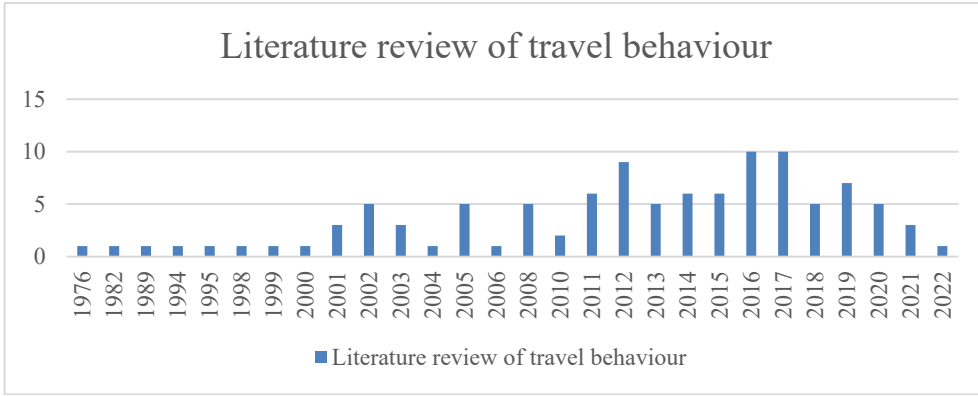

Figure 1: Year of publication of the 106 documents selected in the Literature review of travel behaviour.

Fig. 1 shows the reviewed publications. Publications have been considered based on very important, important and medium importance, and then according to the research topic, the most relevant publications, the most cited and the most important, and also considering the publications of recent years have been selected. This selection also guarantees the diversity of publications for any type of systematic approach, which of course, does not mean that the remaining publications are less important, but in this way, we search for the most relevant and important publications. These publications have been systematized using a Microsoft Excel file.

3 CHARACTERISTICS OF TRAVEL BEHAVIOUR

Societies are increasingly looking for the concept of urban planning on a new level to use it as an effective strategy to reduce car dependence. However, reaching this concept is impossible without understanding users' travel behaviour. Therefore, at the beginning of work, we need to know the main characteristics of users' travel behaviour, which undergoes many changes over time under the influence of various factors. These behavioural characteristics mainly include travel purpose, time, distance, and mode.

3.1 Travel purpose

The purpose of travel usually includes commuting and achieving recreational, shopping, tourist, and social goals. Of course, it has also been stated that journey is primarily influenced by the time dimension commuters use to commute on weekdays, especially during peak hours. However, during off-peak and weekends, passengers tend to change their travel goals to allow them to use shared vehicles such as bicycles.

3.2 Travel time

Travel time is mainly determined by factors such as the purpose of travel and the natural and built environment. In addition, travel times can change underpricing due to policies, transportation benefits, and weather. In his study on shared vehicles, Mateo-Babiano et al. [5] found that using such devices as shared bicycles can reduce the average travel time to less than 30 minutes. But another study states that, despite HOV (high occupancy vehicles) lines' availability, passengers using private cars experience shorter travel times [6]. On the other hand, as mentioned, the weather affects this feature. Seasonality is essential because summer transportation, especially shared vehicles, is more than winter use [7].

3.3 Travel distance

Travel distance is influenced mainly by the purpose and time of travel. In this case, we can refer to a study that was conducted in 2014 and showed that half of the origin–destination pairs were less than 3 km, which was deeply influenced by the purpose of the trip [8]. Another study on the impact of car use shows that the service and non-use of a car in terms of distance to the place of work of schools/universities for drivers in France were similar and did not change much [9].

3.4 Travel mode

A large body of literature shows that the choice of travel mode is one of the first characteristics of travel behaviour that changes due to influencing factors. A study of travel mode choice in the UK confirms that the share of car use declines in older age [10]. It is also acknowledged that traditionally, higher-income passengers travel more by private car. Bhat and Lockwood [11] observed that high-income individuals with driver's licenses drive more. Regarding the level of education, Plaut [12] and van den Berg et al. [13] both showed that highly educated people travel more by public transport (mainly leisure trips). On the other hand, it is said that car ownership also determines car trips. Finally, people living in larger families use fewer non-motor modes than people living in smaller families.

