Sustainable Mobility and the Environment: How our transportation choices shape our future

Maria-Alexandra Ivănescu[1,*]

[1]Doctoral School of Urban Planning, 'Ion Mincu' University of Architecture and Urban Planning, 10014, Bucharest, Romania

Abstract. This article is an overview of how travel behavior and urban mobility are shaping and influencing each other. The paper is structured in two parts. The first one presents the factors that influence travel behavior and in the second one, a few examples of good practices and unsuccessful projects are analyzed in order to determine how community collaboration affects the planning and decision-making process. The behavior patterns are influenced by socio-demographic factors, land use, transportation, or travel costs. Lifestyle represents one of the important factors in choosing transportation services. Thus, understanding the user's mobility patterns is a complex process and varies depending on the context and the needs.

1 Introduction

Sustainable mobility is a concept that aims to address the environmental, social, and economic challenges associated with transportation. As the world becomes more urbanized and the population grows, the number of private cars and other transportation modes increases as well. Currently, the transportation sector is the cause of well over 20% of global emissions. Up to 75% of these CO_2 emissions are generated by road transportation alone [1].

Nowadays, the development of urban areas and sprawl, made urban mobility an essential factor in day-to-day life causing, at the same time, a dependency in order to travel between different places - going to work, school, shopping, leisure, etc. Assuring freedom of movement is one of the human rights [2] and facilitating it by offering different transportation modes and services should be equitable and inclusive for everyone.

The 11th goal of the World Sustainable Development Goals refers to Sustainable Cities and Communities: Make cities and human settlements inclusive, safe, resilient, and sustainable [3] by implementing targets such as affordable and sustainable transport systems (target 11.2), reducing the environmental impact of cities (target 11.6) or strong national and regional development planning (target 11.8). Therefore, planning the cities in an integrated manner, considering the population's necessities, represents an essential factor for sustainable development. In this way, the impact that urbanization and population growth have on the environment and the future can be mitigated. [4][5].

When analyzing urban mobility and travel behavior, the link between the two can be defined as a two-way approach, where there are codependence and interconnection relations, influencing each other, and adapting to one another. These two entities are meeting success when cooperating and working together permanently. Well-connected, accessible, and affordable public transportation and micro-mobility are changing travel behavior, as well as mobility patterns, are changing transportation demand.

The scope of this paper is to emphasize in what manner the type of transportation we choose affects our daily lives, the environment, and the future. It analyzes the different factors that influence our behavior when choosing a transportation mode, as well as the role of policies and planning in shaping our mobility patterns.

2 Methodology

2.1 Literature review

A comprehensive literature review was made in order to study and help understand better the travel behavior and urban mobility. The bibliographic sources were used in concordance with the main topics of this article using Google Scholar, Science Direct, Researchgate, and Springer Link as the primary and reliable resources. Articles and strategic documents were also consulted for the case studies that were detailed in this paper.

2.2 Materials and models

Firstly, the factors that influence travel behavior were defined based on the literature available in order to highlight the complexity of the subject. Then, based on the hypothesis from the beginning of the research regarding the users' behavior patterns based on different factors, three examples of good practices in urban planning and three examples of unsuccessful or partly successful projects were analyzed in order to show the link between urban mobility behavior patterns and

.
* Corresponding author: ivanescu.alexandra12@gmail.com

planning when the users' demand is taken into consideration and when not. Having these examples as a base helps in understanding better how travel behavior and urban mobility influence each other. Moreover, by studying these projects, similarities in the approaches were identified.

3 Travel behavior and urban mobility

In order to understand better the link between travel behavior and urban mobility it is necessary to identify first the factors that can influence the users' choices while moving to different destinations.

3.1 Factors that influence mobility patterns

The factors that contribute to travel behavior are varied, from socio-demographic factors (including age, gender, income, education, employment status, and household size)[6][7] to land use and transportation infrastructure (availability of public transportation, the layout of streets and sidewalks, and the distance between home, work, and other destinations) or travel cost (cost of fuel, parking, and public transportation fares). Moreover, as Van Acker [8] says, travel behavior is also influenced by lifestyle, not only by cost, comfort, or travel time. As Salmon says, *"Lifestyles refer to the individual's opinions and orientations toward issues such as family, work, leisure, and consumption, which in turn structure behavior patterns"* [9].

