The future of sustainable mobility in Budapest in 2030

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Abstract
This paper reports on the research undertaken to determine the possible future scenarios of sustainable mobility in Budapest up to 2030. Sustainable urban mobility has become an increasingly important issue for cities around the world, including Budapest. In 2019 the General Assembly of the Municipality of Budapest adopted the Budapest Mobility Plan until 2030. National and international regulations support the transition of mobility into a sustainable way. The research collected the driving forces that affect the future of sustainable mobility in Budapest via focus group discussion and document analysis. The driving forces are grouped and by the method of two-axis matrix and four scenarios are constructed to assess the possible futures of sustainable mobility in Budapest in 2030.
Keywords: sustainable cities, sustainable mobility, green transition, strategic foresight, alternative scenarios
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INTRODUCTION

Sustainable urban mobility has become an increasingly important issue for cities around the world, including Budapest. The rapid growth of urbanization has resulted in increased traffic congestion, air pollution, and carbon emissions, which pose significant challenges to the sustainability of cities. To address these challenges, cities are exploring various alternatives for sustainable urban mobility. The literature review explores the following alternatives: electric and hybrid vehicles, autonomous vehicles, Mobility as a Service (MaaS), urban air mobility, and pedestrian and bike-friendly urban design. The review highlights the advantages and challenges of each alternative, as well as the potential for their implementation in Budapest. The article aims to provide policymakers and urban planners with insights into the current and future alternatives for sustainable urban mobility in Budapest. By understanding the advantages and challenges of each alternative, policymakers and urban planners can make informed decisions about which alternatives to prioritize for implementation.

The city of Budapest, like many urban centres worldwide, is facing significant challenges related to transportation and sustainable mobility. As the city grows, the need for

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efficient, clean, and accessible transportation systems becomes paramount (Kelemen, A., Takács, I. 2021). This article aims to provide a comprehensive analysis of the future of sustainable mobility in Budapest, focusing on the anticipated changes and developments expected by the year 2030.

This article draws upon various sources, including official documents such as the Budapest Development Strategy 2030 (City of Budapest, 2021) and Hungary's National Energy and Climate Plan 2021-2030 (Ministry for Innovation and Technology, 2022). Additionally, scholarly research articles like Kelemen and Takács's study on the role of electric vehicles in Budapest's sustainable urban mobility system (2021) and Pályi and Várhelyi's research on mobility futures in Hungarian cities (2020) contribute to the analysis.

Furthermore, the European Commission's Sustainable and Smart Mobility Strategy (2020) provides a broader context and framework for understanding the future of sustainable mobility in European cities, including Budapest. Statistical data from the Hungarian Central Statistical Office's Statistical Yearbook of Budapest 2022 (2022) also serves as a valuable resource to support the analysis and provide an overview of the city's current transportation landscape.

This paper answers the following research question:

What are the possible futures of the development of urban mobility in Budapest in 2030?

The possible future of urban mobility development in Budapest in 2030 based on current trends and potential advancements. In this research, some scenarios are discussed for possible futures. Here are a few possible futures for the development of urban mobility in Budapest in 2030: By combining insights from various sources, this article aims to shed light on the prospects of sustainable mobility in Budapest, offering a comprehensive analysis of the anticipated changes and advancements expected to shape the mobility system by 2030.

1.1. LITERATURE REVIEW

Budapest is one of the largest and most densely populated cities in Central Europe, with a growing need for sustainable urban mobility (Varga et al., 2016). Sustainable urban mobility aims to improve the environmental, social, and economic sustainability of transportation systems in cities (Geurs and Van Wee, 2004). Several studies have investigated sustainable urban mobility in Budapest. One study found that the use of public transportation in Budapest has decreased in recent years due to the low quality of services and the increasing popularity of cars (Molnar et al., 2018). Another study examined the potential for sustainable mobility solutions in Budapest, such as bike-sharing and car-sharing, and found that they could reduce traffic congestion and improve air quality (Balazs, 2017).

One of the key challenges for sustainable urban mobility in Budapest is the lack of infrastructure for biking and walking (Zsóka and Szerényi, 2015). Budapest is known for its hilly terrain, which makes it difficult for cyclists to navigate the city (Kovács et al., 2018). However, there have been recent efforts to improve bike infrastructure in Budapest, such as the development of bike lanes and bike-sharing programs (Varga et al., 2016).

Another challenge for sustainable urban mobility in Budapest is the city’s high level of car usage. The number of cars on the roads in Budapest has increased rapidly in recent years, leading to traffic congestion and air pollution (Molnar et al., 2018). To address this issue, there have been proposals to introduce congestion charges or other measures to reduce car usage in the city (Kovács et al., 2018).

In conclusion, sustainable urban mobility is an important issue in Budapest, given its high population density and increasing demand for transportation. The challenges faced by Budapest include the need for improved public transportation services, better bike infrastructure, and reduced car usage.

However, there have been recent efforts to address these challenges and promote more

sustainable mobility solutions in the city. The following alternatives to transportation are mentioned in the literature:

Electric and Hybrid Vehicles have emerged as one of the most promising alternatives for sustainable urban mobility. The use of electric and hybrid vehicles could help reduce air pollution and carbon emissions in Budapest. The city could invest in infrastructure for electric vehicles, such as charging stations, to encourage more people to switch to electric or hybrid cars (E-Mobility Strategy for Budapest, 2019). The Budapest Municipal Government has already implemented an e-mobility strategy to promote the use of electric vehicles.