Changes in travel behaviour characteristics, such as reducing the number of trips, changing the purpose of travel, and choosing the mode of travel, can reflect the distribution, spatial organization, and efficiency of jobs and urban housing. In addition, it can overshadow

the decision-making mechanism of people (such as the place of work and residence), so the discovery of the relationship between travel and transportation behaviour and the factors influencing this relationship during periods of mobility research is integral.

4 WHAT FACTORS AFFECT TRAVEL BEHAVIOUR?

With the ever-increasing growth of the population and economy of cities, most municipalities have considered and tried urban transportation to meet people's needs. Meanwhile, urban planners had long thought urban land use might be the only factor affecting transportation travel behaviour. In this regard, the first empirical studies [14] compared transportation fuel consumption at the aggregate level (usually between cities or urban areas). Later, more studies investigated other influencing factors at the individual level. At the beginning of this way, some studies targeted other influencing factors other than the urban structure. Gradually, several empirical studies were conducted to include demographic and socioeconomic variables in the analysis.

4.1 Urban form and built environment

Due to urbanization and civilization, various functional areas are emerging in cities, including residential, commercial, educational, etc. It is noteworthy that the environmental parts of a city are closely related to people's daily travel activities. In terms of density, the distance between the city and the built environment, the urban form can play an essential role in the synergism and environmental and social conflicts of urban sustainability. On the other hand, it is related to mental well-being, which is an integral part of social sustainability. Therefore, the analysis of this factor can be separated into two aspects:

1. built environment,
2. housing and choosing a place to live.

4.1.1 Built environment

It isn't easy to distinguish between urban form, sustainable transport practices, and even travel behaviour because various factors influence this relationship. Factors such as income, family composition, and labour force participation have a unique role in commuting behaviour and choice of transportation method. Secondly, the location (either in the city centre or in the suburbs), the compactness of the residential environment, and the availability of transportation methods cannot be denied. Thirdly, the purpose of the trip is along with the length of the journey and the choice of travel mode. Based on this, the researchers analyzed the impact of the built environment, the impact of city size, density, mixed land use in cities, public transport provision, and the behaviour of the urban system.

But the most extensive and cited study on the effect of density goes back to Dimitriou's study [15] on car energy use in 32 large cities in Europe, the United States, Australia, Asia, and Canada, which shows that petrol consumption decreases with increasing population density. It shows the change in behaviour in this field.

On the other hand, the dispersion of urban land use in a wide area may lead residents to use private cars. So, in general, for the residents of the city centre, the commuting distance increases with the size of the city. On the other hand, for non-business trips, the space may be reduced, and therefore the behaviour changes to more active modes of travel. It should be noted that the density of cities should be high enough to provide an acceptable level of services and jobs to residents.

A study known as Nordic, which examined 30 studies on the impact of urban form on travel behaviour during a period from 1982, can also be considered as one of the complete

researches, although experimental, that has been carried out during the last three decades. There are significant differences between the five Nordic countries regarding research activities in this field [16].

Li and Zhao's research [17] show that the probability of owning a car can have a lower effect on kilometres travelled by work or non-work vehicles in mixed-use areas. This study, conducted in Beijing, showed that people who prefer to live near the subway system and travel on foot are more likely to own a car in the future than others. They also acknowledge that increasing the variety of land use in access to living facilities in neighbourhoods near the station can improve the transportation system's performance by reducing dependence on cars.

Some researchers question the built environment's impact on car ownership and state that this issue and neighbourhood renewal have only a limited role in reducing car use. According to Ewing and Cervero [18], the characteristics of the built environment include residential density, land use composition, urban form, access to destinations, distance to transportation stations, and parking provision, and most of the existing studies on the impact of the built environment on car ownership and its use; it is mainly concentrated at the neighbourhood level. But opponents doubt whether the local built environment can help reduce car ownership and shift behaviour toward other modes. Studies such as Khattak and Rodriguez [19] and Aditjahdra et al. [20] British studies also prove this issue.

