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D.1.3.1 Local plan for the city of Pécs

Final version

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Abbreviations

AF	Application form
DRT	Demand-responsive transport
KPI	Key Performance Indicator
PT	Public transport

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1. Introduction

This document is a plan for development of public transport in city of Pécs, in line with the efforts of OPTI-UP project, developed in the framework of EU Interreg for Central Europe programme.

The Local Plan is derived from: Sustainable Urban Mobility Plan of Pécs (2017) and Comprehensive data report on existing public transport networks and best practices (D.1.1.1) and a survey about quality of local public transport.

This document facilitates the implementation, but also evaluation, of public transport planning as well as future pilot projects, OPTI-UP pilot project in Pécs being one of them.

Through collaboration with project associated partners (AP) and knowledge sharing with other stakeholders, this local plan aims to promote Pécs local and further local development objectives and to serve as a model for other European countries and for future cross-border cooperation.

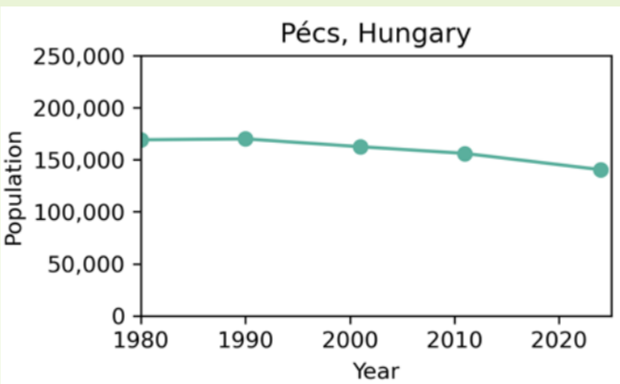
2. Background and Context

This chapter outlines the background and context in which the Local Plan operates. It summarizes the main findings from the territorial, demographic, and transport analyses—with a specific focus on public transport supply and usage—and provides a review of objectives set by higher-level policies and plans on mobility. Together, these results establish the knowledge base for the strategic choices developed in the following chapters.

2.1. Context overview

The information presented in this chapter constitutes a core set of baseline inputs relevant to the development of the Local Plan and derives from the in-depth analysis carried out by Opti-Up in Deliverable D.1.1.1.

Pécs is the fifth-largest city in Hungary and the economic and cultural centre of the Southern Transdanubia region. The city proper has a population of around 136,000, while the metropolitan area, including surrounding settlements, reaches approximately 150,000 residents.



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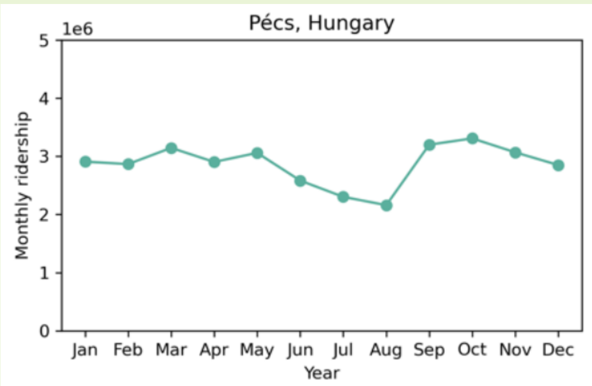
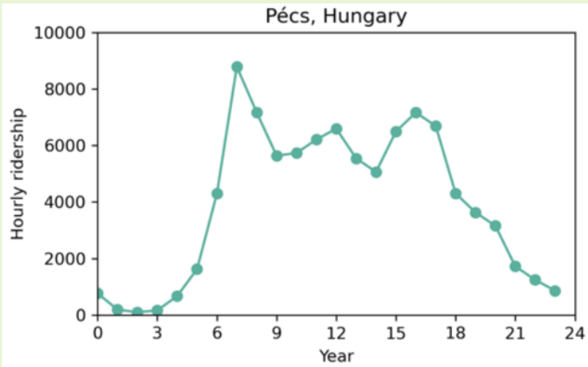
Pécs has experienced moderate population decline over the past three decades, particularly after the transition period of the early 1990s. By 2022, the population decreased by more than 15% compared to its peak in the 1980s. The city has an aging demographic structure, with approximately 30% of the population aged 60 or above, and its median age is higher than the national average. The population density is around 430 people per square kilometre.

Historically, Pécs operated a tram system between 1913 and 1960. The horse-drawn tram service began in 1897 and was electrified in 1913. However, due to rising operational costs and urban development priorities, tram services were phased out and replaced by an expanding bus network. Today, the city relies exclusively on bus-based public transport.

Public transport in Pécs is provided by Tüke Busz Zrt., a municipally owned company. As of 2024, the active fleet includes approximately **202 buses, comprising both diesel and electric vehicles.** The electric fleet consists of 18 buses: 10 BYD eBus (K9UB) models introduced in 2020, and 8 Mercedes-Benz eCitaro buses added in 2023. These electric buses account for about 9% of the total fleet and are part of the city's commitment to sustainable and environmentally friendly public transportation.

The PT network in Pécs encompasses 92 daytime bus lines, including regular urban routes, suburban services, and night lines. On school days, including night services, there are approximately 1,800 scheduled departures, covering around 20,000 kilometres daily. The network is organized around four main bus stations, facilitating efficient coverage across the city and its outskirts.





The yearly ridership generally hovers around 3 million in the first half of the year, with a noticeable dip during the summer months of July and August, falling to just over 2 million. There's a significant rebound in ridership in September and October, reaching the year's peak before slightly decreasing towards the end of the year. This pattern reflects typical seasonal variations influenced by factors such as school holidays and tourism.

The daily ridership is very low in the early morning hours, sharply increasing to a significant morning peak around 7 AM, reaching nearly 9,000 riders. After this morning rush, ridership fluctuates but remains elevated throughout the day, showing a second, albeit smaller, peak in the late afternoon around 4 PM to 5 PM, before steadily declining into the late evening and night.

2.2. National and regional mobility Plans goals

The goals and measures defined within a local public transport plan should not be developed in isolation. Instead, they must align with the broader strategic objectives established at European, national, regional, and local levels. For small and medium-sized cities, this alignment is especially important: it ensures consistency with overarching policy directions, facilitates access to funding and technical support, and enhances the strategic coherence of local actions.

A comprehensive understanding of these higher-level frameworks allows cities to build their local strategies on a robust foundation, ensuring that local choices actively contribute to shared goals such as climate neutrality, improved public health, digitalization, and social equity in transport systems.

In Hungary, there is a national development plan, called **2030 National Development and Regional Development Concept**, which focuses on mobility issues.

The main goal of the concept is to create a transport structure that promotes social mobility and quick and easy access to different territorial levels, creating a dynamic regional network, through which all services become available to both the narrower and wider environment of a settlement or region.

Areas of intervention at the regional level is ensuring the accessibility of employment centres, at the national level is resolving centralization and strengthening transversal connections.

National Transport Infrastructure Development Strategy (2014)

Hungary's transport structure is shaped by two key industrial axes: the automotive axis in the west and the heavy and chemical industry axis in the east. Nationwide, around 2.5 million intercity trips occur daily, 95% of which are related to commuting. Local and suburban transport dominate travel patterns, mainly using motorized transport, with buses and railways leading intercity passenger traffic.

Compared internationally, Hungary maintains a balanced ratio between public and private transport, unlike Western Europe, where car use prevails. Within public transport, buses outperform rail threefold, though rail remains stronger for long-distance travel.

Mobility-related objectives

Transport policy emphasizes environmental protection, climate goals, and sustainable energy use, ensuring infrastructure development respects natural landscapes and biodiversity.

Economic aims include enhancing efficiency, productivity, and employment, particularly by improving rural mobility and reducing regional disparities.

Social goals focus on accessible, sustainable mobility for all, contributing to overall well-being.

Strategic priorities involve optimizing the transport structure, promoting resource-efficient and sustainable modes such as walking and cycling, and improving service quality and infrastructure to ensure long-term transport sustainability.

Baranya County Regional Development Concept

The regional development of Baranya County is strongly shaped by its fragmented geographical structure and the dominant role of the Mecsek Hills, which separates the northern and central areas of the county. This topography creates physical barriers to east-west transport and limits internal accessibility, particularly in rural and peripheral areas. Development has traditionally been concentrated in the southern axis along the Pécs–Mohács line, where better infrastructure and economic activity are present. However, significant disparities remain between urban and rural districts.

Transport infrastructure in Baranya faces multiple challenges. While the M6 motorway and main road 6 provide north-south connectivity with Budapest and Pécs, east-west connections are underdeveloped, and local roads are often in poor condition. The lack of a functional M9 expressway segment through the county limits transversal accessibility and integration with the national network. Several rural areas are still poorly connected by public transport, and road maintenance backlogs further hinder mobility.

Past developments—such as the extension of the M6 and improvements to road 58—have increased regional accessibility, but these investments have primarily benefitted urban centres, leaving disadvantaged districts relatively isolated. In addition, the absence of a comprehensive intermodal transport strategy reduces the efficiency and sustainability of mobility solutions in the county.

Mobility-related objective

Baranya County's mobility strategy emphasizes the promotion of sustainable and inclusive transport modes. Priorities include modernizing public transport services, supporting the use of low-emission buses, expanding the electric vehicle charging network, and improving cycling infrastructure. The county seeks to reduce car dependency by enhancing rural bus services and increasing access to mobility hubs and park-and-ride facilities.

Key infrastructure objectives include completing the missing sections of the M9 expressway, improving road links between small settlements and urban centres, and refurbishing existing transport infrastructure. These measures aim to reduce spatial disparities, support economic development, and enable greener transport alternatives.

The transport-related social goals of the county focus on reducing emissions, promoting climate-friendly solutions, and enhancing accessibility for vulnerable groups. The strategy supports the introduction of electric buses in urban and peri-urban areas, with a long-term vision of creating a more integrated, resilient, and environmentally conscious mobility system.

2.3. Results of survey

The goal of the survey is to find out what the current level of citizen satisfaction is, considering various aspects, such as the coverage of the transportation system relative to the city, reliability of schedules, vehicle capacity, and cleanliness, and what can be improved. Users' input can serve Transportation operators as well as the Public Administration or Municipalities, Regions that manage public transportation, as a basis for future improvements and to create a public transportation system that is more efficient, comfortable, accessible for all, and takes into account the real needs of citizens.