Different behavior patterns were also observed by Haustein [10] and Hunecke [11], depending on gender and age group as well as social status and income or culture. *Scientific surveys have attributed to women more sustainable mobility behavior than men* [10]. *However, if income increases* [11], *negative effects on sustainable travel behavior have been observed.* Some studies show a behavior shift in travel patterns in women in the young adult groups who tend to have shorter travel times, but more trips than men [12] [13], compared to the elder adult users, among which elder men are using public transportation more than their counterpart [14].

Others have highlighted the correlation between the distance to work and income, concluding that the population with lower incomes tend to live closer to the workspace and use predominantly public transportation in contrast to the higher income people that tend to live far from the workspace and use private cars [15]. Furthermore, a big difference in car ownership can be observed between more developed countries (better public transportation system, multi-, and intermodality) and the ones that are developing (lack of public transportation - informal transportation system, cultural factors - higher income means a higher rate of cars ownership - car ownership is also a status factor)[16]. In this particular situation, the behavior is mainly engraved in the cultural practices as well as access to information and education.

By understanding the factors that influence travel behavior, planners and decision-makers can develop policies and programs that can help reduce traffic congestion, improve air quality, and make cities more livable. Also, it is very important to note that these factors can interact with each other in complex ways; for example, the availability of public transportation can affect the cost of travel, which can, in turn, affect people's travel choices [17].

3.2 Planning urban mobility

Policymaking and planning are considered factors that can contribute to changing behavior patterns as well. Having a good planning strategy and well-developed policies can conduct to changes in mobility patterns by offering varieties and alternatives for traveling to different destinations [18]. Moreover, by using measures like introducing congestion taxes, offering subsidies or tax breaks to encourage people to use car-sharing and ride-hailing services, or promoting walking and cycling through education campaigns and infrastructure investments, the users' travel patterns can be influenced toward more sustainable alternatives. In this way, planning and policies are tools that can be used in favor of sustainable development and climate mitigation, taking into consideration, at the same time, the users' mobility needs. Instruments like *the carrot and the stick* [19] are often used in policymaking strategies in order to promote modal shifts. Thus, offering a variety of transportation modes and alternatives without imposing penalties or restrictions can make urban mobility offer not sustainable, not rentable, and not used at its real capacity if car ownership continues to be an option without any limitations.

As the study of Rasmusse [20] showed, these policies work hand in hand in order to have an optimal and real impact on users' behavior toward sustainable mobility. For example, on one hand, policies that make it easier and more convenient to use alternative modes of transportation, such as public transportation, walking, and biking, can encourage people to make these modes their primary form of transportation. On the other hand, policies that make it more expensive to drive, such as congestion pricing and parking fees, can discourage people from driving and promote in this way the usage of alternative modes of transportation. Other examples of this manner can be by making telecommuting easier by providing tax breaks or other incentives. This can reduce the number of people who commute to work by car, which can reduce traffic congestion and pollution. In order to be able to create a switch from private cars to public transportation, some changes are necessary.

Public transportation needs to be more competitive when it comes to price, comfort, and travel time in order to become attractive for users - intermodality, multimodality, and frequency for high-quality transportation services. Offering alternatives, but at the same time giving penalties for the decisions that the users make while traveling to different destinations, can result in more awareness in choosing the travel pattern that they use in their day-to-day lives [20].

Therefore, mobility policymaking has the potential to make a significant impact on travel behavior. By implementing measures that make it easier, more convenient, and more affordable to use alternative modes of transportation, and by changing the way people think about transportation (having in mind the restrictions or the taxes that are enforced), policymakers can make a shift in mobility patterns, which will later have effects in reducing traffic congestion, improving air quality, and most importantly make cities more livable.