Zhang et al. [21] also found a non-linear relationship between accessibility measures and the built environment and car ownership, showing that local accessibility plays a more critical role in predicting car ownership than regional accessibility and transportation. A study examines the development of stationless bike-sharing. Considering that the subway or bus station cannot accurately reflect the origin and destination of people, this solution has been proposed to provide planners with a new opportunity to discover the functions of the urban area. Because sharing helps to solve the problem of first and last mile by creating seamless connections between modes of transportation, so the feature of proximity to destinations in high data coverage makes it an ideal source for understanding land use distribution and understanding travel behaviour; therefore, it enables the discovery of functional urban areas [3].

In East Portland, the research investigated the intelligent mobility space in disadvantaged and low-income areas. The result showed that lower car ownership, income, and license rates lead people to rely heavily on modes other than private cars. But unfortunately, this can also mean they get fewer opportunities in the region because transportation services outside the desired core density are more minor [22]. It is also acknowledged that the development of shared transportation in urban form has dramatically changed individual travel behaviours. In addition, it can also reflect the decision-making mechanism of the place of employment and residence.

In their study on travel satisfaction and the built environment, Mouratidis et al. [23] state that neighbourhood density based on population affects transportation and thus the average walking distance to stops and the number of trips, and considering that parking conditions and the availability of the local store are usually different with the density of the area, however, in most metropolises, the density of the neighbourhoods is influenced by the distance from the city centre. Accordingly, it overshadows the travel behaviour in the direction of choosing the mode. In this regard, many articles, mainly in Europe but also in America, Australia, and Asia, have shown that residents of suburban neighbourhoods travel longer overall distances by car than their inner-city counterparts.

Although many researchers found significant differences in travel choices between people living in urban and suburban areas, the built environment's impact on travel behaviour may

be indirect through travel attitudes and preferences. Studies have shown that people want to find themselves in a neighbourhood that facilitates using their preferred mode of transportation. Wang and Lin [24] analyzed travel behaviour and attitudes before and after residential relocation in Beijing. It finds significant effects in the justifications of travel before and after moving to the environment and admits that travel attitudes have been more preferred in this issue.

Along with these studies, researchers showed that people often change their travel mode after moving independently from the previous and newly built environment.

4.1.2 Choosing a place to live and housing

A significant number of studies showed that people partially choose their living place in specific neighbourhoods to be able to travel in their desired direction. A new residential context has the potential to disrupt previous travel choices and can potentially change travel behaviour. Therefore, residential relocation can be considered an important event in life and can create new contexts in travel and travel restrictions. Even so, travel behaviour, in this case, is also affected by attitudes.

The extent to which a residential location is chosen based on travel preferences may also affect changes in travel behaviour after relocation. Suppose people self-select some neighbourhoods based on their travel experiences. In that case, they will likely use selective travel modes through local areas (e.g., suburban neighbourhood rotation, public transportation, and active suburban travel). Many types of research have focused on the relationship between the built environment and travel behaviour at the local scale. Still, the housing characteristics in all of them have shown the most substantial impact on user behaviour, which offers its position in the urban structure [16], [18], [25].

Is it essential to match the residential neighbourhood based on the attitude toward living in a high-density community. Also, based on travel by alternative means instead of a car [26] travel by public transportation [27] and residential preferences of passengers [28] have been determined that the residential area does not match the attitude of 23.6% to 51.4% of the people. It is mainly explained by the fact that the choice of a residential place is influenced by broad factors such as the distance to the workplace, different preferences in the family, and the limitations of people's budgets that can limit it.