The survey was conducted in May 2025 using Google Forms. It was distributed through the social media platforms of STRIA and Tüke Busz. The target group consisted of people using public transportation in Pécs. A total of 314 individuals completed the questionnaire.

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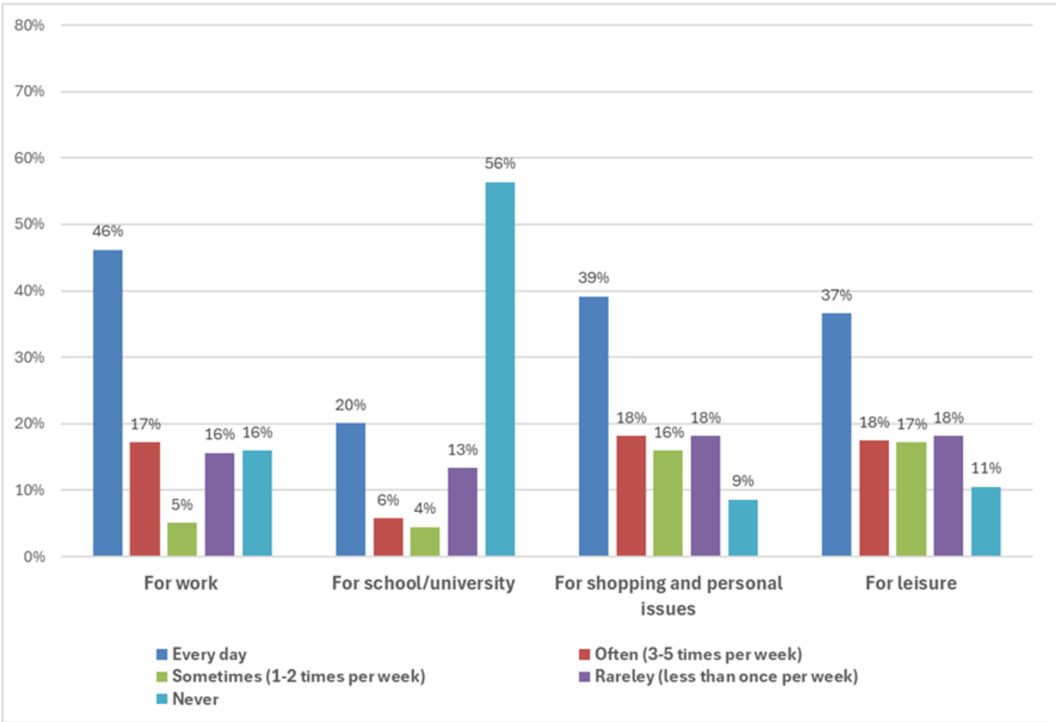
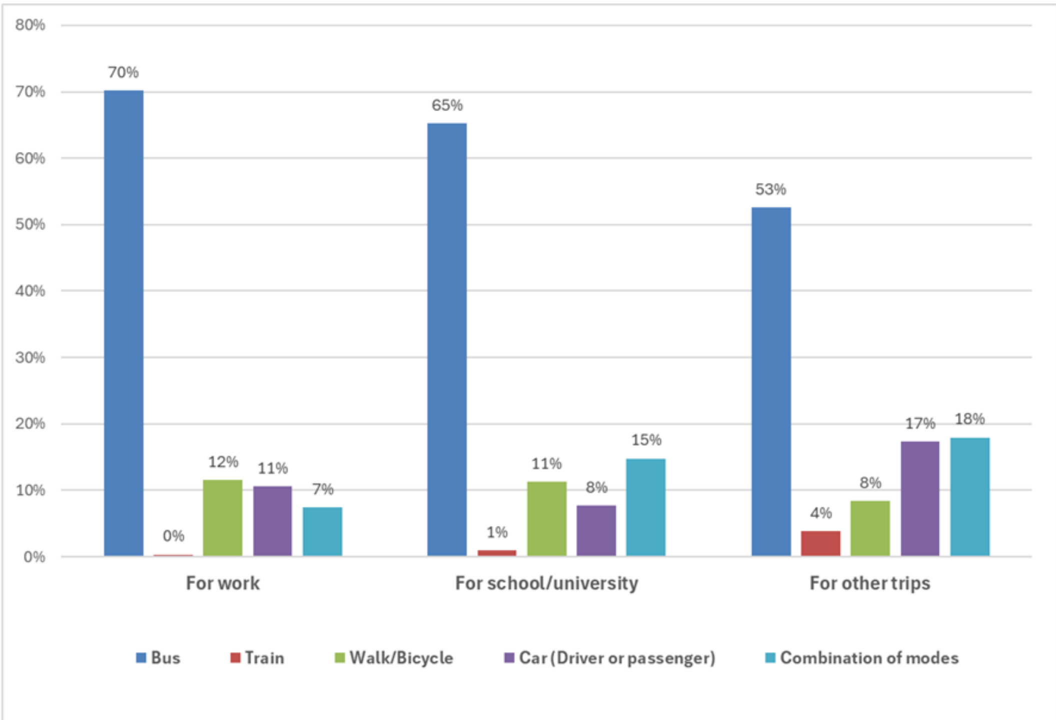
How often do you use the Public Transport?	
Which mode of transport do you use most often?	

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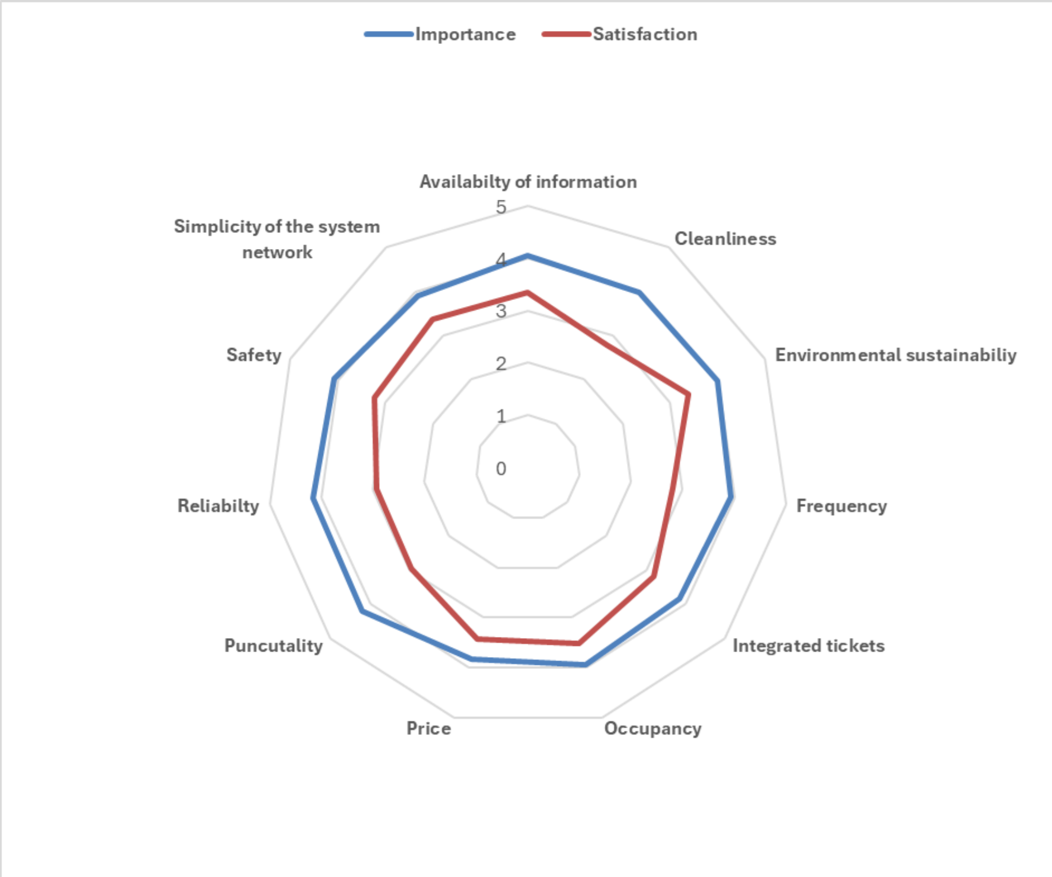
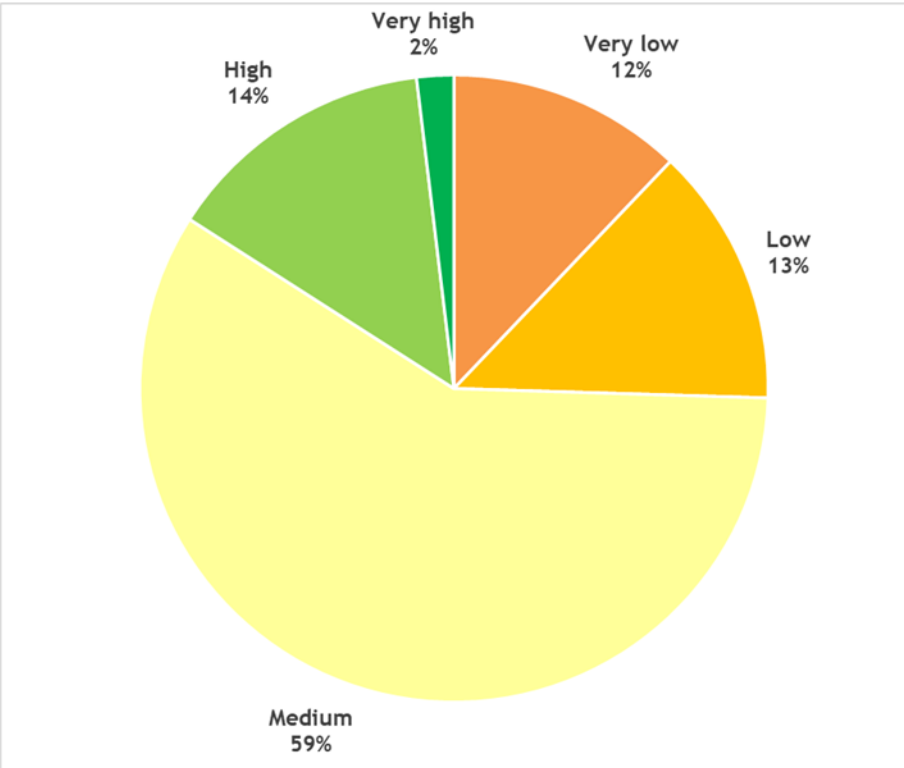
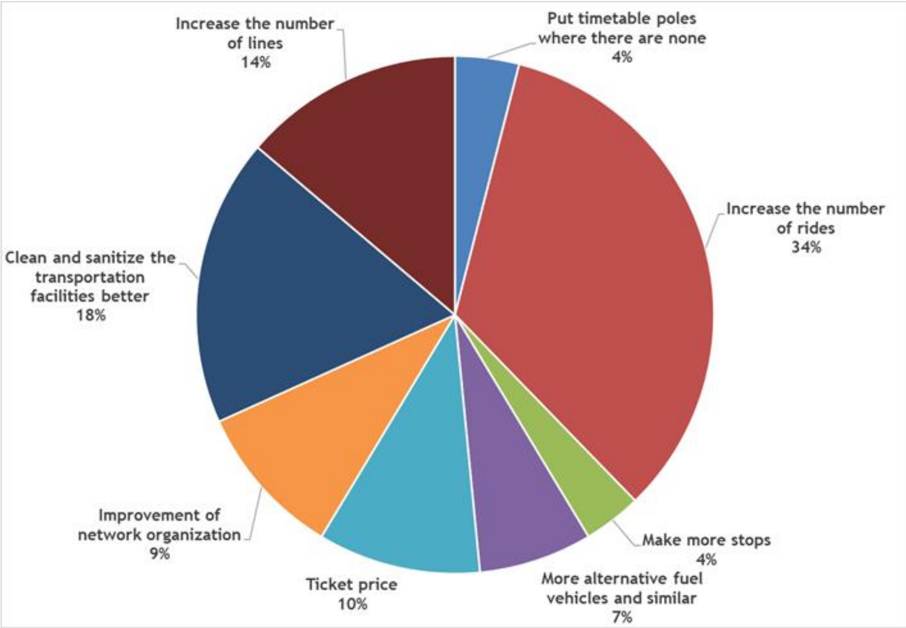
Grade the satisfaction and the importance of the following characteristics about the public transport. [Grades from 1= very low to 5= very high]	
Rate your satisfaction with the public transportation you use most frequently?	