4 Case studies

This part of the paper will focus on six case studies, half of them presenting examples of projects of urban mobility that are considered good practices in planning. The second half will detail projects that are unsuccessful or partially unsuccessful and their impact.

In this research, a comprehensive study was made in order to better understand the various dynamics influencing travel behavior within urban areas. To underscore the complexity of this subject, key factors that shape travel behavior were identified from the robust body of literature. With a hypothesis in mind regarding the various factors influencing user behavior patterns, then, six exemplars were selected as case studies of urban planning initiatives.

The objective was to illustrate the profound interplay between urban mobility behavior patterns and planning outcomes when considering or neglecting user demands as well as community involvement. These case studies served as vital exemplars, offering a tangible foundation for better comprehending the codependence relationship between travel behavior and urban mobility. Additionally, through an in-depth examination of these projects, notable similarities were discerned in their approaches and outcomes.

4.1 Good practices projects planned in collaboration with communities

Vauban Neighborhood in Freiburg, Germany is an example of good practices project towards sustainable development planned in collaboration with Form Vauban - the local organization taking part in the planning process. This neighborhood is a pioneering example of sustainable urban development which has garnered international attention for its innovative approach to eco-friendly living and transportation [21]. Moreover, it was presented by Germany as best practice project development at the United Nations Conference on Human Settlements in Istanbul in 1996 and has become a model for sustainable mobility.

The key features of the Vauban Neighborhood project were emphasizing car-free movement (designed to minimize car usage and encourage residents to rely on public transportation, bicycles, and walking), a strong public transportation system (efficient and well-connected with tram and bus lines connecting it to the rest of Freiburg), a cycling infrastructure extensive network (making cycling a convenient and attractive option for

commuting), energy-efficient housing, green spaces and last but not least, community involvement [22].

The involvement of the community has played an important role in shaping the project's development, fostering a sense of ownership, and contributing to its success. The citizens were implicated in the planning process of the Vauban project, being actively engaged in participatory decision-making. In this manner, they were given the opportunity to voice their opinions, concerns, and ideas, regarding the important decisions that would be taken in the design and planning process of the neighborhood. Furthermore, workshops and consultations were organized in order to allow the community members to interact directly with urban planners, architects, and policymakers in order to provide feedback on various aspects of the project (from housing designs to transportation solutions).

This active involvement has allowed for a degree of experimentation. The planners have been open to trying out new concepts, observing how they work in practice, and adjusting them based on real-time feedback from residents. This flexibility has been crucial in refining the project's features to align with the community's needs. It has also contributed to the project's adaptability and success, as the features implemented are more likely to be well-received and effectively utilized. This participatory approach has set a precedent for inclusive and sustainable urban development that respects the values and aspirations of the people who live there.

The city of Groningen in the Netherlands is one of the most bicycle-friendly cities in the world with more than 60% of the trips are using bicycles as a primary mode of transportation [23], being named as well by the Global Institute of Sustainability and Innovation the *Bicycle capital of the world* [24]. Over the years, the citizens of Groningen have prioritized cycling as a primary mode of transportation, leading to high bicycle usage rates, therefore making the city invest in building dedicated cycling lanes, parking facilities, and bike-friendly traffic policies. These efforts have made cycling a safe, convenient, and preferred mode of transport for residents, significantly reducing car usage and promoting sustainable mobility.

The community played a significant role in the planning and decision-making process of the Groningen cycling infrastructure project. The city recognized the importance of involving residents in shaping the future of urban mobility and ensuring that the cycling infrastructure met the actual needs and preferences of the people [25].

Similar to the Vauban project, the community has been engaged in collaborative workshops and consultations, in the design process as well as partnerships with cycling advocacy groups and NGOs. Moreover, educational initiatives and promotional campaigns made, aimed to raise awareness about the benefits of cycling and encourage more residents to adopt cycling as a mode of transportation. The strong implication of the community in the planning and decision-making process not only helped create adequate cycling infrastructure but also fostered a sense of ownership and pride among residents. The resulting cycling network has transformed Groningen

into a model city for sustainable urban mobility, where cycling is seamlessly integrated into daily life.