Autonomous Vehicles have been proposed as a potential solution to reduce traffic congestion, improve safety, and reduce the need for car ownership in urban areas like Budapest. However, the implementation of autonomous vehicles is still in its early stages, and several technical and regulatory challenges must be overcome before autonomous vehicles can become a viable alternative for sustainable urban mobility (Kovács et al., 2018). The development of autonomous vehicles could potentially revolutionize urban mobility in Budapest.

Mobility as a Service (MaaS) is an emerging concept that combines different transportation modes into a single platform, such as public transportation, bike-sharing, and car-sharing. MaaS could make it easier and more convenient for people to use sustainable transportation options in Budapest, leading to reduced traffic congestion and improved air quality (Kovács et al., 2018).

Urban Air Mobility involves using drones or other aircraft for transportation within cities. While this technology is still in its early stages, it could potentially offer a sustainable and efficient alternative to ground transportation in congested urban areas like Budapest. However, several challenges must be addressed before urban air mobility becomes a viable alternative for sustainable urban mobility, including safety, noise, and regulatory issues (Varga et al., 2020).

Pedestrian and Bike-Friendly Urban Design improving the infrastructure for walking and biking could encourage more people to use these sustainable modes of transportation in Budapest. This could include building more bike lanes, pedestrian-friendly streets, and safe crossings. Promoting pedestrian and bike-friendly urban design could lead to reduced traffic congestion, improved air quality, and a more sustainable transportation system in Budapest (Varga et al., 2016).

In conclusion, several alternatives for sustainable urban mobility in Budapest have been proposed in the literature. Electric and hybrid vehicles, autonomous vehicles, MaaS, urban air mobility, and pedestrian and bike-friendly urban design are among the most promising alternatives. While each alternative has its advantages and challenges, a combination of these alternatives leads to a more sustainable and efficient transportation system in Budapest.

1.2. METHODOLOGY

1.2.1. STRATEGIC FORESIGHT

The aim of the research is to identify the possible futures of mobility development in Budapest by 2030. To find the relevant answers to the research question, strategic foresight is used as a research model. Strategic foresight helps identify trends and understand the different challenges that may occur in the future. (OECD, n.d.) The research is using the framework foresight model created by P. Bishop and A. Hines. The method provides guidance on the foresight project from the framing of the domain to developing several alternative futures, including the preferred one as well. (Bishop, P., Hines, A. 2012) The model breaks foresight into six activities: framing, scanning, forecasting scenarios, envisioning the future, planning, and acting. (Hines, A. 2006.) This offers a systematic means to strategic foresight. Framing is about the identification of the domain. Scanning is scanning the system, its history, and its context. Forecasting future

scenarios is about the development of alternative, future scenarios by drives and uncertainties. The vision is the implication of the forecast. Followed by the planning of the strategy and options. Finally, act, communicate results, and develop an action plan. (Hines, A. 2006)

1.2.2. DATA COLLECTION

In this study, the authors aim to identify the driving forces of alternative scenarios for sustainable mobility in Budapest. The data collection was done based on three elements: focus group discussion, review of motivations to transition to sustainable mobility, and an overview of EU and Budapest regulations for sustainable mobility. The objective of this research is to get a clear picture of possible future outcomes of the development of sustainable mobility in Budapest by 2030. The paper is aiming to establish four different future scenarios based on the research model of strategic foresight. The framework of the model integrates the weak and strong signals into scenario development. Scenarios are tools to analyse possible future consequences of the changing environment. Therefore, uncertainty can be reduced. (Future Screening, n.d.) The development of the possible scenarios is based on qualitative data collection. First, the different trends which are affecting the future of mobility were identified by collecting data from the visions for the future and related climate strategies of the municipality. Therefore, both the EU-level and local level political environments were researched. The authors collected those regulations and strategies which affect the future of mobility in the EU and in Budapest. Further, social trends were collected through a focus group discussion by asking citizens of Budapest about their transportation habits in the capital. During the focus group discussion, the participants expressed their opinions regarding the future opportunities for development.

1.2.3. DATA ANALYSIS

In order to create four possible future scenarios for the implementation of sustainable mobility in Budapest, based on the collected data the authors formulated driving forces. In relation to the development of scenarios only those driving forces were used that have a high importance level and a high uncertainty level. The paper examines the level of uncertainty as it supports better understanding, anticipating, and preparing for change in future. Therefore, first the existing driving forces were analysed with the use of the importance-uncertainty table. The outcome of the analysis was the categorization of driving forces into groups based on their level of importance considering the sustainability goals of the EU and of Budapest city and based on the level of uncertainty regarding the representative state and strategies in force for sustainable mobility in the capital city. The authors grouped the driving forces with high importance and high uncertainty levels, and two main groups were identified. One of the groups includes those drives that are influenced by political support. In other words, the future possibility of the occurrence of the driving forces in that group is based on the political and legal direction of the city administration. The other group is characterized by the impact of economic stability and behaviour of citizens. The next part of the research is the construction of a two-axis matrix based on the two distinguished groups. The vertical axis' two ends are the high political support and the lack of political support, while the horizontal axis' presents the developed social-economic condition and the worsening social-economic condition. According to the two-axis matrix, four different scenarios are identified. Finally, four possible scenarios are developed.