Based on interviews with 15 people who lived in three locations in Oslo (inside the city, suburbs, and along the urban railway, a low-density area with poor access to public transport), Næss [29] found the mobile lifestyle of most people and their behaviour, it specifies and states that proximity to work and leisure activities are less influential in choosing a place to live. There is more flexibility based on the preference for public transportation. Mouratidis et al. [23] state that, given that most daily trips are made outside the residential area, the total trip distance is likely to be more influenced by the distance from the residence to the end of the journey than reflecting the characteristics within the residential area and it usually reflects the central structure of the city.

4.2 Social factors and demographic

Social conditions are different in each part of the population and are defined by various factors. This section is described under the demographic information that reflects the lifestyle and behaviour of users regarding the choice and time of daily travel; of course, the research of socio-economic differences in indicators such as budget or travel time, or even travel goals will be shown different behavioural patterns.

4.2.1 Gender factor

Mobility has not been equal for all socio-economic groups. On the other hand, Daily mobility and gender are inseparable and mutually influence each other. Cities are not gender-neutral and offer significant opportunities to reduce gender gaps and inequalities [30].

A priority issue is incorporating a gender perspective in urban planning and mobility studies. The travel habits of gender groups have long been recognized in the literature as an outcome and a cause. Given that the current transportation system is still male-centric, women are more deprived of vehicle access. Lack of gender equality in access, opportunities in the labour market, and full participation in the activities offered by the city deprive women.

According to Brown [31], women do multipurpose activities and plan several things in one trip. Similarly, Iveth et al. [32] argue that gender differences in mobility are due to physical and social factors rooted in the region's specific cultural characteristics. Because the possibility of access to a car is limited for women under certain conditions and relying on public transportation in a car-oriented world, they may emphasize their time budget. Furthermore, women often do not share car-centric transportation preferences.

Therefore, the discussion of gender mobility can be divided into two categories. The first category has two dominant themes [1]: social justice and environmental perspectives. This part of the research shows that using women's experience is helpful for future sustainable transport development. As Matthies et al. [33] and Polk [34] point out that women are more stable in travel behaviour and show a greater tendency to reduce car use.

Another central aspect of this discussion is related to the difference in access and use of existing modes of transportation.

Seeking to understand the gender gap, studies generally refer to the different social roles that men and women play in the home, workplace, community, and family. Traditionally, women make more daily trips and organize multiple activities due to organizational time frames. Many of these behaviours are part of caring mobility, that is, accompanying children and the elderly. Therefore, as shown in Motte-Baumvol et al.'s study [35], this has led to more trips and women's reliance on slower modes of transportation such as public and pedestrian transportation.

On the other hand, it has been shown that gendered travel preferences go beyond social structures, resources, and transportation opportunities. Maciejewska et al. [1] study examined the changes in travel behaviour between 2007 and 2012; they say that the female travel pattern has been less flexible, and only minor changes have been made. They also state that the results showed a significant reduction in the use of private transport in men, who may have been forced to do so by financial circumstances. This study also showed that when men's travel habits are affected by an external factor, they tend to change it by reducing their dependence on the car and choosing alternative methods.

4.2.2 Age

Although it has been proven that gender is one of the main factors in changing the pattern of mobility and behaviour, alone and without considering age, it is not enough to understand travel behaviour. Age also has a noticeable effect on daily mobility. Living longer and maintaining an active lifestyle creates opportunities and aspirations for various activities. However, functional limitations become more familiar with age, and many older people acquire more than one disability that can complicate travel. Boschmann and Brady [36] found that as the passengers get older, they make fewer and shorter trips, although women make fewer and shorter trips than men.

The routine activities of young people differ from those of middle-aged or older people depending on their age, time, and budget they have to invest in transportation. A clear and

relevant example is the demand schedule for night-time transportation, which mostly begins in late adolescence and young adulthood.

The travel needs of middle-aged people are usually focused on accompanying children and paying attention to parents. Because older people have limited mobility and rely more on the public, and as people age, their ability to move and access decreases [2]. It is also important to note that since women are usually the ones who are involved in caregiving tasks, the gender gap in travel due to age will usually increase during the middle period because that is when women's lifestyles will differ the most from their male counterparts.