What would you suggest improving the public transport? (max 3) *	
What improvements would you suggest that were not mentioned in the previous question?	Punctuation should be better, stations should be safer and friendlier Night services Improve frequency, because it is terrible during the weekend Speed More realistic travel time, then the punctuality will be better

The survey results indicate diverse patterns in the use of public transport depending on the purpose of travel:

Most respondents use public transport daily for work (47%), followed by shopping/personal issues (39%) and leisure (37%). In contrast, school/university trips show a high rate of non-users (56%). “Rarely” and “often” responses remain relatively balanced across non-work purposes. Public transport is clearly most essential for commuting to work, while other uses are more varied.

In terms of preferred modes of transport:

Bus is the dominant transport mode across all trip purposes—used by 70% for work, 65% for school/university, and 52% for other trips. Alternatives like walking/biking and car use remain secondary, while train use is minimal. For other trips, multimodal travel and car use become more common, each accounting for around 18%. The data clearly shows that public buses are the primary transport choice, especially for commuting.

About the characteristics of the public transport system:

The biggest gaps between importance and satisfaction of the present situation are related to Cleanliness, Frequency, Reliability and Punctuality. Theses should suggest the priority for future improvements.

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Most of the other characteristics show a very close satisfaction compared to the importance for users. Currently the state of Price, Occupancy, Environmental Sustainability and Simplicity of the network are the closest to users' expectations.

About the rating of satisfaction: The largest portion of the chart, a dominant 59%, indicates a "Medium" level of satisfaction, suggesting that most users experience a service that meets basic expectations but doesn't necessarily exceed them. Conversely, highly satisfied users (those rating "High" or "Very high") collectively account for a modest 16% (14% "High" and 2% "Very high"). On the other end of the spectrum, a quarter of the respondents, 25%, reported dissatisfaction, with 13% indicating "Low" satisfaction and 12% feeling "Very low" satisfaction. This distribution highlights a substantial opportunity for service improvement to elevate the overall user experience and reduce the proportion of dissatisfied commuters.

3. SWOT and Best Practice Analysis

The following chapter is structured in two parts: the first regarding the SWOT Analysis and the second one regarding the selection of Best Practices that could be useful for the Local Plan and Pilot Action.

3.1. SWOT Analysis

The SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats) is a strategic tool that helps small and medium-sized cities assess their current public transport landscape and develop a forward-looking plan for improvement. This methodology enables the city of Pécs to systematically evaluate its transport systems from economic, environmental, and social perspectives, ensuring a balanced and sustainable approach to future development. The analysis incorporates and summarizes all findings from the previous qualitative and quantitative work and is enhanced by engagement with stakeholders.

Table 1: SWOT definition

Strengths	What is currently working well in your LPT system, or what characteristics of your city support a good LPT service?
Weaknesses	What is NOT working well in your LPT system, or what characteristics of your city make it difficult to provide a good LPT service?
Opportunities	Are there any future developments in your city (not necessarily related to transport) that could improve the LPT service?
Threats	Are there any future developments in your city that could negatively impact the LPT service?

Strengths (S)
Frequent bus services between the city centre and housing estates.
Night services are operated from the city centre to the most populated areas of the city.
About 90% of buses are low floor vehicles.
Local government is committed to providing good public transport
There are direct connections from the outskirt areas to the city centre.
Weaknesses (W)
Limited financial resources to expand or improve services.
Lower ridership levels make it harder to sustain frequent services.
Poor integration with regional or long-distance transport networks.

Fragmented transport network.
A major bus service on the east-west axis is run on a busy arterial road, causing heavy congestions during peak hours.
Opportunities (O)
Introduction of eco-friendly solutions (Increasing the number of electric buses).
Government or EU funding for sustainable mobility initiatives.
Collaboration with local businesses to support public transport use.
Government or EU funding for sustainable mobility initiatives.
Development of smart mobility apps for real-time information and route optimization.
Threats (T)
Rising operational costs (fuel, maintenance, wages).
Insufficient number of bus drivers will be available.
The old buses are in poor technical condition.
Due to the low frequency of rides, there is a risk that existing passengers switch to other transport modes (e.g to private transport)
Economic downturns that could reduce public funding.

3.2. Best Practices

In this section, a selection of best practices is presented. They are the most valuable insights can be drawn in relation to the pilot action planned for this project.

Table 2: Best Practices

Best Practice	City	Relevance to Actions
Citizen-oriented planning of public transport system in Rezekne city	**Rezekne, Latvia**	**public transport network and route optimisation, alternative fuel**
Car sharing of Electric City Cras	**Jyvaskyla, Finland**	**alternative fuel**
Development of public transport	**Győr, Hungary**	**new buses, eco-friendly new transport options, involvement of citizens**

by purchasing electric buses in Győr and its economic zone		
New public transport lines	Pula, Croatia	direct consultation with users and the city, collaborative approach between the municipal administration and public transport operators, tailoring public transport services to community needs, clear communication using informative flyers

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4. Vision and Goals

The vision represents the overarching, long-term aspiration for the evolution of the local transport system. It provides a unifying direction that guides decision-making and serves as a reference point for all subsequent planning choices. Defining a clear and shared vision helps ensure coherence in the strategy, aligning individual measures with a broader transformative goal.

The goals translate this vision into concrete ambitions, outlining what the local public transport plan aims to achieve through its intervention measures. These goals encompass mobility, social, economic, and environmental aspects. The integration of goals referring to different dimensions is a crucial moment in the planning process, as it is often necessary to pursue conflicting goals simultaneously.

In this chapter the city of Pécs lists its vision and goals based on:

- The results of the SWOT Analysis
- The results of the survey on LPT
- The political view

4.1. Vision

Our vision is that the city's public transport is sustainable and environmentally friendly, contributing to a more liveable city. We strive to ensure that city citizens recognise the benefits of public transport as an environmentally friendly and affordable option for their travel. Increased use of electric buses can contribute to this.

4.2. Goals

The following Goals are related to at least one of the four main dimensions:

- Mobility
- Economic
- Social
- Environmental

Table 3: List and descriptions of Local Plan’s Goals

Goal	Description
G1: Reducing of operational costs of PT **(Economic)**	Operating costs can be reduced if electric buses run more kilometres, and if the charging of the buses is managed by software, the use of electricity could be more economical.
G2: Increasing the average range per electric vehicle per charge	By increasing the mileage of electric buses on a single charge, they can cover more kilometres because they take less time to charge.

(Economic/Mobility)	
G3: Increasing the share of mileage of zero emission vehicles **(Mobility/Environmental)**	By increasing the mileage of electric buses, we can reduce operating costs, and green buses contribute to cleaner urban air.
G4: Improve the accessibility and connectivity of local public transport **(Mobility/Social)**	Extension and new bus stops on the bus network, increasing frequency of PT lines
G5: Increase the number of public transport passengers **(Mobility)**	Increase of number of passengers by better PT frequency, better harmonisation of services and optimisation of lines network

4.3. Goals coherence analysis

The local objectives selected in this section must be consistent with the objectives defined at European level, as well as with national/regional objectives. The following table shows a verification of the consistency of the Local Plan objectives and indicates the level of consistency according to the following scale:

■ ■	Strong Coherence
■	Coherence
□	Weak coherence

Local Plan's Goal	European Strategies Priority	National Strategies on mobility and transport	National Strategies on Energy/Environment	Regional/Local Strategies on mobility and transport	Regional/Local Strategies on Energy/Environment

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Reducing of operational costs of PT (Economic)	Priority 1	□	□	■	■
Increasing the average range per electric vehicle per charge (Mobility)	Priority 1	□	□	■	■
Increasing the share of mileage of zero emission vehicles (Mobility/Environmental)	Priority 1	■ ■	■ ■	■ ■	■ ■
Improve the accessibility and connectivity of local public transport (Mobility/Social)	Priority 1	■ ■	■ ■	■ ■	■ ■
Increase the number of public transport passengers (Mobility)	Priority 1 and 2	■ ■	■ ■	■ ■	■ ■

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5. Actions

This chapter introduces the first structured outline of possible actions that the city of Pécs may undertake to achieve its vision and goals. These actions are grounded in the results of the SWOT analysis and developed through participatory dialogue involving technical experts, political representatives, citizens, and relevant stakeholders.