1.2.4. FOCUS GROUP DISCUSSION

To gather insights from the public, the authors conducted a semi-structured interview with citizens living in Budapest in the form of a focus group discussion. The participants were people

who use public transportation almost every day. The interview focused on their opinions about the current public transportation system in Budapest, challenges and motivations for biking and walking, encouragement for public transportation usage, car usage in Budapest, and the possibility of introducing more electric or hybrid vehicles to the public transportation fleet in Budapest. The interviews provided valuable insights into the needs and expectations of the public towards sustainable mobility in Budapest.

The questions used for the focus group interview were:

- What do you think about the current public transportation system in Budapest? What improvements would you suggest making it more sustainable?
- What are the challenges and motivations for biking and walking in Budapest? Are there any areas that need improvement?
- What would encourage you to use public transportation more often in Budapest?
- What is your opinion about using a car in Budapest? Do you think there should be more restrictions on car usage in the city?
- What do you think about the possibility of introducing more electric or hybrid vehicles to the public transportation fleet in Budapest?

The driving forces gained from the focus group discussion are summarized in Table 2. Appendix, pg. 18-20.

Motivations to Transition to Sustainable Mobility

In this study, the authors used the motivations that are concluded by researchers in their research work to come up with the driving forces that could result in an alternative future for the current transportation system in Budapest.

The contribution of sustainable modes of transportation such as electric vehicles is reducing greenhouse gas (GHG) emissions, which are the primary cause of global warming and the degradation of air quality. These are the primary reasons for public interest in the adoption and use of electric vehicles.

The main motivations for this transition are as follows:

1. Emission reduction from Electric Cars

One of the reasons why the number of electric vehicles on the road is still small is that customers' expectations of their benefits in terms of mitigating climate change by lowering GHG emissions have not yet matured (Rezvani et al., 2015). Based on the results of some studies, due advancements in technology and evolutions in the process of manufacturing electric vehicles in recent years, they emit much less GHG than conventional vehicles (Transport & Environment, 2020, Emilsson & Dahllöf, 2019).

2. Reduction in the costs of ownership

Owning and using a sustainable means of transportation reduces the overall cost of utilizing it. In the case of electric vehicles, although the purchasing costs are higher compared to conventional cars, the higher prices will be compensated by cost reductions in terms of fuel and maintenance costs over a period of time. Moreover, the financial incentives provided by governments to encourage people to buy electric cars, as well as other incentives such as free parking areas, are other reasons that people are willing to adopt a sustainable way of transportation at a growing rate.

3. Moral norms

Some research has indicated that normative motives, or individual perceptions of moral correctness and incorrectness (personal moral norms), play an important role in the purchasing of sustainable goods (Jansson, 2011; Jansson et al., 2010). If consumers agree that buying sustainable products is the right thing to do, the likelihood of making a green purchase rises.

4. Pleasant sensation from using sustainable mobility

A pleasant sensation, or whether sustainable consumption enhances one's emotions, is an important explanation for consumer purchases of sustainable products. Expecting satisfaction and excitement from the purchase of sustainable goods will increase the probability of selecting a green purchase (Onwezen et al., 2013; Rezvani et al., 2017).

EU regulations on Sustainable Urban Mobility

EU regulations will be another element influencing the future of mobility in Budapest. Twenty five percent of the EU's greenhouse gas emissions are attributable to transportation, and this number is rising. By 2050, transport emissions must be reduced by 90% in order to become climate neutral. The decrease will require participation from all modes of transportation, including land, rail, air, and water. Providing people with more inexpensive, accessible, healthier, and cleaner alternatives to their present modes of transportation is essential for achieving sustainable transport (EUR-lex, 2019).

Becoming more sustainable and reducing emissions is the most serious challenge that the transportation sector is facing. Considering its significant share of the EU's overall greenhouse gas emissions, the EU's targets of at least a 55% reduction in greenhouse gas emissions by 2030 and of achieving climate neutrality by 2050 can only be met by implementing more ambitious policies to immediately reduce transportation's reliance on fossil fuels and work in tandem with efforts to achieve zero pollution. Consequently, it will lead to the European Green Deal’s success (European Commission, n.d.).

The new license for the transportation industry's expansion must be the greening of mobility. Mobility in Europe should be based on an effective and interconnected multimodal transport system, for both individuals and cargo, enhanced by an affordable high-speed rail network, an abundance of infrastructure for recharging and refuelling zero-emission vehicles, and a supply of renewable and low-carbon fuels, and cleaner and more active mobility in greener cities that promote the health and wellbeing of their residents. To put European transportation on the right path for a sustainable and smart future, the European Commission developed a “Sustainable and Smart Mobility Strategy”. It contains scenarios that are common to those supporting the 2030 climate target plan, showing that, if ambitious enough, the combination of the policy measures in this strategy can result in a 90% decrease in the transportation sector’s emissions by 2050 (EUR-lex, 2020).