It has also been stated that middle-aged men usually do not balance their travel goals and focus more on leisure activities. On the other hand, older adults use more active means of transportation, mainly walking, and women are more involved in this field than men.

4.2.3 Education and household size

The level of education and size of the household has a positive and significant relationship with users' travel behaviour. Travellers with a bachelor's degree or higher are less likely to choose driving in their travel chain but have a more positive association with public transportation. Users with high education, especially the elderly between 35 and 54 years old, prefer to limit their activities after work. They are considering the importance of travel time.

Married people find it easier to own a vehicle because they accept more responsibilities at home and organize more trips. Especially in the case of families with children under the age of six who tend to adjust the order of their activities in a way that leads to the choice of a model with a shorter travel time and distance. But low-income travellers mainly use public transportation and non-motorized modes due to economic constraints.

4.2.4 Social inequality

Mobility policies and the resulting travel restrictions can cause and intensify social inequalities. Some groups of people suffer from injustice due to personal and spatial heterogeneity. Vulnerable groups will probably face more deprivation than others, potentially leading to adverse effects on their physical and mental health due to their choice of travel due to physical and economic conditions. As Yang et al. [4] show in their study in China affected by the effects of the COVID-19 pandemic, its results are visible in cities with large populations. They have created a significant discussion about social inequalities and deprivation caused by transportation-related factors.

4.3 Economic factor

Since the economic conditions also determine mobility, the resulting fluctuations can strongly affect the user's travel behaviour. On the other hand, mobility also determines the amount of money and temporary resources people have available. It is worth pondering that financial crises affect men more than women. Therefore, the traces of factors affecting travel behaviour show their combined existence.

A case study in Greece suggests that the tendency to reduce the number of personal trips leads to reduce costs [37]. This shows that despite the crisis, people satisfy their needs and desires with travel and therefore seek to increase their activities.

Disruptive events such as the financial crisis caused significant changes in living conditions that go beyond reducing economic activity. The impact of economic problems in the literature is considered an essential and mutually reinforcing finding between poverty and transportation deprivation. Meanwhile, it can be expected that the number of trips will decrease with the increase in unemployment. Marquet and Miralles-Guasch [38] have found

that unemployed people tend to substitute their daily commute for other purposes. Similarly, considering the close relationship between income and car use, Maciejewska et al. [1] state that the crisis can lead to the substitution of the car for other modes of transportation, as well as changes in distances travelled and places of activity.

One of the financial crises affecting mobility behaviour was the Great Recession that started in 2008 and spread rapidly in the international financial circuits, especially in Southern European economies such as Spain, Greece, and Italy [39]. It made an impact that caused changes in the mobility pattern, primarily women as captive modal users.

4.4 Psychological factors

There are two approaches in the travel behaviour literature: the theory of utility maximization and the theory of psychological behaviour. The idea of utility maximization assumes that decisions and changes in travel behaviour are entirely rational. Therefore, travellers choose the mode that has the most utility among the alternatives, as determined by their socio-economic characteristics and the service characteristics of the methods. The psychological theory of behaviour assumes that state selection and behaviour change may be considered a general process resulting from behavioural habits. There is a philosophy in this case as a guide that the combination of psychological factors leads to a more realistic representation of the user's behavioural process and thus its better explanatory power.

Studies show that the choice of travel mode is explained by psychological factors both as a rational action and as normal behaviour. Studies also state that psychological factors as logical determinants significantly impact travel intention, and travel behaviour can improve the mode choice model compared to the traditional model. Also, perceived behavioural control greatly affected behavioural sense towards train use in Phnom Penh city and intention to use the motorcycle in Taipei and Kaohsiung in Taiwan [40]. On the other hand, Nordfjærn et al. [41] and Chen and Chao [42] showed that a subjective norm was the most effective predictor of destination and change from private vehicle to public transportation.