Totnes, a small town in the United Kingdom, has embraced the Transition Town movement [26], which aims to create more sustainable and resilient communities by encouraging local solutions, community engagement, and a shift toward renewable energy sources. This is a community-led initiative whose main objectives are to reduce dependence on fossil fuels, strengthen local economies, and enhance community cohesion. As part of this initiative, Totnes has implemented various sustainable mobility measures like establishing car-sharing programs, introducing electric vehicle charging stations, or improving public transportation options. The city has also prioritized pedestrian-friendly infrastructure and created walkable neighborhoods.

Totnes Transition Town project serves as a model for how a community can come together to address environmental challenges and create a more sustainable and resilient way of life. Its results highlight the positive impact that *grassroots initiatives* [27] can have on local economies, communities, and the environment. The transition town movement demonstrates how local communities can take action to address global environmental challenges, by working together and focusing on practical, localized solutions, these projects contribute to a more sustainable, resilient, and interconnected world.

These examples illustrate how the implication and collaboration of the communities in the planning and designing process by implementing measures tailored to their specific needs, have influenced the outcome of different urban mobility-related projects.

4.2 Unsuccessful/ partly successful projects that failed because of the lack of collaboration with the community

One of the examples is the bike-sharing system called Proto implemented by Seattle and discontinued three years later. The goal of the project was to provide a convenient and sustainable mode of transportation for residents and visitors. From the start, the project has encountered challenges, especially financial. The implementation was more expensive than anticipated, and the number of users to cover its operational costs was too low, insufficient to sustain the system's operations. Other factors that contributed to the failure of the system were the limited coverage of the system as well as the competition with electric scooters which offered flexibility and convenience that may have drawn users away from the city-operated system [28]. On top of that, Seattle's climate and elevations might have discouraged the individuals from using the bike-sharing service regularly due to the rainy weather and chilly temperature as well as the hilly terrain which is physically demanding, especially for casual riders.

Due to these and other factors, Pronto Cycle Share faced financial deficits, low ridership, and public criticism. In 2017, after struggling to secure additional funding, the City of Seattle decided to discontinue the Pronto bike-sharing system. This decision highlighted the challenges of operating a bike-sharing service in a complex urban environment and the importance of addressing issues related to coverage, user experience, and financial sustainability. After the failure of the project, the lessons learned, by understanding the users' and communities' needs helped them launch the dockless bikes which were a success, making the system easier to use and more affordable [29].

The Dublin Metrolink project in Ireland was envisioned to provide a rapid transit link between the city center and the northern suburbs of Dublin and the airport. However, even though the planning of this project started in the early 2000s, the project faced delays and eventually failed due to a combination of factors. A lack of strong community engagement and insufficient communication with affected neighborhoods led to opposition and concerns about the project's impact on local businesses and the environment [30]. The project also faced financial challenges, and changing economic conditions further hampered its progress. Ultimately, due to a lack of community support and economic feasibility, the project was postponed multiple times, the last deadline being 2027 [31][32].

Another example of an urban mobility alternative that partially failed in practice was the implementation of shared electric scooters in Europe [33]. Even though firstly it had a positive impact on the micro-mobility in the cities, offering a last-mile and sustainable traveling alternative, e-scooters have encountered challenges and failures due to the lack of planning and policy-making when implemented. The system was a success regarding the popularity and usage area among the users, but at the same time, it has caused safety concerns and confusion among the riders due to the lack of regulation [34]. Moreover, the e-scooter users' behavior has affected the day-to-day life of pedestrians causing a negative perception of micro-mobility because of the lack of clear guidelines about parking as well as inappropriate usage and lack of dedicated infrastructure - riders might use sidewalks or mix with traffic, posing risks to pedestrians and themselves.

Lately, Paris has had a referendum in order to ban electric scooters due to a lack of policies and measures to regulate this type of micro-mobility which has caused security and safety concerns as well as an impact on the urban landscape [35][36]. It's important to note that even though some cities faced challenges in the implementation of electric scooter systems due to a lack of planning and policy-making, others managed to successfully integrate them into their micro-mobility network with better-defined regulations, and lessons learned from other cities best practices or failures [37].