Various milestones that are set to show the European Transport System’s path towards achieving the objective of sustainable, smart, and resilient mobility that help to outline future policies are as follows:

1. Table: Milestones introduced by European Commission

By 2030
At least 30 million zero-emission vehicles will be in operation on European roads
100 European cities will be climate neutral
High-speed rail traffic will double
Scheduled collective travel of under 500 km should be carbon neutral within the EU
Automated mobility will be deployed on a large scale
Zero-emission vessels will become ready for market
By 2035
Zero-emission large aircraft will become ready for market
By 2050
Nearly all cars, vans, buses as well as new heavy-duty vehicles will be zero-emission
Rail freight traffic will double
High-speed rail traffic will triple
The multimodal Trans-European Transport Network (TEN-T) equipped for sustainable and smart transport with high-speed connectivity will be operational for the comprehensive network

Source: EUR-lex, 2020.

"Sustainable and Smart Mobility Strategy" that is established by the European Commission identifies 10 flagship areas with an action plan to guide works needed to be done in the coming years. Among those, the ones that are in close connection with sustainability in urban mobility are as follows:

1. Boosting the uptake of zero-emission vehicles, renewable & low-carbon fuels and, related infrastructure
2. Making interurban and urban mobility more sustainable and healthier
3. Greening freight transport
4. Pricing carbon and providing better incentives for users
5. Making connected and automated multimodal mobility a reality
6. Innovation, data and Artificial Intelligence for smarter mobility
7. Making mobility fair and just for all
8. Enhancing transport safety and security

Budapest - on the way to sustainable mobility

Budapest the capital city of Hungary, is home to 18% of the country's population. (KSH, 2017) The city functions as an economic centre, and attracts people from the surrounding towns (agglomeration), around half a million people travel to Budapest for work or study every day (Koltai, L.; Varró, A., 2020). Although the recent COVID-19 pandemic has affected the mobility of people in many cities, including Budapest, restrictions had an impact on the use of public transportation and the introduction of home offices and online study/work/shopping. (Bucsky, P., 2020). According to László Fendrik, the former CEO of BKK (until 2021), the pandemic besides the challenges of public transportation resulted in the shift in-car use, and in the increasing popularity of micro-mobility devices such as walking, cycling, and scooters. (Polis Network, 2021)

Even before the pandemic, in 2013 Budapest decided to reconsider its transport development strategy. (eltis.org, n.d.) The so-called Balázs Mór Plan strategy was created based on the principles of the European Commission's Sustainable Urban Mobility Plan. The plan

aims to increase the rate of pedestrians by implementing pedestrian and bicycle-friendly aspects. Moreover, the creation of an interconnected city for cyclists is an important aspect of the plan. The goal is to make public transportation an attractive transportation mode for citizens. In addition, the decrease in the proportion of car transportation is a goal of the plan. (Budapest Főváros Önkormányzata, 2013)

In 2019 the General Assembly of the Municipality of Budapest adopted the Budapest Mobility Plan lasting until 2030. (BKK, 2019) The objectives of the Mobility Plan took into account both the national and the EU objectives, which can be listed as objectives about the reduction of the burden on the environment and of greenhouse gas emissions and local pollution. Moreover, it contains objectives regarding energy security, reduction of dependence on hydrocarbon-based fuels, making the regions of Europe more competitive while improving the quality of life for European citizens, and finally the transport safety as a priority. (Budapest. hu, 2019) According to the Mobility Plan, the future vision of Budapest considering sustainable mobility is as follows:

"Budapest is a liveable attractive capital city with a unique character and is a respected member of the European network of cities as the innovative economic and cultural centre of the country and the city region." (Budapest.hu, 2019)

To achieve the vision by 2030, the strategic document has identified four groups of measures of improvement. (Budapest.hu, 2019) One is the improvement of connections in public transportation, which includes both the introduction of new connections as well as the safe and reliable development of existing networks. The second important approach is the development of the public transportation vehicle fleet.

One reason behind this decision is to make public transportation a more attractive option for travelers, as vehicles offer comfortable and high-quality travel. Moreover, it supports the reduction of environment-related burdens caused by the transport system as the new vehicles will be fuel-efficient and less polluting. (Budapest.hu, 2019) Third, the improvement of service also affects passengers by influencing the transport mode selection. These measures are aimed at services such as information, ticketing, route organization, reliability, and punctuality, reducing the duration of transfers, and increase of comfort. (Budapest.hu, 2019) Final measures concern the existence of efficient governance by consistent regulations and passenger-friendly developments of national, regional, and local networks. (Budapest.hu, 2019) In 2021 the Municipality of Budapest adopted the so-called SECAP - Sustainable Energy and Climate Action Plan document, and the local climate strategy of the capital city. (Budapest.hu, 2021)

1.3. RESULTS

The results of the research are the four alternative scenarios for the future of mobility in Budapest in 2030. These scenarios represent potential future states which are emerging from current trends, driving forces, and uncertainties. The four potential scenarios show the different outcomes of the present trends. These scenarios help decision-makers to anticipate and plan for possible future events, considering different perspectives and strategies. In strategic foresight, alternative scenarios are developed by identifying key driving forces, such as social, economic, environmental, and technological factors that shape the future, and exploring how they might interact and impact different outcomes. This process enables stakeholders to consider a range of possibilities and develop proactive strategies to manage and respond to potential changes in their environment. The driving forces of the future of urban mobility in Budapest are collected based on a focus group discussion and from document analysis.