Along with this logical procedure, habitual behaviour is also the main predictor explaining travel behaviour. Because habits are also practical in that they are done to achieve a specific goal, studies show that habits influence destination and mode choice behaviour. For example, the habits identified in choosing to travel by private vehicle affect the choice and changes in the travel pattern of private vehicle users. Similarly, Domarchi et al. [43] found that car use habits strongly affected Chilean workers' choice of car use.

In another study conducted in two major cities of Taiwan to investigate travel mode selection behaviours in this area dependent on motorcycles, psychological factors showed a more substantial impact on changing travel behaviour than socio-economic factors. However, according to the reviewed literature, it is not yet clear which is the most vital factor between rational and habitual behaviour.

4.5 Safety

Travel literature usually distinguishes between traffic volume, modal split and traffic distribution over time. On the other hand, any decision resulting from travel behaviour is summarized to reach the intended goals. These decisions lead to risk exposure when combined with traffic, and the safety literature on risk exposure relates directly to travel behaviour. It should be noted that single-vehicle accidents may affect only one vehicle and one road user, while collisions involve multiple vehicles and road users. Risks of accidents and injury resulting from infrastructure, road users and the vehicle used will lead to a link in

the framework of risk and exposure, which includes factors that determine vulnerability to risk. In addition, most perceived risk plays a role in choosing the mode, that is, the idea that the unsafeness of a specific type of vehicle can be an obstacle to its use.

5 CONCLUSION

The advantage of looking at changes in travel behaviour over time is that it is possible to discover general trends. In addition, the background conditions change over the years, so citizens are trying to find strategies and adapt to the new requirements, which is often clearly visible in their behaviour. On the other hand, policies can strengthen the effects of factors affecting travel behaviour. Because there is a belief that the correct design, the application of rational policies and appropriate to the conditions can create suitable environments and encourage people towards active transportation and reduce the use of private vehicles. In the same way, although people present different perception and behavioural patterns methods, the reality of action in the environment with social and cultural characteristics in other comparisons of the country, city, region and neighbourhood creates frequent perceptions and behavioural patterns.

REFERENCES

[1] Maciejewska, M., Marquet, O. & Miralles-Guasch, C., Changes in gendered mobility patterns in the context of the Great Recession (2007–2012). *Journal of Transport Geography*, **79**, 2019.

[2] Steiniger, S., Fuentes, C., Villegas, R., Ardiles, R., Rojas, C.A. & Poorazizi, E., *AccesoBarrio-Medición de la accesibilidad urbana usando perfiles demográficos y OpenStreetMap*, Plataforma Municipal CEDEUS, Municipal Indicator Dashboard View project Acceso Barrio View project, 2017. https://www.researchgate.net/publication/320138411.

[3] Chang, X., Wu, J., He, Z., Li, D., Sun, H. & Wang, W., Understanding user's travel behavior and city region functions from station-free shared bike usage data. *Transportation Research Part F: Traffic Psychology and Behaviour*, **72**, pp. 81–95, 2020.

[4] Yang, Y., Cao, M., Cheng, L., Zhai, K., Zhao, X. & de Vos, J., Exploring the relationship between the COVID-19 pandemic and changes in travel behaviour: A qualitative study. *Transportation Research Interdisciplinary Perspectives*, **11**, 2021.

[5] Mateo-Babiano, I., Bean, R., Corcoran, J. & Pojani, D., How does our natural and built environment affect the use of bicycle sharing? *Transportation Research Part A: Policy and Practice*, **94**, pp. 295–307, 2016.

[6] Xiao, L.L., Liu, T.L. & Huang, H.J., On the morning commute problem with carpooling behavior under parking space constraint. *Transportation Research Part B: Methodological*, **91**, pp. 383–407, 2016.

[7] Zhou, X., Understanding spatiotemporal patterns of biking behavior by analyzing massive bike sharing data in Chicago. *PLoS ONE*, **10**(10), 2015.

[8] Faghih-Imani, A., Anowar, S., Miller, E.J. & Eluru, N., Hail a cab or ride a bike? A travel time comparison of taxi and bicycle-sharing systems in New York City. *Transportation Research Part A: Policy and Practice*, **101**, pp. 11–21, 2017.