At this stage, the actions are presented in a general and strategic form. They represent a preliminary list of intervention measures that address identified needs and opportunities and reflect the city's ambitions in improving its public transport system.

However, these proposed actions are not final. They will undergo a validation process through scenario-based assessments and modelling tools. This process will help refine the actions, add technical and financial detail, and establish a hierarchy of priorities based on impact, feasibility, and consistency with the overall strategy. In this way, the initial list becomes a foundation for informed decision-making in the subsequent phases of the plan.

Table 4: List of actions

Action	Brief description	Goal
To increase the milage of electric buses	Increase the mileage of electric buses, reducing costs and CO_2 emissions (according to the City Local Plan)	G1, G2
To analyse the costs of public transport and to reduce them	Analyse the costs, optimize them	G1, G3
Marketing campaign to boost ridership	Launch a public awareness campaign emphasizing benefits of public transport.	G4
Promote digitalisation and smart mobility	Give better information through the use of smartphone apps and improve integration of different means of transport introducing sharing mobility	G4
Introduce new bus lines in underserved areas	Connection between underserved or no-served areas and the high-frequency bus corridor	G5

5.1. Actions and Traffic Models Scenarios

The use of transport and land use models support evidence-based decision-making and guide the prioritization of interventions. This methodology incorporates—specifically, the classic four-step transport model (e.g. VISUM) and land use-transport interaction (LUTI) models. These tools could allow the city of Pécs to move beyond static, prescriptive planning toward a dynamic, scenario-based approach aligned with European best practices and Sustainable Urban Mobility Plan (SUMP) guidelines.

By simulating future mobility and land use conditions under varying assumptions, models enable local decision makers to assess the likely impacts of different policies or actions—such as new transit lines, fare adjustments, or urban development strategies—on accessibility, modal shift, environmental outcomes, and social equity.

Data collection is progress for the LUTI model and scenario development can then begin.

Table 5: List of actions and models scenario results

Action	Description of model results
ST1: Develop a new bus line	Connecting one of the head stations with no-served area
ST2: Modify frequency	Alternative timetable for all buses during peak period
ST3: Alternative route for the new bus line	Pilot action line will get a new route to reach more people
LT1: Development of inhabitants	See what happens if the number of inhabitants increases in some developing zones
LT2: Reduce PT tickets prices	See what happens to modal split
LT3: Combination of increase in price and frequency	Price increases by 5%, Frequency increases by 10% and see what happens to modal split

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5.2. Overview of scenarios in PTV Lines and LUTI

The short-term scenario development for public transport of Pécs was based on modelling with PTV Lines and LUTI, integrating both operational feasibility and potential passenger impacts. The focus was on measures that could realistically be implemented within a shorter timeframe while responding to local needs and existing mobility challenges.

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Three scenarios were selected for analysis:

Pilot action: new bus line – the introduction of a completely new line, coordinated with the bus operator and starting from 1 October for a two-month test period. The line will connect one of the terminal stations with the depot where electric buses are charged, while at the same time extending public transport coverage to areas currently not served by buses. Both the route and the timetable have already been defined. This pilot aims to test operational feasibility, assess demand in newly served areas, and contribute to improving the energy efficiency of electric buses.

Modification of frequency – during the morning peak period (6-8 a.m.), bus intervals on the nine busiest lines will be reduced from the current 15–20 minutes to 8–10 minutes. This scenario focuses on better aligning capacity with demand, minimising overcrowding, and improving service reliability during critical hours. This measure aims to decrease waiting times and improve the overall quality of service. The analysis focuses on the performance changes and resource implications resulting from this adjustment.

Alternative route for the new bus line – examination of the pilot action with an alternative routing. The focus is on testing how the new line would perform if operated on a different alignment, with additional stops and coverage of other neighbourhoods, and analysing the results of such a variation.

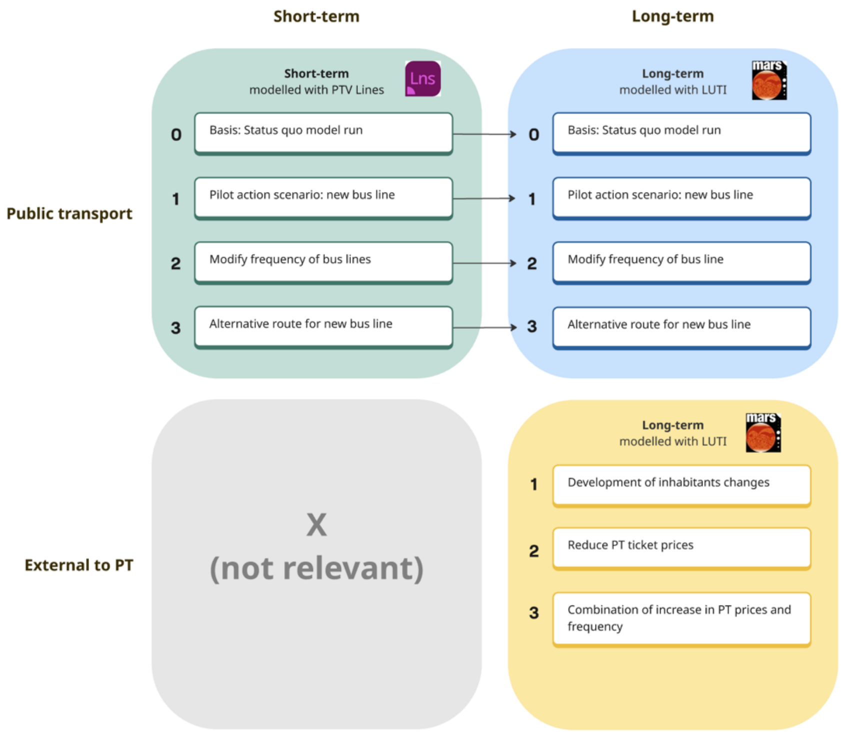

Figure 1: Scenario identification

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5.3. PTV Lines model of short-term scenarios

The short-term scenario development for public transport in Pécs focused on realistic measures that could be implemented quickly while addressing local mobility challenges. Three scenarios were modelled and their results are shared below:

- Section 6.2.1 presents the simulation results of adding a new bus line, which is also the Pilot Action to be taken in Pécs: during a two-month trial from 1 October, a new route will be introduced connecting a terminal station with the electric bus depot and serving areas currently without public transport, aiming to test feasibility, demand, and energy efficiency.
- Section 6.2.2 presents the results of modifying PT service frequency – reducing headways on the nine busiest lines from 15–20 to 8–10 minutes during the morning peak. The aim is to improve service quality while analysing performance and resource impacts.
- Section 6.2.3 focuses on assessing the outcomes an alternative route of the new line in Section 6.2.1. The new alignment has additional stops and coverage of other neighbourhoods.

These scenarios provide a practical framework for evaluating improvements in coverage, efficiency, and service quality within a short timeframe.

5.3.1. Scenario ST1 – New bus line (pilot action scenario)

As part of the pilot action, a completely new bus line (Number 90) will be introduced, operated with 100% electric buses in cooperation with the bus operator. The line will run on weekdays only, from October 1 to November 30, 2025, with eight trips per day. The route follows: Fagyöngy Street – Illyés Gyula Street – Nagy Imre Road – Aidinger János Road – Málomi Road – Táncsics Mihály Road – Siklósi Road – Diófa Street – Légszeszgyár Street – Tüskésréti Road, as shown in Figure 2(a). The buses complete the 7 kilometres route in approximately 17 minutes per trip.

The new line has a dual purpose: firstly, to extend public transport coverage to areas not previously served by buses, and secondly, to provide a connection between the terminal station and the depot where the electric buses are charged. The buses are equipped with passenger counting devices, allowing continuous monitoring of ridership at the new stops and tracking the usage of the service.

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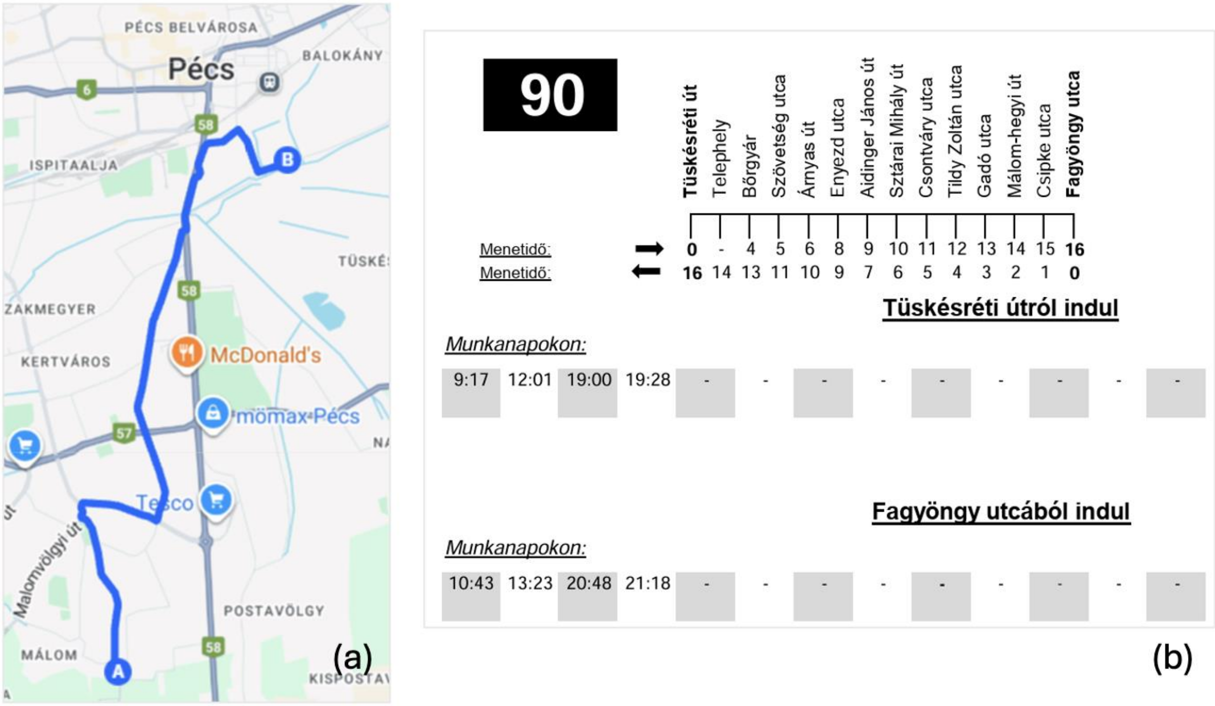

Figure 2: Route of the new line, bus 90. (a) Visualization of the Map; (b) Timetable of the new line

The new test route was modelled in the PTV Lines software, and the necessary data was recorded in the program (Figure 3). We recorded the new route, the stops, the departure times, and the travel times between stops. Several metrics are extracted from the software, which can be used to determine various performance indicators for the new line.