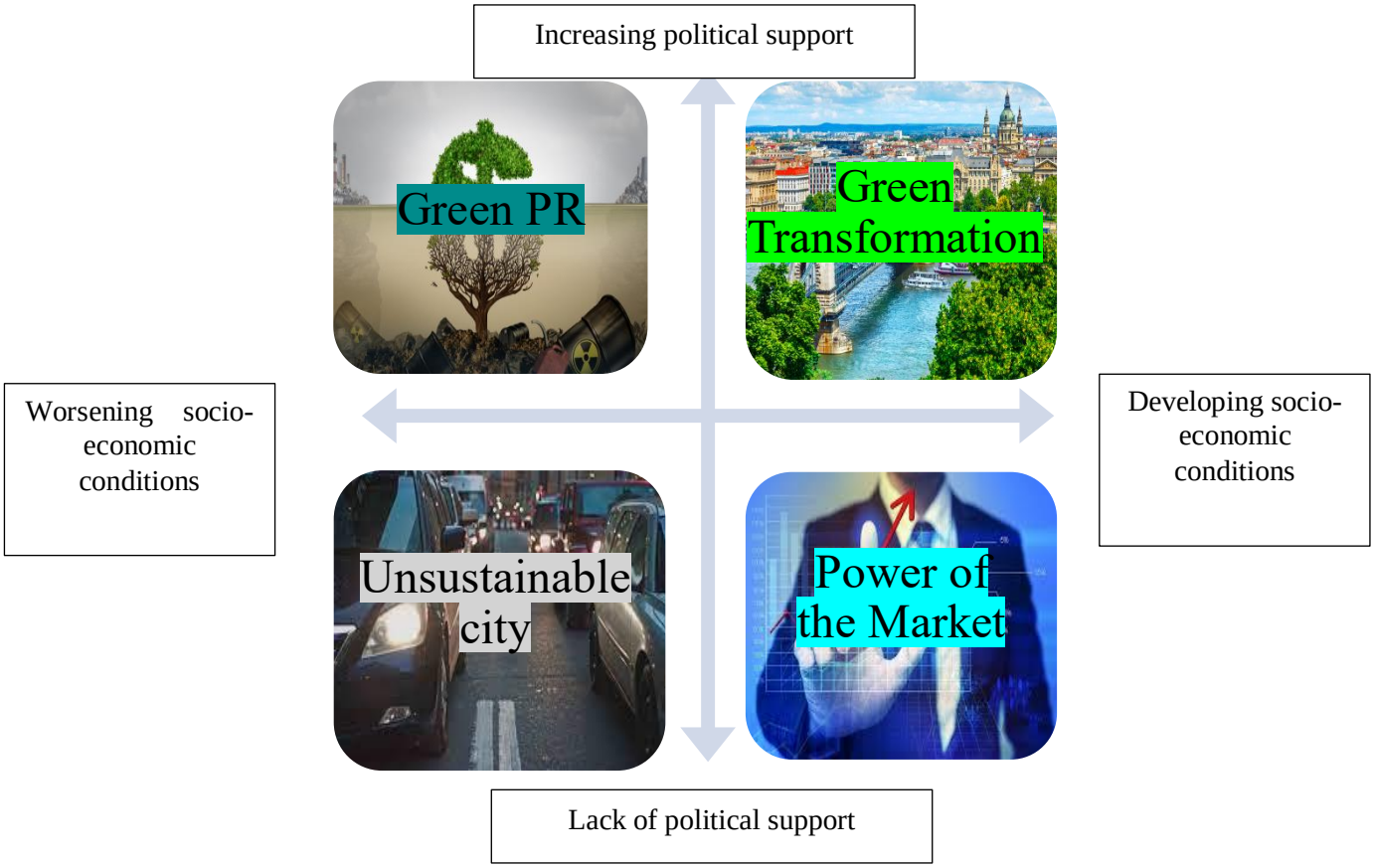
Importance-Uncertainty Analysis

The data collection – focus group discussion and document analysis - has resulted in a list of driving forces that all effecting the future of urban mobility in Budapest. The driving forces help us to understand the change because drivers are those trends that can influence the future. Ultimately, 48 driving forces were collected. Table 2. in the Appendix summarizes the driving forces. The authors rated each driving force according to the level of their importance in influencing the future and how uncertain the occurrence of the force is in 2030. The rating is done on a 1-10 scale, where the value 1 means that the force is not important at all and the value 10 means the force is very important; and value 1 shows that the force's occurrence is certain, and value 10 describes the total uncertainty of the occurrence of the driver. In the next stage, those forces which are rated with high importance and high uncertainty values will be used. (Appendix, Table 2, pg. 18-20)

Two-Axis Method

After analysing the importance and uncertainty level of the collected driving forces two main groups of driving forces were identified (Appendix, Table 3, pg. 21-22) One group includes those forces with high importance and high uncertainty level which possibility and outcome are influenced by the level of political support. The other group includes those driving forces whose future possibility is highly dependent on the level of economic-social development. By using these two factors the two-axis matrix was created that offers four possible scenarios for Budapest's sustainable mobility by 2030. (Figure 1.)