[9] Delhomme, P. & Gheorghiu, A., Comparing French carpoolers and non-carpoolers: Which factors contribute the most to carpooling? *Transportation Research Part D: Transport and Environment*, **42**, pp. 1–15, 2016.

[10] Li, H., Raeside, R., Chen, T. & McQuaid, R.W., Population ageing, gender and the transportation system. *Research in Transportation Economics*, **34**(1), pp. 39–47, 2012.

[11] Bhat, R.C. & Lockwood, A., On distinguishing between physically active and physically passive episodes and between travel and activity episodes: An analysis of weekend recreational participation in the San Francisco Bay area. *Transportation Research Part A: Policy and Practice*, **38**(8), pp. 573–592, 2004.
[12] Plaut, P.O., Non-motorized commuting in the US. *Transportation Research Part D: Transport and Environment*, **10**(5), pp. 347–356, 2005.
[13] van den Berg, P., Arentze, T. & Timmermans, H., Estimating social travel demand of senior citizens in the Netherlands. *Journal of Transport Geography*, **19**(2), pp. 323–331, 2011. DOI: 10.1016/j.jtrangeo.2010.03.018.
[14] Keyes, D.L., Energy and land use: An instrument of US conservation policy? *Energy Policy*, **4**(3), pp. 225–236, 1976.
[15] Dimitriou, H., Cities and automobile dependence: An international sourcebook: Peter Newman and Jeffry Kenworthy Gower: Aldershot, UK, 388 pp., *Utilities Policy*, **1**(4), pp. 352–354, 1991.
[16] Næss, P., Urban form and travel behavior: Experience from a Nordic context. *Journal of Transport and Land Use*, **5**(2), pp. 21–45, 2012.
[17] Li, S. & Zhao, P., Exploring car ownership and car use in neighborhoods near metro stations in Beijing: Does the neighborhood built environment matter? *Transportation Research Part D: Transport and Environment*, **56**, pp. 1–17, 2017.
[18] Ewing, R. & Cervero, R., Travel and the built environment. *Journal of the American Planning Association*, **76**(3), pp. 265–294, 2010.
[19] Khattak, A.J. & Rodriguez, D., Travel behavior in neo-traditional neighborhood developments: A case study in USA. *Transportation Research Part A: Policy and Practice*, **39**(6), pp. 481–500, 2005.
[20] Aditjandra, P.T., Cao, X. & Mulley, C., Understanding neighbourhood design impact on travel behaviour: An application of structural equations model to a British metropolitan data. *Transportation Research Part A: Policy and Practice*, **46**(1), pp. 22–32, 2012.
[21] Zhang, W., Zhao, Y., Cao, X., Lu, D. & Chai, Y., Nonlinear effect of accessibility on car ownership in Beijing: Pedestrian-scale neighborhood planning. *Transportation Research Part D: Transport and Environment*, **86**, 2020.
[22] Golub, A., Satterfield, V., Serritella, M., Singh, J. & Phillips, S., Assessing the barriers to equity in smart mobility systems: A case study of Portland, Oregon. *Case Studies on Transport Policy*, **7**(4), pp. 689–697, 2019.
[23] Mouratidis, K., Ettema, D. & Næss, P., Urban form, travel behavior, and travel satisfaction. *Transportation Research Part A: Policy and Practice*, **129**, pp. 306–320, 2019.
[24] Wang, D. & Lin, T., Built environment, travel behavior, and residential self-selection: A study based on panel data from Beijing, China. *Transportation (Amst)*, **46**(1), pp. 51–74, 2019.
[25] Næss, P., Strand, A., Wolday, F. & Stefansdottir, H., Residential location, commuting and non-work travel in two urban areas of different size and with different center structures. *Progress in Planning*, **128**, pp. 1–36, 2019.
[26] de Vos, J., Derudder, B., van Acker, V. & Witlox, F., Reducing car use: Changing attitudes or relocating? The influence of residential dissonance on travel behavior. *Journal of Transport Geography*, **22**, pp. 1–9, 2012.
[27] Kamruzzaman, M., Baker, D., Washington, S. & Turrell, G., Residential dissonance and mode choice. *Journal of Transport Geography*, **33**, pp. 12–28, 2013.