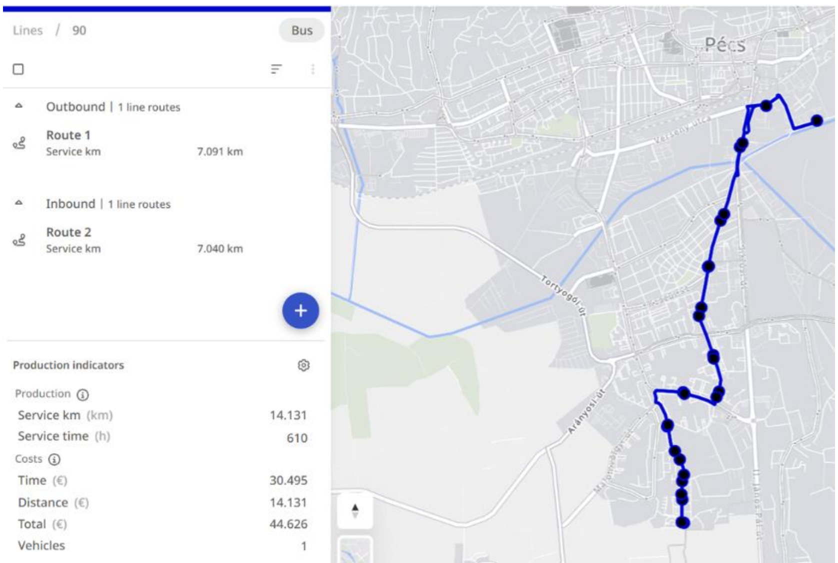

Figure 3: Screenshot from PTV Lines – new line, bus 90

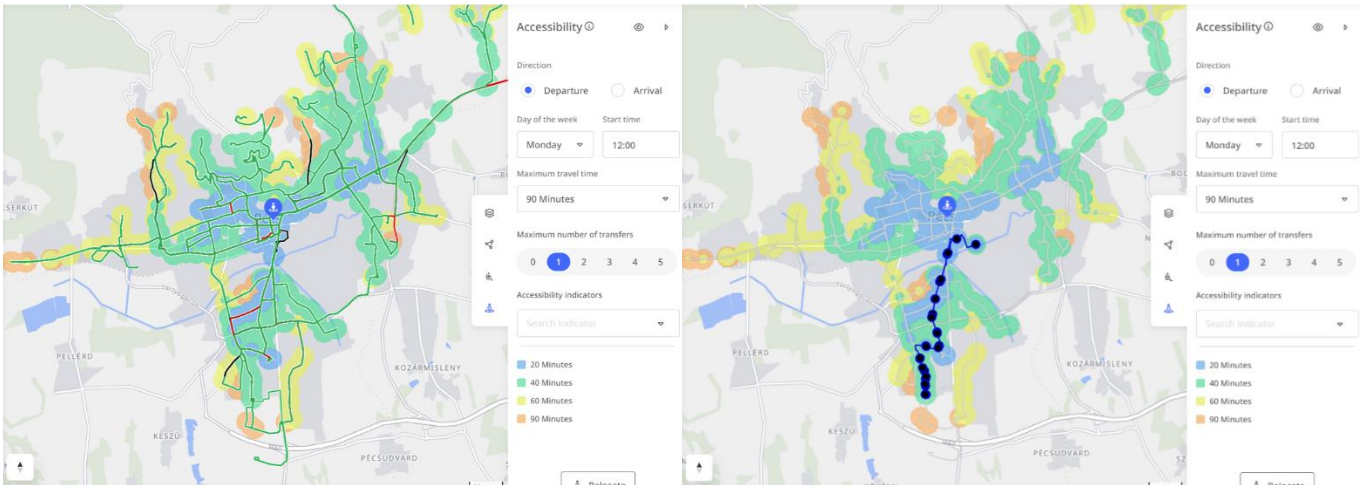

Figure 4: Before-after accessibility map computed using PTV Lines.

The buses run 14,131 kilometres per year, with a service time of 610 hours. The cost of Line 90 is €44,626. As we can see on the accessibility map in Figure 6.4, the northern end of the new line. (around the terminus on Tüskésréti út area), is connected to the city's public transport system. As a result, many locations in the city centre (blue shaded areas) can be reached from the city centre with one transfer.

Figure 6.1 provides further details about the fleet size, operation and emission statistics associated with the new line. Since the existing lines run by traditional fuel vehicles are not replaced, the total emissions are not estimated to decrease. The benefit of the new line rather lies in the improved accessibility of the city.

Table 6: Comparisons of the adding the new electric bus with the base scenario

		Base scenario		ST1: new bus line	
		Line 90	Total	Line 90	Total
Fleet (number)	Diesel	0	139	0	139
	CNG	0	0	0	0
	Electric	0	18	1	18
Number of daily departures		**0**	**1,825**	**8**	**1,833**
Number of daily bus operation kilometres		0	20,253.7	56	20,309.7
Emissions (kg/year)	CO_2		5,797,820	2,386	5,800,206
	NO_x		34,841		34,841
	PM		511		511
	SO_2		43		43

	CO		12,859		12,859

5.3.2. Scenario ST2 - Modification of frequency

This scenario focuses on adjusting bus frequencies during the morning peak hours (6–8 a.m.) on the busiest lines. Specifically, the headways of lines 1, 2, 2A, 3, 103, 4Y, 6, 7, 8, and 55 have been modified for modelling, as shown in Table 7. These lines typically operate at intervals of 10, 15, or 20 minutes, often alternating or overlapping with other lines to provide dense service.

By reducing the intervals and increasing the number of departures, buses will run more frequently during the critical morning period, improving service quality. These buses operate along the city's main transport corridors, connecting large residential areas with the city centre, with each other, or with the university district. The measure aims to better match capacity with demand, minimize overcrowding, and improve service reliability, while shortening waiting times and enhancing the overall quality of public transport during peak hours.

Table 7: New frequency of selected lines tested in the simulation

Line number	Direction	From - To	New frequency (min)
1	one route	6:40 - 7:30	8
2	to Mecsekszabolcs	6:25 - 7:45	10
2	to Uránváros	7:07 - 8:27	10
3	one route	6:12 - 7:42	15
103	to Klinikák	6:20 - 7:50	15
103	to Kertváros	6:54 - 8:24	15
4Y	to Újhegy	6:33 - 7:37	15
4Y	to Uránváros	6:58 - 7:58	15
6	to Kertváros	6:32 - 7:32	15
7	to Malomvölgyi út	6:45 - 7:45	15
7	to Főpályaudvar	6:51 - 7:51	15
8	to Fagyöngy utca	6:26 - 7:44	15
55	one route	6:22 - 7:21	15

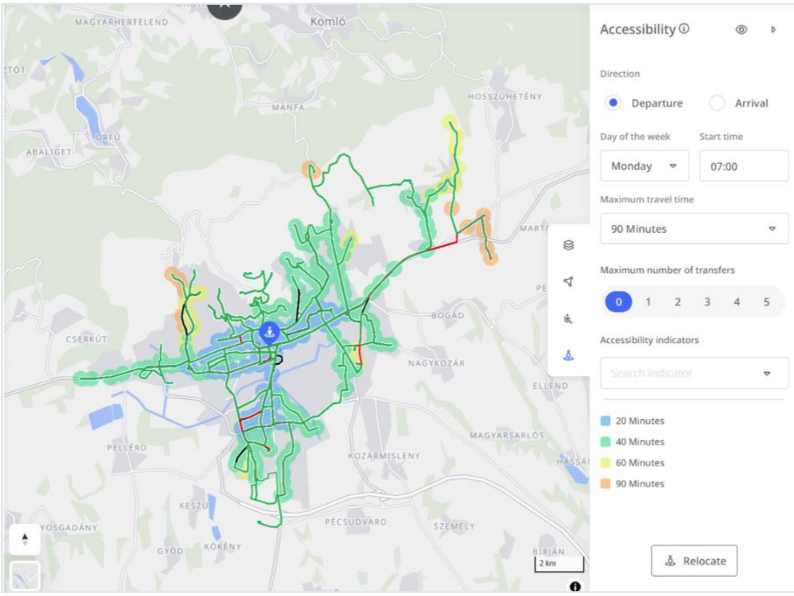

Figure 5: Screenshot from PTV Lines – accessibility after increase the frequency of selected lines

The analysis of performance indicators for Scenario 2 shows a clear increase in operational activity compared to the base situation (Table 8). The total service distance reached 6,698,952 kilometres per year, representing an increase of 112,247 kilometres. Similarly, the service time rose to 303,399 hours per year, which is 5,380 hours more than in the baseline scenario. These figures indicate a higher service intensity and a broader operational coverage.