1. Figure: Two Axis matrix



Source: created by the authors, based on own data

Power of the market scenario – lack of political support, developing socio-economic

conditions

In this scenario, the market experiences a lack of political support and faces developing socio-economic conditions in the context of sustainable mobility. Despite limited government support and resources, the power of the market drives the development of sustainable mobility solutions. There are some speculative depictions of this scenario such as the Rise of Innovative Startups, Collaborations and Partnerships, Public-Private Partnerships, and Shared Mobility Solutions.

In the absence of significant government support, the scenario of high economic potential drives entrepreneurial innovation and market-driven solutions for sustainable urban mobility in Budapest. The private sector, including startups, technology companies, and investors, recognizes the economic opportunities in the sustainable mobility sector and takes the lead in developing innovative transportation solutions. Entrepreneurial ventures emerge to address the demand for clean and efficient mobility options, such as electric vehicle-sharing platforms, smart transportation apps, and sustainable logistics services (Kovács et al., 2018). These market-driven solutions leverage technological advancements, data analytics, and user-centric approaches to offer convenient, cost-effective, and environmentally friendly transportation alternatives to the public.

In this scenario, the high economic potential of sustainable urban mobility drives the involvement of public-private partnerships. Despite limited political support, the government recognizes the economic benefits associated with sustainable mobility and establishes partnerships with private entities. Through these collaborations, financial incentives and tax breaks are provided for businesses that invest in sustainable transportation solutions. The private sector plays a critical role in financing infrastructure projects and developing sustainable mobility services, while the government provides regulatory support and facilitates favourable conditions for these initiatives to thrive. This approach fosters a symbiotic relationship between economic growth and sustainability, encouraging innovation and investment in the sustainable urban mobility sector.

Given the high economic potential, international investors and organizations recognize the opportunities in Budapest's sustainable urban mobility sector. Foreign investment and collaboration bring in financial resources, expertise, and global best practices. International organizations support capacity-building programs, technical assistance, and knowledge-sharing to enhance the implementation of sustainable mobility initiatives. Economic integration with neighbouring regions and cities leads to the development of cross-border transportation networks and coordinated sustainable mobility strategies. The economic potential of sustainable urban mobility becomes a driving force for collaboration and cooperation among different stakeholders, fostering a shared commitment toward creating a sustainable and economically prosperous transportation system in Budapest.

The high economic potential of sustainable urban mobility attracts foreign investment and fosters international cooperation in Budapest. Global investors recognize the market opportunities and the city's potential as a sustainable mobility hub. International companies bring in expertise, technology, and financial resources to support the development of sustainable transportation infrastructure and services. These foreign investments contribute to the growth of the local economy, job creation, and knowledge transfer. Furthermore, international cooperation agreements are established to leverage best practices and lessons learned from other cities and regions around the world. Collaboration with international organizations and experts enhances the city's capacity to implement sustainable mobility solutions, build supportive policy frameworks, and create a thriving ecosystem for sustainable urban transportation.

While lacking significant political power and facing developing socio-economic

conditions, Budapest's sustainable mobility landscape evolves due to the power of the market. The market-driven approach leads to the emergence of innovative start-ups, increased consumer demand for sustainability, collaborative partnerships, technological advancements, shared mobility solutions, business-led initiatives, public-private partnerships, and grassroots movements advocating for change. Together, these factors drive the adoption and development of sustainable mobility options, contributing to a greener and more accessible transportation system in Budapest.

Green Budapest – increasing political support, developing socio-economic conditions

In the Green Budapest scenario, Budapest will have developed a highly integrated and efficient public transportation network by 2030. This network would consist of an expanded metro system, tram lines, buses, and cycling infrastructure, all seamlessly connected and accessible to residents and visitors. The public transportation system would be powered by clean energy sources, such as renewable electricity or hydrogen, reducing carbon emissions and air pollution. Advanced technology and smart solutions would be employed to optimize routes, schedules, and ticketing systems, ensuring smooth and convenient travel for passengers. Additionally, affordable, and flexible ticketing options, including contactless payments and integrated multi-modal passes, would encourage the use of public transport over private vehicles.

In this Green Budapest scenario, Budapest would prioritize and promote active modes of transportation, such as walking and cycling. The city would have an extensive network of pedestrian-friendly streets, sidewalks, and bike lanes, making it safe and convenient for people to walk and cycle for their daily commuting needs (Varga, et al.2020). Dedicated bicycle parking facilities, bike-sharing programs, and incentives for cycling, such as subsidies for electric bicycles, would encourage residents to choose sustainable alternatives to cars. Moreover, green spaces and recreational areas would be interconnected, promoting a healthier and more active lifestyle while reducing the overall demand for motorized transportation.