[28] de Vos, J., Mokhtarian, P.L., Schwanen, T., van Acker, V. & Witlox, F., Travel mode choice and travel satisfaction: bridging the gap between decision utility and experienced utility. *Transportation (Amst)*, **43**(5), pp. 771–796, 2016.
[29] Næss , P., Urban structures and travel behaviour: Experiences from empirical research in Norway and Denmark. *Land Use and Travel Behaviour*, pp. 1–24, 2000. http://www.ejtir.tbm.tudelft.nl/issues/2003_02/pdf/2003_02_03.pdf.
[30] Gauvin, L. et al. Gender gaps in urban mobility. *Humanities and Social Sciences Communications*, **7**(1), 2020.
[31] Brown, D., Urban informality and building a more inclusive and resilient green economy: The peri-urban interface: Development, governance and poverty. Urban Africa Risk Knowledge (Urban ARK) View project. http://pubs.iied.org/10722IIED.
[32] Iveth, R.D.L.R., Eric, G. & José Sergio, P.J., Relationships between urban form and mobility: gender and mode of transport. Universidad Politecnica de Cartagena, 2022.
[33] Matthies, E., Kuhn, S. & Klöckner, C.A., Travel mode choice of women: The result of limitation, ecological norm, or weak habit? *Environment and Behavior*, **34**(2), pp. 163–177, 2002.
[34] Polk, M., Are women potentially more accommodating than men to a sustainable transportation system in Sweden? www.elsevier.com/locate/trd.
[35] Motte-Baumvol, B., Bonin, O. & Belton-Chevallier, L., Who escort children: Mum or dad? Exploring gender differences in escorting mobility among Parisian dual-earner couples. *Transportation (Amst)*, **44**(1), pp. 139–157, 2017.
[36] Boschmann, E.E. & Brady, S.A., Travel behaviors, sustainable mobility, and transit-oriented developments: A travel counts analysis of older adults in the Denver, Colorado metropolitan area. *Journal of Transport Geography*, **33**, pp. 1–11, 2013.
[37] Papagiannakis, A., Baraklianos, I. & Spyridonidou, A., Urban travel behaviour and household income in times of economic crisis: Challenges and perspectives for sustainable mobility. *Transport Policy*, **65**, pp. 51–60, 2018.
[38] Marquet, O. & Miralles-Guasch, C., The walkable city and the importance of the proximity environments for Barcelona's everyday mobility. *Cities*, **42**(PB), pp. 258–266, 2015.
[39] Hadjimichalis, C., Uneven geographical development and socio-spatial justice and solidarity: European regions after the 2009 financial crisis. *European Urban and Regional Studies*, **18**(3), pp. 254–274, 2011.
[40] Chen, C.F. & Lai, W.T., The effects of rational and habitual factors on mode choice behaviors in a motorcycle-dependent region: Evidence from Taiwan. *Transport Policy*, **18**(5), pp. 711–718, 2011.
[41] Nordfjærn, T., Şimşekoɨlu, Ö. & Rundmo, T., The role of deliberate planning, car habit and resistance to change in public transportation mode use. *Transportation Research Part F: Traffic Psychology and Behaviour*, **27**(PA), pp. 90–98, 2014.
[42] Chen, C.F. & Chao, W.H., Habitual or reasoned? Using the theory of planned behavior, technology acceptance model, and habit to examine switching intentions toward public transit. *Transportation Research Part F: Traffic Psychology and Behaviour*, **14**(2), pp. 128–137, 2011. DOI: 10.1016/j.trf.2010.11.006.
[43] Domarchi, C., Tudela, A. & González, A., Effect of attitudes, habit and affective appraisal on mode choice: An application to university workers. *Transportation (Amst)*, **35**(5), pp. 585–599, 2008.