This example demonstrates how a public transport initiative can be unsuccessful when there is a mismatch between the implemented system and the needs and preferences of the local population. It underscores the importance of thorough feasibility studies, considering factors such as population perception, transportation patterns, coverage infrastructure readiness, regulations,

and public interest before launching a public transport project.

After having an overview of both sides, on one hand, the best practice projects and on the other hand the failures in planning, it is clear that bottom-up as well as top-down approaches are necessary in the planning and implementation process, due to the effects and the impact that they have on each other [38][39]. Moreover, a good collaboration with the users in the early stages of the process as well as in the decision-making phases can ensure a greater success rate in implantation and use.

5 Results and discussions

The results show that urban mobility behavior patterns and planning are codependent and should work hand in hand for optimal results. Travel behavior is a complex process that is influenced by various factors, from gender, age to lifestyle or urban mobility planning. Moreover, a good collaboration is necessary between communities and decision-makers both in designing and planning as well as using top-down and bottom-up approaches in policy making. Furthermore, in order to ensure a good balance between the alternatives of sustainable transportation modes and restrictions for the more polluted ones, a *carrot and stick* approach is necessary in policy making.

The case studies demonstrated how community involvement and collaboration significantly influence the outcomes of urban mobility-related projects. By addressing the specific needs and preferences of the local population and engaging communities in the planning process, cities can enhance the success and sustainability of their mobility initiatives. These examples underscore the value of both bottom-up and top-down approaches, emphasizing the critical role of early and ongoing collaboration with users to ensure the effectiveness and acceptance of urban mobility projects.

The research has limitations regarding data collection and the real situation in the field that should be developed further in order to show a tendency between different user category types (young and elder, man and female, employed and unemployed, etc.) Moreover, surveys would be necessary in order to test the theoretical hypothesis that has developed in this paper.

6 Conclusions

The study shows that a paradigm shift toward sustainable mobility needs to be done in order to achieve the global goals towards climate mitigation for the future. Urban mobility is a complex interplay between infrastructure, policies, and the choices individuals make on a daily basis. The decisions to commute, mode of transportation, and lifestyle preferences collectively shape the mobility ecosystem of a city. There is *no recipe* or *one size fits all* solution for changing the travel behavior of people but more of a combination of factors that helps to shape the mobility patterns. As urban populations continue to grow, it becomes increasingly important to foster behaviors that prioritize sustainability, efficiency, and inclusivity in urban mobility. By making conscious choices that embrace shared transportation, alternative modes of transit, and environmental stewardship, individuals can create a positive ripple effect that transforms the way cities move and evolve.

References

1. Our World in Data, *Cars, planes, trains: where do CO2 emissions from transport come from?* (World Resource Institute's Climate Data Explorer)

2. United Nations, *Universal Declaration for Human Rights, Article 13,* https://www.un.org/en/about-us/universal-declaration-of-human-rights#:~:text=Article%2013,to%20return%20to%20his%20country

3. The Global Goals, *11 Sustainable cities and communities,* https://www.globalgoals.org/goals/11-sustainable-cities-and-communities/

4. C40 Cities, *Deadline 2020: How Cities Will Get the Job Done* (2021)

5. United Nations Environment Programme, *Global Environment Outlook 2019: Healthy Planet* (Healthy People, 2019)

6. E. Chita, E. Drimili, Z. Gareiou, C. Milioti, A. Vranna, S. Poulopoulos, E. Zervas, Promet. **32**(3), 347-60, (2020)

7. G. Chira, D. Kaika, F. Kehagia, E. Drimili, Z. Gareiou, L. Vatikioti, E. Zervas, IOP Conference Series: Earth and Environmental Science, **899,** (2021)