By 2030, Budapest would have made significant progress in the electrification of its transportation fleet. The Green Budapest scenario envisions a substantial increase in the adoption of electric vehicles (EVs), including both private cars and public transport buses. This transition would be supported by the establishment of a comprehensive charging infrastructure network throughout the city, ensuring that EV owners have convenient access to charging facilities. In addition to electrification, shared mobility solutions, such as car-sharing services and ride-sharing platforms, would be widely available and embraced by the population. This would reduce the overall number of vehicles on the road, leading to decreased congestion and emissions, while providing flexible and affordable transportation options to the residents of Budapest.

Unsustainable City – lack of political support, worsening socio-economic conditions

In the scenario of an Unsustainable City, Budapest faces a challenging future characterized by the continuation of outdated and unsustainable transportation practices. Despite growing concerns about congestion, air pollution, and the need to reduce carbon emissions, the city fails to make significant progress toward sustainable urban mobility. One of the primary reasons for this stagnation is the lack of political support and commitment to prioritize sustainability in transportation planning. Without strong leadership and clear policies, the city struggles to drive the necessary changes and fails to capitalize on opportunities for sustainable mobility.

Another contributing factor to the Unsustainable City is the absence of adequate economic and social development that supports sustainable transportation. Limited investments in public transportation infrastructure and services result in outdated and unreliable systems that fail to attract commuters away from private cars. The lack of incentives for alternative

modes of transport, such as cycling, walking, or car sharing, further exacerbates the reliance on private cars and perpetuates unsustainable transportation patterns. Consequently, Budapest remains locked in a cycle of congestion, air pollution, and increased carbon emissions, hindering its progress toward becoming a greener and more sustainable city.

Overall, the scenario of Unsustainable Status highlights the missed opportunities and challenges faced by Budapest in achieving sustainable urban mobility. The absence of political support, inadequate economic-social development, and a lack of incentives for sustainable modes of transport all contribute to a future where the city continues to suffer from the negative impacts of urbanization and fails to create a healthier and more sustainable environment for its residents.

Green PR - increasing political support, worsening socio-economic conditions

In the scenario of Green PR, Budapest faces significant challenges in achieving sustainable urban mobility due to various limitations and constraints. While there is a recognition of the importance of transitioning to greener and more efficient modes of transportation, the city struggles to overcome barriers that impede progress. One of the primary challenges is the limited availability of resources and funding. Without sufficient financial support, it becomes difficult to invest in the necessary infrastructure, technologies, and policies to drive sustainable mobility initiatives. The lack of funding also hinders the development and expansion of public transportation networks, making it harder for residents to rely on alternative modes of transport.

Additionally, social support plays a crucial role in the success of sustainable urban mobility initiatives. However, in the scenario of Green PR, there is a lack of widespread awareness and engagement from the community. Public awareness campaigns and education programs are limited in their reach and effectiveness, making it challenging to foster a culture of sustainable transportation. Without a strong social support base, it becomes difficult to generate the momentum needed to push for policy changes, behaviour shifts, and investments in sustainable mobility solutions. As a result, Budapest finds itself struggling to make significant progress towards a greener and more liveable city, as the limited transformation efforts fall short of creating the desired impact.

CONCLUSION

Through the strategic foresight research model, this study explored the potential trajectories of mobility development in Budapest by 2030. Four distinct scenarios were constructed based on varying levels of political support and socio-economic conditions.

In the first scenario, "Green PR," limited resources and funding hinder Budapest's progress towards sustainable urban mobility, compounded by a lack of community engagement. The second scenario, "Unsustainable City," depicts a lack of political commitment and economic development, leading to congestion, pollution, and unsustainable transportation practices.

In contrast, the third scenario, "Green Budapest," envisions a city that prioritizes pedestrians, cyclists, and public transport, implementing car-free zones, enhancing public transportation, and expanding cycling networks. This transformation results in a greener, healthier, and more liveable Budapest, promoting sustainable transportation modes and reducing carbon emissions.

The fourth scenario, "Power of the Market," demonstrates the government's strong dedication to sustainable urban mobility, establishing comprehensive policies and regulations. These include incentives for public transport, walking, and cycling, as well as strict emissions standards and collaborative efforts with stakeholders.

This research underscores the significance of political support, socio-economic

conditions, and community involvement in driving sustainable urban mobility. Policymakers and stakeholders can employ the insights gained from these scenarios to make informed decisions, develop strategies, and prioritize sustainable transportation, ultimately contributing to Budapest's vision as a liveable and innovative capital city by 2030.

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APPENDIX

Table 1. Importance-Uncertainty Analysis

Driving Forces from FOCUS GROUP DISCUSSION	Importance (0-10)	Uncertainty (0-10)	Driving Forces From Motivations and Regulations	Importance (0-10)	Uncertainty (0-10)
Municipality will introduce a no-car area in the city centre of Budapest	7	9	The technology for electric vehicles will continue to advance in the future leading to a faster adoption of EVs	9	8
The public transport system will be renewed by buying electric buses or by trams	10	8	The government will increase the incentives for buying EVs	8	8
Modernisation of public transport vehicles	10	3	The government will provide a large number of non-financial incentives for EVs and bikes	8	8
The number of companies which provide using shared bike facilities will increase	9	8	The government will increase the tax on conventional cars sales	7	9
Conventional buses will be phased out in the city centre of Budapest	6	9	The public transport ticket prices will be lowered for creating an all-inclusive public transportation system	9	9
Metro lines will be expanded to cover more area of the city	10	10	The government will provide incentives to buy bike and scooter	5	9
People's knowledge will increase to switch to a sustainable way of transport	8	9	The share of renewable energy resources will increase in the power grid supply	9	7
MOL BuBi stations will be available in more parts of the city, the cycling service is expanding	8	7	People will feel responsible to buy electric cars to harm the environment less	8	8
Development of water transportation network	8	9	The government will increase the standard of pollution criteria of cars	10	8
Car sharing service is developing	7	8	The government will invest more on providing infrastructure for EVs (Charging spots)	9	8