In parallel with the increase in service supply, the total operating costs also rose. The overall expenditure reached €21,868,923, marking an increase of €381,268. The number of vehicles deployed grew by 38, resulting in a total of 256 buses in operation. However, this number is considered unrealistic, as currently only 102 buses are in operation under the regular timetable. This suggests that the simulation assumes a higher fleet demand than what would actually be needed in practice, indicating a limitation of the model rather than a real operational requirement.

Overall, the data confirm that Scenario 2 results in a significant improvement in the availability and quality of public transport. Although the operational costs are higher, the more frequent service reduces waiting times, alleviates overcrowding, and enhances passenger satisfaction. The increased service coverage contributes to a more reliable and accessible public transport system, supporting the city's sustainable mobility goals.

Table 8: Comparisons of increasing the service frequency of selected lines with the base scenario

		Base scenario	ST2
Fleet (number)	Diesel	139	139
	CNG	0	0
	Electric	18	56
Number of daily departures		1,825	1,851
Number of daily bus operation kilometres		20,253.7	20,702.7

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Yearly operating cost (EUR)		21,487,655	21,868,923
Emissions (kg/year)	CO_2	5,797,820	5,816,947
	NO_x	34,841	34,841
	PM	511	511
	SO_2	43	43
	CO	12,859	12,859

5.3.3. Scenario ST3 -- Alternative route of the Pilot Action line

This scenario examines an alternative routing for the new bus line, designed to bypass the largest residential estate from the northern side. Unlike the original route, it does not follow the fastest path to the city centre, but instead passes several commercial facilities along the main road.

The alternative route is shown in Figure 6.6 (a) and follows: Fagyöngy Street – Illyés Gyula Street – Nagy Imre Road - Maléter Pál Road - Siklósi Road - Diófa Street - Légszeszgyár Street - Tüskésréti Road, covering a total distance of 6.8 kilometres. The timetable remains unchanged from the pilot route described in Section 6.2.1.

This scenario was also modelled using PTV Lines software, with the main purpose to analyse how the line performs when serving different areas, including the potential impact on ridership at commercial stops and overall connectivity for residents. The results will help evaluate whether such an alternative alignment could complement or improve the service coverage of the new bus line. A visualization of the accessibility of adding the new line is given in Figure 6 (c).

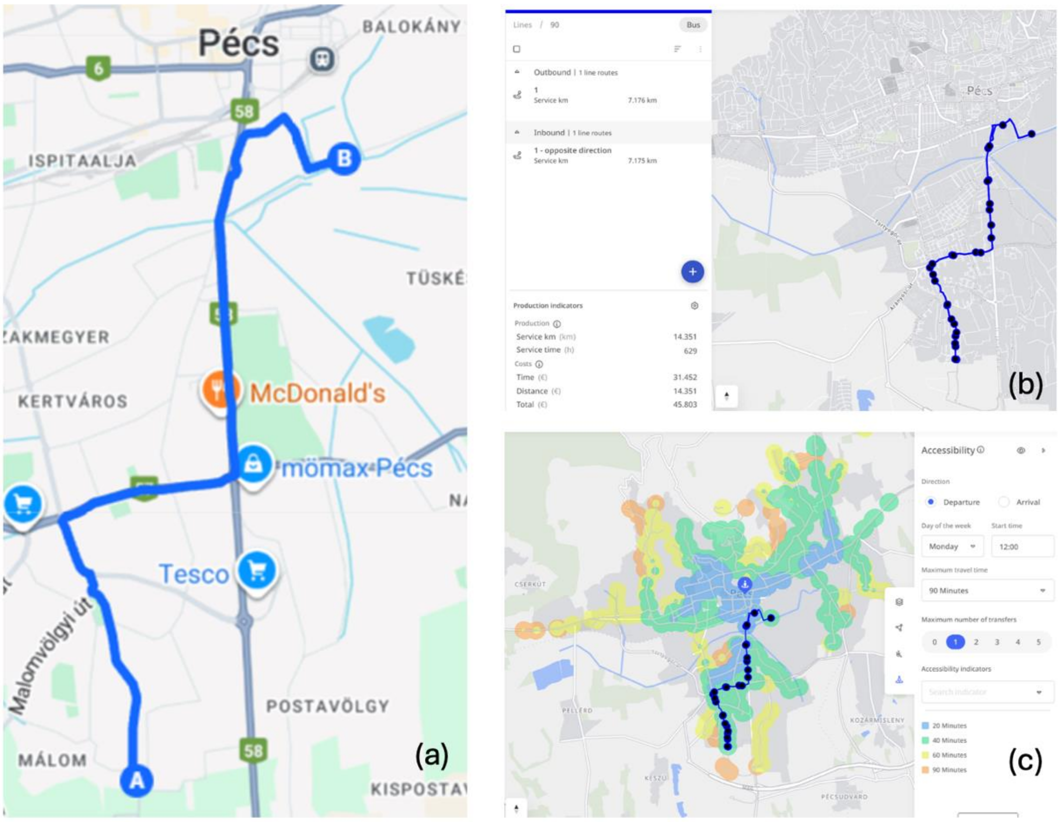

Figure 6: Scenario ST3: (a) Route of the modified line; (b) Screenshot from PTV Lines – modified line, bus 90; (c) Accessibility map calculated from PTV Lines

This modified route is only 100 meters longer than the route examined in the pilot scenario in Section 6.2.1, but there is still a significant difference in annual costs. The buses run 14,351 kilometres per year, with a service time of 629 hours. The cost of Line 90 is €45,803.

Table 9: Comparisons of increasing the service frequency of selected lines with the base scenario

Indicator		Base scenario		ST1: new bus line		ST3: modified route	
		Line 90	Total	Line 90	Total	Line 90	Total
Fleet (number)	Diesel	0	139	0	139	0	139
	CNG	0	0	0	0	0	0
	Electric	0	18	1	18	1	18
Number of daily departures		0	1825	8	1,833	8	1833
Number of daily bus operation kilometres		0	20253,7	56	20,309.7	56,8	20,310.5

Annual operation cost (EUR)				44,626		45,803	
Emissions (kg/year)	CO_2		5 797 820	2,386	5,800,206	2 420	5 797 820
	NO_x		34 841		34,841		34 841
	PM		511		511		511
	SO_2		43		43		43
	CO		12 859		12,859		12 859

5.4. LUTI model of long-term scenarios

5.4.1. LUTI Scenario ST1, ST2 and ST3 - PT improvements

The bus and public transport optimization scenarios described above were also simulated in the LUTI model MARS to assess their long-term impacts. The resulting changes in mode share and passenger-kilometres are presented in Table 10. Overall, the results indicate only minor effects on city-wide transport indicators. A noticeable modal shift appears only in Scenario ST2, where bus trips increase by 0.3 percentage points (p.p.), while all other modes show a slight decline. Interestingly, despite the rise in bus trips, total passenger-kilometres for buses decrease, suggesting that passengers may be opting for shorter journeys.

Table 10: MARS results of ST1-ST3

Indicator	Base scenario	ST 1	ST 2	ST 3
Mode split at 2040				
Walking	15.1%	15.1%	14.9%	15.1%
Cycling	4.2%	4.2%	4.1%	4.2%
Bus	36.5%	36.5%	36.8%	36.5%
Car	44.3%	44.3%	44.1%	44.3%
Passenger-kilometre in 2040 (in thousands)				
Walking	20.56	20.56	20.19	20.56
Cycling	982.96	983.22	987.25	983.22
Bus	864.86	864.85	857.69	864.85
Car	33.94	33.94	33.41	33.94
Daily passenger counts at 2040				
Walking	61,556	61,554	60,625	61,554

Cycling	16,967	16,966	16,642	16,966
Bus	149,095	149,119	149,565	149,119
Car	180,734	180,731	179,232	180,731

5.4.2. LUTI Scenario LT1 - Development of inhabitants

Scenario LT1 reflects a different population development than the base scenario. Based on estimates provided by colleagues from Pécs, population is expected to be between 2% and 5% higher than in the base scenario BAU in several central zones, as illustrated in Figure 7. Although the city's overall population continues to decline at an average rate of 0.5% per year, these zones start from a higher population level in the initial timestep. Overall, the population is 2.9% larger in scenario LT1 than in BAU. To maintain consistency with the land use component of the MARS model, these population estimates were incorporated at the initial stage of the simulation.