8. V. Van Acker, P. Goodwin, P.F. Witlox, Int. J. Sustain. Transp. **10**(1), 25–32 (2014)

9. I. Salomon, M. Ben-Akiva, Environ, Plann, A Econ, Space, **15**(5), 623–638 (1983)

10. S. Haustein, M. Hunecke, J. Appl. Soc. Psychol. **37**(8), 1856–1883 (2007)

11. M. Hunecke, S. Haustein, S. Grischkat, S. Böhler, J. Environ. Psychol. **27**(4), 277–292 (2007)

12. V. Basarić, A. Vujičić, J.M. Simić, V. Bogdanović, N. Saulić, Transp. Res. Procedia **14,** 4324–4333 (2016)

13. M. Miramontes, M. Pfertner, H.S. Rayaprolu, M. Schreiner, G. Wulfhorst, Transp. **44**(6), 1325–1342 (2017)

14. J. Villena-Sanchez, E. Boschmann, S. Avila-Forcada, J. Transp. Geogr. **104**, (2022)

15. M. Abdullah, N. Ali, M.A. Javid, C. Dias, T. Campisi, Transp. Eng. (2021)

16. L. Al Otary, M. Abou-Zeid, I. Kaysi, Transp. (2021)

17. H. Pouttamazani, J.L. Miralles-Garcia, The Sustainable City XVI, Rome, Italy, **260**, 217 - 228 (2022)

18. M.D. Meyer, Transp. Res. A Pol. Prac. **33**, 575-599 (1999)

19. L.R. Rasmusse, N. Agerholm, A. Vingaard Olesen, H. Lahrmann, Danish J. Transp. Res. **4**, 16-30 (2022)

20. D. Banister, Transp. Pol. (2008)

21. W. Frey, W. Freiburg, *Green City: Approaches to Sustainable Urban Development*, (Herder, Freiburg Basel Wien, 102, 2011)

22. Quartier Vauban, https://www.freiburg.de/pb/,Lde/208732.html?QUERYSTRING=vauban

23. Groningen well on the way, *Sustainable Urban Mobility Plan Towards a liveable, clean and healthy municipality*

24. Groningen: Bicycle capital of the world, https://sustainability-innovation.asu.edu/sustainabilitystudies/2014/06/groningen-bicycle-capital-of-the-world/

25. Cycling as a city changer, https://www.chestercyclecity.org/wp-content/uploads/2022/04/Groningen%20Cycling%20Strategy%202015-2025.pdf

26. Transition Network, https://transitionnetwork.org/about-the-movement/

27. Grassroots organizations are just as important as seed money for innovation, https://www.unhcr.org/innovation/grassroots-organizations-are-just-as-important-as-seed-money-for-innovation/

28. F. Sun, P. Chen, J. Jiao, Transp. Res. D Transp. Environ. **63**, 533–547. (2018)

29. S. McQuate, *How bike sharing in Seattle rose from the ashes of Pronto's failure* (2019)

30. T. Concannon, *How does citizen involvement in the Irish planning system impact mega-infrastructure projects such as the Dublin MetroLink project?* (University of Groningen, Netherlands, 2021)

31. G. Deegan, *Up to €300m spent on various Dublin metro projects to date - MetroLink scheme to comprise 16 new stations running from Swords to Charlemont* (2023)

32. Metrolink, - https://www.metrolink.ie/en/about/metrolink/

33. E-Scooters Are Everywhere in Europe. So Are Grisly Accidents, https://www.wired.com/story/escooters-accidents-europe/

34. A. Li, P. Zhao, X. Liu, A. Mansourian, K.W. Axhausen, X. Qu, Transp. Res. D Transp. Environ. **105**, 103229 (2022)

35. *After the Paris ban, what's next for e-scooters?* (2023)

36. C. Latinopoulos, A. Patrier, A. Sivakumar, Transp. Res. D Transp. Environ. **100**, 103037 (2021)

37. EuroCities 2020, *Playing by the rules Report on e-scooter operators and fleets in cities, A survey of city approaches and options to optimise regulations*

38. T. Semeraro, N. Zaccarelli, A. Lara, F. Cucinelli, R. Aretano, Land **9**, 98 (2020)

39. I. Pissourios, Eur. Spat. Rese. Policy. **21** (2014)