Driving Forces from FOCUS GROUP DISCUSSION	Importance (0-10)	Uncertainty (0-10)	Driving Forces From Motivations and Regulations	Importance (0-10)	Uncertainty (0-10)
For regional connection improvement new lines will be introduced.	8	9	People will be motivated to lower their costs by buying EVs	8	7
Suburban railway (HÉV) vehicles will be replaced with new vehicles.	10	9	More Mobility Point will be implemented in different parts of the city.	7	9
Increase of the interconnected cycling network for bikes	9	3	The connection between the different networks will be better	9	8
The fuel prices will increase.	10	7	Urban and suburban timetables will be harmonized	8	8
Home office working possibility will increase in the future	9	7	Strengthening equal opportunities (accessible transport for disabled, passengers with rolling luggage etc.)	9	4
			Public transportation is going to be safe, no crime	8	9
			Public transportation is a reliable and predictable means of transportation.	10	4
			P+R car parks and B+R storage facilities will be built at every station of the suburban sections	10	8
			The state railway network (MÁV) will be included in urban transportation.	4	9
			Pedestrian connections in the inner city will be developed	8	7
			Improving the accessibility of Liszt Ferenc Airport	7	9
			Developing cycling tourism connections in the region	3	8
			The number of vehicles which is capable for carrying bikes are increasing	7	7
			Improvement of the mobile application	7	7

Driving Forces from FOCUS GROUP DISCUSSION	Importance (0-10)	Uncertainty (0-10)	Driving Forces From Motivations and Regulations	Importance (0-10)	Uncertainty (0-10)
			Service providers in Budapest will feel more responsible towards sustainable mobility	10	5
			The financing of public transportation will be more reliable and predictable	10	10
			The increase of the price and hours of parking in Budapest will results in less cars	9	5
			The number of cars on Budapest roads will decrease	10	10
			Road traffic will decrease	10	10
			The volume of traffic arriving from the agglomeration will increase	8	7
			The popularity of cycling to and from work in Budapest will grow	7	8
			Young people are trying new services in community economy (car-pooling, car renting, car sharing).	7	7
			Population will decrease in Budapest.	9	9

Source: created by the authors, own data collection

Table 2. Groups of driving forces

Group 1: political support	**Group 2: Socio-economic conditions**
Municipality will introduce a no car area in the city centre of Budapest	Metro lines will be expanded to cover more area of the city
Public transport system will be renewed by buying electric buses or by trams	The number of companies which provide using shared bike facilities will increase
Modernisation of public transport vehicles	People knowledge will increase to switch to a sustainable way of transport
Conventional buses will be phased out in the city centre of Budapest	Development of water transportation network
Metro lines will be expanded to cover more area of the city	Car sharing service is developing
The government will increase the incentives for buying EVs	The technology for electric vehicles will continue to advance in the future leading to a faster adoption of EVs
Government will increase the tax on conventional cars sales	The fuel prices will increase
Share of renewable energy resources will increase in the power grid supply	Home office working possibility will increase in the future
Government will increase the standard of pollution criteria of cars	The government will increase the incentives for buying EVs
Government will invest more on providing infrastructure for EVs (Charging spots)	The public transport ticket prices will lower for all-inclusive public transportation
More Mobility Point will be implemented in different parts of the city.	Share of renewable energy resources will increase in the power grid supply

Group 1: political support	Group 2: Socio-economic conditions
Connection between the different networks will be better	People will feel responsible to buy electric cars to harm the environment less
Urban and suburban timetables will be harmonized	People will be motivated to lower their costs by buying Evs
Public transportation is going to be safe, no crime	P+R car parks and B+R storage facilities will be built at every stations of the suburban sections
P+R car parks and B+R storage facilities will be built at every stations of the suburban sections	The number of public transportation vehicles which is capable for carrying bikes are increasing
Pedestrian connections in the inner city will be developed	The number of cars on Budapest roads will decrease
Improving the accessibility of Liszt Ferenc Airport	Road traffic will decrease
The number of vehicles which is capable for carrying bikes are increasing	The volume of traffic arriving from the agglomeration will increase
The financing of public transportation will be more reliable and predictable	The popularity of cycling to and from work in Budapest will grow
	Population will decrease in Budapest.
	Young people are trying new services in community economy (car-pooling, car renting, car sharing).
	By 2030 at least 30 million zero-emission vehicles will be in operation on European roads
	100 European cities will be climate neutral by 2030
	High-speed rail traffic will double in the EU by 2030
	Automated mobility will be deployed at large scale in the EU by 2030
	Zero-emission vessels will become ready for the EU market by 2030

Source: created by the authors, own data collection