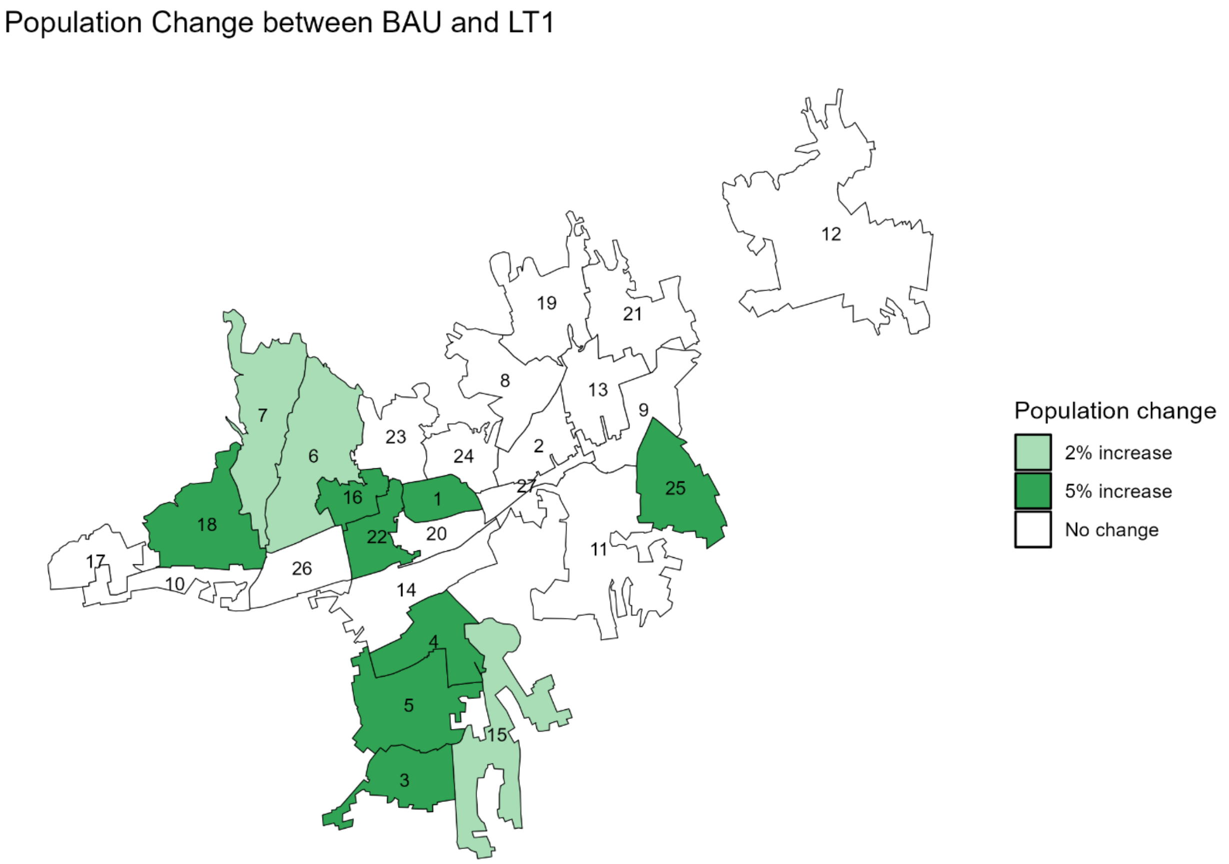

Figure 7: Change of population assumptions comparing scenario LT1 with the base scenario BAU

The results of the LUTI simulations are presented below. Figure 7 illustrates the development of passenger-kilometres by mode, while Table 11 provides the corresponding numerical values for the year 2040. A declining trend is observed across all modes except car travel, consistent in both scenarios, although overall levels are higher in LT1 due to the larger population. Notably, the modal split indicates an increase in walking and cycling shares, along with a slight rise in bus use, accompanied by a small reduction in car trips.

The largest increases in passenger-kilometres occur for walking and cycling, followed by bus travel, while car trips are only marginally higher by +1.4%.

Figure 8: Passenger-kilometres per mode comparing base scenario BAU and scenario LT1

Table 11: Modal split and passenger-kilometres comparing BAU and LT1

Indicator	Base scenario	LT 1	Change in p.p.	Change in %
Mode split at 2040				
Walking	15.07%	15.32%	0.24%	1.60%
Cycling	4.15%	4.23%	0.08%	1.91%
Bus	36.51%	36.73%	0.22%	0.59%
Car	44.26%	43.72%	-0.54%	-1.21%
Passenger-kilometres in 2040				
Walking	33 940	35 481		4.54%
Cycling	20 559	21 463		4.39%
Bus	982 964	1 014 970		3.26%
Car	864 862	876 953		1.40%

5.4.3. LUTI Scenario LT2 - Sensitivity to PT ticket prices

Scenario LT2 explores the sensitivity of mobility behaviour to changes in PT ticket prices. The aim of this scenario is to assess how variations in fare levels influence mode choice and overall travel demand within the study area. To capture both moderate and strong price effects, a stepwise testing approach was applied:

- LT2a: Ticket prices increased by 10%
- LT2b: Ticket prices decreased by 10%
- LT2c: Ticket prices increased by 50%
- LT2d: Ticket prices decreased by 50%

The initial fare level in the model was very low (approximately 1 € per trip), which meant that the first pair of tests (±10%) produced only minor behavioural responses. To observe a more pronounced reaction in mode choice, the ±50% variations were introduced. These larger adjustments allow for better identification of elasticities in PT use and highlight potential shifts between car, bus, walking, and cycling modes under different pricing conditions.

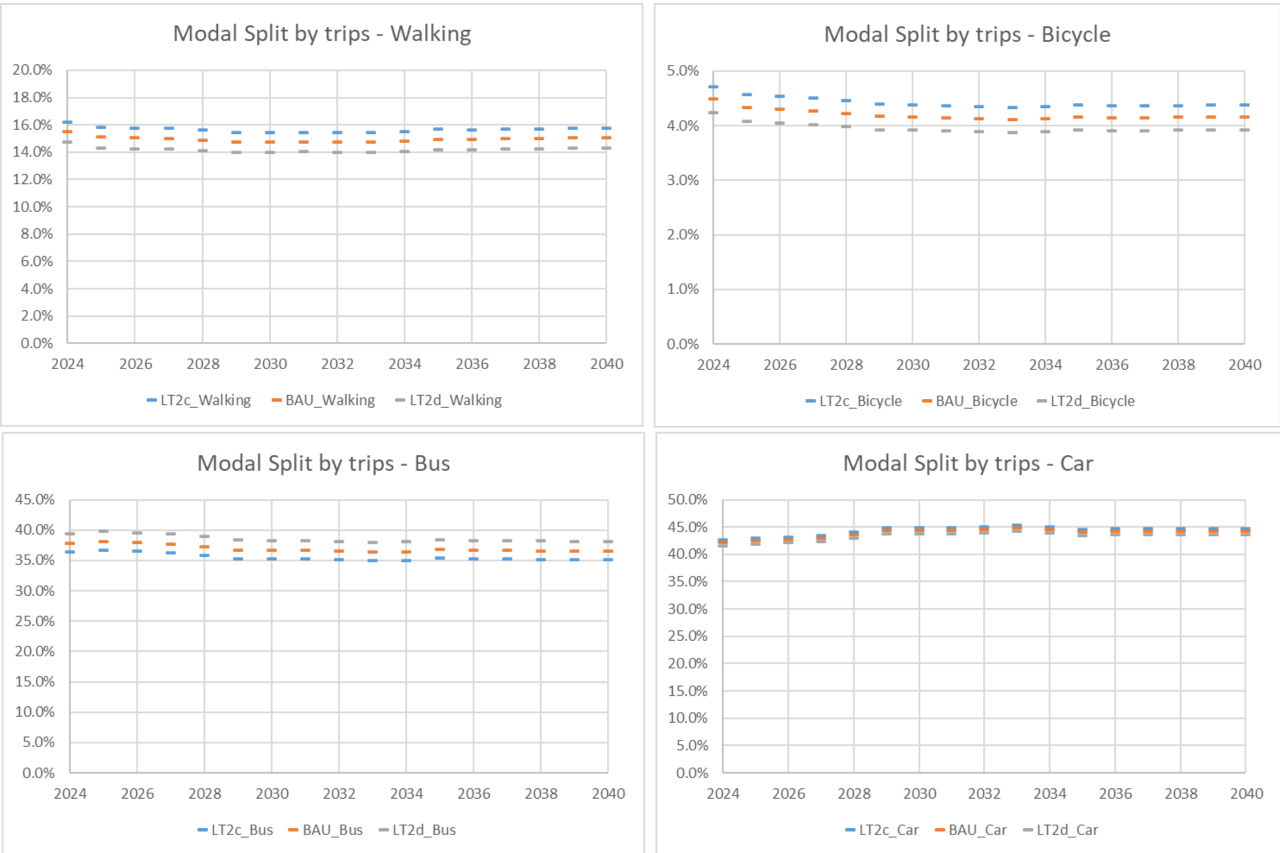

Figure 9: Modal Split comparison of scenarios BAU, LT2c (+50%) and LT2d (-50%)

The results indicate that reducing public transport (PT) ticket prices has a more pronounced effect on travel behaviour than increasing them. When fares are reduced by 50% (Scenario LT2d), the share of bus trips rises by +1.6 percentage points (+4.5%), accompanied by a decrease in car use (−0.6 p.p., −1.4%). Conversely, when fares are increased by 50% (Scenario LT2c), bus use declines (−1.4 p.p., −3.9%) while car use grows slightly (+0.5 p.p., +1.1%).

Interestingly, walking and cycling are proportionally more affected than car use. Under both pricing scenarios, the changes in active modes are larger in relative terms (around ±5%) compared with cars (±1-

2%). This suggests that households without access to a private vehicle are most sensitive to public transport affordability—switching between walking, cycling, and bus travel depending on ticket prices.

Table 12: Results for LT2c (+50%) Modal Split and pkm in the year 2040

	BAU 2040	LT2c scenario 2040	Difference in %-points	Difference in %
Modal Split				
Walking	15.07%	15.78%	0.71%	4.70%
Bicycle	4.15%	4.37%	0.22%	5.27%
Bus	36.51%	35.08%	-1.43%	-3.92%
Car	44.26%	44.76%	0.50%	1.14%
Passenger-kilometres				
Walking	33 940	35 880		5.72%
Bicycle	20 559	21 800		6.04%
Bus	982 964	963 660		-1.96%
Car	864 862	883 179		2.12%

Table 13: Results for LT2d (-50%) Modal Split and pkm in the year 2040

	BAU 2040	LT2d scenario 2040	Difference in %-points	Difference in %
Modal Split				
Walking	15.07%	14.31%	-0.76%	-5.07%
Bicycle	4.15%	3.92%	-0.24%	-5.67%
Bus	36.51%	38.14%	1.63%	4.46%
Car	44.26%	43.63%	-0.63%	-1.42%
Passenger-kilometres				
Walking	33 940	31 918		-5.96%
Bicycle	20 559	19 246		-6.39%
Bus	982 964	1 003 410		2.08%
Car	864 862	844 558		-2.35%

5.4.4. LUTI Scenario LT3 - Combination of increase in PT ticket prices and frequency

In Scenario LT3, a 5% increase in public transport fares was combined with a 10% increase in bus service frequency during both peak and off-peak periods. The results, presented in Figure 10 and Table 14, indicate only minor changes in both modal split and passenger-kilometres compared to the base scenario.

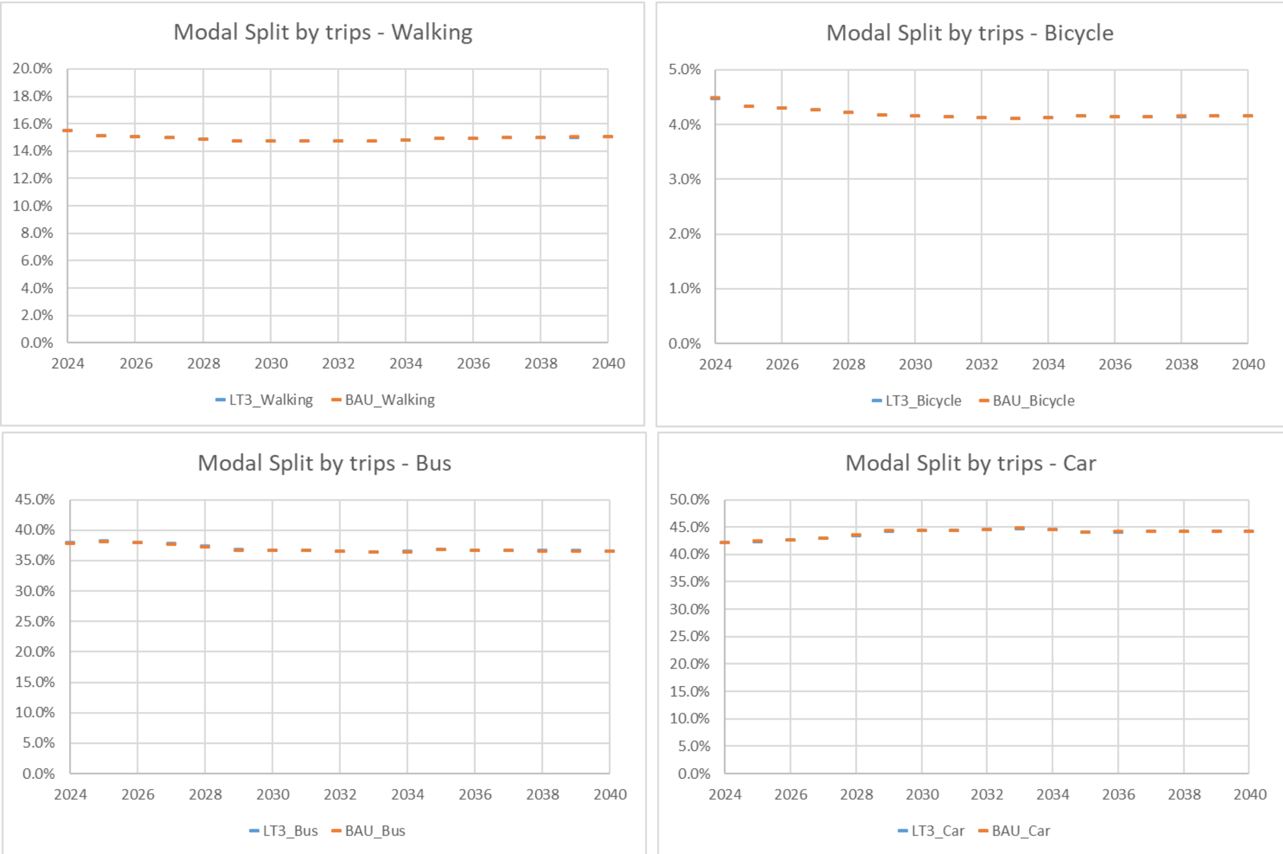

Figure 10: Modal split results for scenario LT3

Table 14: Modal split and passenger-kilometres comparing BAU and LT3

Indicator	Base scenario	LT 3	Change in p.p.	Change in %
Mode split at 2040				
Walking	15.07%	15.06%	-0.02	-0.10%
Cycling	4.15%	4.15%	0.00	-0.06%
Bus	36.51%	36.60%	0.08	0.23%
Car	44.26%	44.19%	-0.07	-0.15%
Passenger-kilometres in 2040				
Walking	33 940	33 998		0.17%
Cycling	20 559	20 599		0.19%

Bus	982 964	987 173		0.43%
Car	864 862	865 963		0.13%

5.5. Conclusion of scenario modelling

Summary of scenario modelling results

In the case study area of Pécs, three alternative PT improvement scenarios are evaluated in PTV Lines alongside the base scenario. Two of these scenarios involve introducing new lines operated by electric buses, while the third focuses on adjusting the service frequency of existing routes. As all scenarios represent an expansion in PT supply, their primary benefits stem from enhanced accessibility and improved system performance, albeit with increasing budgetary requirements. Among them, the scenario introducing new electrified bus lines proves most effective in mitigating the rise in carbon and other emissions associated with the expanded service provision.

The LUTI simulations with MARS show only modest city-wide impacts of the tested transport and land-use scenarios in Pécs. Public transport optimization (ST1–ST3) produces minimal changes, with a small bus mode increase in ST2 (+0.3 p.p.) and slightly shorter bus trips. Higher population in central zones (LT1) leads to, slightly higher walking, cycling, and bus shares, and a small decline in car use. Fare sensitivity tests (LT2) reveal that reducing ticket prices can strongly increase bus use (+1.6 p.p.), while fare increases have weaker effects. The combined fare and frequency scenario (LT3) shows almost no overall change. Isolated PT improvements or pricing measures yield only minor shifts, while population growth produces the more noticeable yet still moderate effects on mode choice and travel demand.

Connections with Local Goals and Visions set in Chapter 4

The short-term scenarios developed for Pécs directly support the city's strategic mobility and environmental goals. The pilot action introducing a new bus line contributes to G3 (increasing the share of zero-emission vehicle mileage) by integrating electric buses into regular operation, improving their energy efficiency and utilisation. At the same time, by extending service to previously uncovered areas, it strengthens G4 (improving accessibility and connectivity of local public transport). The frequency modification scenario enhances service quality and reliability, making public transport more attractive during peak hours, which supports G5 (increasing the number of public transport passengers). Finally, the alternative route scenario explores options for better spatial coverage and accessibility, further advancing both G4 and G5 through improved connectivity and user-oriented network design.

Limitations in Scenario Definition, Modelling, and Results Analysis

Compared to other case study areas, the PTV VISUM model is unfortunately not available for Pécs. This limits the analysis that can be carried out especially regarding ridership, since PTV Lines cannot model the interaction with the demand. This has limited the scenario selection, and those associated with land development cannot be reflected in the current analysis. However, PTV Lines provide a very flexible tool for agencies to quickly prototype new services, such as adding lines, changing lines, or updating the service frequency. Intuitive results, such as accessibility, can be visualized efficiently to assist quick exploration.

The mode share of PT in Pécs is exceptionally high according to the SUMP report. Due to the lack of additional data sources, we recommend further validation efforts, when possible, in the future, and be mindful of this limitation in the scenario results.

How the Modelling Action Informs the Selection of Local Actions

The modelling activity served as a supporting tool rather than a decisive factor in selecting local actions. Operational and organisational aspects were the main drivers of decision-making; however, modelling with PTV Lines and LUTI provided valuable insight into the relative efficiency and potential impacts of various options. It helped quantify expected energy savings from electric bus deployment, assess network optimisation effects of increased service frequency, and estimate accessibility improvements through route adjustments.

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6. Stakeholders

In this chapter were identified key stakeholders from various sectors and regions.

Stakeholder engagement is emphasized through regular meetings, networking opportunities, experience sharing, and study tours, with reports compiled to document best practices and lessons learned.

Table 15: List of stakeholders

Stakeholder	Type	Role	Importance	Influence
Tüke Busz	PTO	operator	high	medium
Municipality of Pécs	municipality	decision-making, financing, strategic planning	high	high
Ministry of Construction and Transport	National ministry	set national policies	medium	medium
Local social/educational organisations	public service providers	Determining PT needs	Medium	High
Local media (social, online, print)	media	Promoting PT, conveying positive messages	High	High

7. Action Plan

For each Action proposed in Chapter 5 a table with the following information are defined: Resources, Timeline, Stakeholders, expected impacts, Risks and mitigation.

Table 16: Actions descriptions

Actions	Resources	Timeline	Stakeholders	Expected impact	Risk
Action 1	Medium	September 2025	Municipality, PTO, OPTI-UP	The appearance of new passengers on the transport network	Frequency of the new line, install new bus stops
Action 2	Low	September 2025	Municipality, PTO	Increase the milage of electric buses and the costs of PT will reduce	It is not possible to reduce the cost to a large extent
Action 3	Low	September 2025	Municipality, PTO	Popularize public transport, focusing on its advantages	Limited reach
Action 4	Medium	October 2025	PTO	Reduced costs of public transport	It is not possible to reduce higher cost
Action 5	Low	September 2025	Municipality, PTO	Reach new areas with public transport	There will be no more passengers, they do not want to use PT

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8. Monitoring and KPIs

A constant monitoring is important to ensure that local plans proceed as planned, with predefined reporting deadlines for each action (action proposed in Chapter 5.)

In this chapter a scheme of KPI's and their main features is proposed.

Table 17: Local Plan KPIs

KPI	Actions	Brief description	Unit	Target
KPI_1	3, 5	Number of passengers per day	passenger /day	75 passengers/ day
KPI_2	5	Number of passengers per one ride	passenger / one ride (per day)	15 passengers / ride
KPI_3	5	Number of km travelled	km / day	
KPI_4	3, 4, 5	Number of passengers at the new bus stops per day	passenger / bus stop (per day)	35 passenger / day
KPI_5	1, 2, 5	Cost of energy consumption per km travelled per passenger on pilot line	EUR/km (per week)	

8.1. Description of data sources & tool for KPIs

In this chapter, data, data sources or providers of data as well as tools (measurement or calculation) in order to collect or calculate key performance indicators (KPIs) are identified. Several data may need to be calculated for each KPI.

Table 18: Identification of data sources & tools for KPIs data

KPI	Data list	Methodology	Data source	Data tool
KPI_1	Number of passengers	Daily trend	passenger counting equipment (PTO)	Excel

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KPI_2	Number of passengers	Daily trend	passenger counting equipment (PTO)	Excel
KPI_3	Number of km runned	Daily trend	statistic database (PTO)	Excel
KPI_4	Number of passengers	Daily trend	passenger counting equipment (PTO)	Excel
KPI_5	Number of km travelled Average consumption of electricity [kWh/km] price of electricity [EURO/kWh] number of passengers	Weekly trend	statistic database (PTO)	Excel