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OPTI-UP

OPTI-UP

Comprehensive data report on existing public transport networks and best practices

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Abbreviations

BKM	Bus- and tram-kilometres in operation, excluding the trip distances to or from the depot
CNG	Compressed Natural Gas
DRT	Demand-responsive transport
P&R	Park and Ride
PT	Public transport
PTO	Public transport operator
BP	Best Practice

This deliverable is based on official data provided or collected by project partners and other relevant project stakeholders. Given that more detailed technical analyses and modelling are planned during the project, there is a possibility that this deliverable will need to be updated in the coming periods in accordance with new findings and potentially more accurate data.

Introduction & Project Scope Area

The OPTI-UP project *(Optimizing and greening Public Transport networks through Integration with Urban Planning and data-driven approaches)* aims to optimise public transport (PT) networks in small and medium-sized cities in Central Europe through integration with urban planning and data-driven approaches. This approach is innovative because it considers the interdependent relationship between land use and transport and recognises the importance of data-driven decision-making in PT planning.

The OPTI-UP project includes six pilot areas in five countries:

- Modena (Italy),
- Pécs and Paks (Hungary),
- Grosuplje (Slovenia),
- Český Krumlov (Czech Republic) and
- Osijek (Croatia).

Figure 1: Locations of the case study areas

The purpose of this report is to understand the current state of the 6 pilot cities in terms of their PT operations and planning based on the data collected related to PT and urban planning (Figure 1).

The spatial-demographic characteristics of the pilot cities are explained below:

- **Modena** is one of the main commercial centres in Emilia Romagna. It is in the Po Valley and has a population of 185,009 inhabitants; the entire province of Emilia-Romagna has 706,972 inhabitants and the country has 58,989,749 inhabitants (data updated to 2024). The demographic rate of the city of Modena is generally in continuous decline.

- **Pécs** is the fifth largest city in Hungary and the capital of the Baranya region. It has a population of 140,422. Baranya has a population of 370,484. Hungary has a population of 9,584,627 (data updated to 2024). Hungary's population data is available from the Hungarian Central Statistical Office.
- **Paks** is the second most populous city in Tolna county, accounting for 8.5% of the population of Tolna county. In terms of population density, however, it is one of the less populated district centres, but the reason for this is its large area, not its low population. The demographic trend of the country, i.e. the decrease in the number of the population, applies to both Paks and the characteristic of the region. Paks has a population of 17,827 (Jan 1, 2023), while Tolna County has a population of 99,933 (Jan 1, 2024). Hungary has a population of 9,584,627 (Jan 1, 2024). These data come from the Hungarian Central Statistical Office.
- **Grosuplje** is a medium-sized Slovenian municipality located on the southeastern edge of the Slovenian capital with a population of 21,870. The area that the demand-responsive transport (DRT) pilot will be conducted is the Pilica settlement inside Grosuplje, which has a population of 2,092. Grosuplje belongs to the Ljubljana Urban Region, which unites 25 municipalities and has a population of 537,893. Slovenia has a population of 2,123,949 inhabitants (as of January 1, 2024).
- **Český Krumlov** is a city located in the South Bohemian Region in Czechia that is popular with tourists thanks to its unique offerings of historical, cultural and sports attractions. It has a population of 13,000 inhabitants, while the South Bohemian Region has a population of 640,000 inhabitants. Czechia has a population of 10,690,000 inhabitants (as of January 1, 2024).
- **Osijek** is the fourth-largest city in Croatia and its urban settlement has a population of 75,535. It is the largest city and the economic and cultural centre of the eastern Croatian region of Slavonia, as well as the administrative area. The administrative area of the city has a population of 96,313. Osijek-Baranja County has a population of 258,026. The Republic of Croatia has a population of 3,871,833. This data comes from the 2021 Census of Population, Households and Dwellings.

The six case study areas are categorised into three categories based on the specific PT improvement strategies that will be piloted during the OPTI-UP project (Table 1).

Specifically, network optimisation refers to the adjustments to the routes and schedules of the existing PT system, which will be piloted in Osijek and Paks.

Demand-responsive transport (DRT) aims to provide flexible PT to low-demand areas to balance the PT service accessibility and financial viability. The DRT strategies will be piloted in Modena and Grosuplje.

Lastly, the alternative fuel technologies refer to testing the provision of new vehicles using electricity as the source of energy, which may help to increase the PT ridership due to the increased comfort levels, cleanness, as well as public awareness towards sustainability. This strategy will be piloted in Pécs and Český Krumlov.

Table 1. PT improvement strategies of the case study areas

PT improvement strategies	Case study areas
Network optimisation	Osijek Paks
Demand-responsive transport (DRT)	Modena Grosuplje
Alternative fuel technologies	Pécs Český Krumlov

The report is structured into 4 chapters and various sections in each chapter as follows:

- Chapter A presents the technical analysis of the spatial-demographic background and PT operation status in the six case study areas. Chapter A is divided into 5 Sections:
    - Section 1 will introduce the spatial-demographic background of each case study area, including metrics such as the population number, age and gender structure, as well as population densities.
    - Section 2 presents the history of PT and the fleet composition of each study area, as well as the operational status of the PT systems, such as the total numbers of lines and annual service kilometres.
    - Section 3 includes more details about the demand characteristics of each case study area, such as the annual ridership trends in the past five years, the monthly as well as the hourly demand profiles.
    - Section 4 presents the financial indicators of each PT system, such as the cost and revenue trends and structures.
    - The current practices of PT planning, including the stakeholders and activities, are given in Section 0.
- Chapter B presents a high-level summary of the Best Practices (BPs) survey methods and results, including an introduction section as well as four sections that present the detailed results of the BPs related to the PT improvement strategies in Europe, guiding the formulation of improvement strategies that can benefit the case study areas in this project.
    - Section 6, which introduces the survey methodology, selected BPs, and summary results.
    - Section 7 focuses on the themes of network optimisation.
    - Section 7.2 focuses on alternative fuel technologies.
    - Section 7.3 introduces the findings of BPs of the DRT, and
    - Section 10 presents best practices featuring mixed approaches.

Chapter C documents the findings from the consultations with the relevant stakeholders for each case study area (mostly PT operators or agencies in the case study areas), highlighting the opportunities and challenges associated with each area.

- Section 11 includes a high-level introduction of the stakeholder meetings and presents the results of the stakeholder meetings.

- As a conclusion, the findings from the technical and empirical data collection and analysis are summarised in Chapter D.

This deliverable is based on official data provided or collected by project partners and other relevant project stakeholders. Given that more detailed technical analyses and modelling are planned during the project, there is a possibility that this deliverable will need to be updated in the coming periods in accordance with new findings and potentially more accurate data.

A. Technical analysis section

1. Spatial-demographic Analysis

In this section, the demographics of the six study areas are presented and analysed. The comparisons show the similarities and differences in scales and structures that each study area must consider in the planning of the PT systems.

Six study areas each collected several different spatial-demographic statistics of their cities. The detailed statistics are published in the Deliverable 1.1.2 “comprehensive database”. Here only the summary or analysed results are presented. Interested readers may refer to the database published on the OPTI-UP homepage on the Interreg Central Europe Programme website for more information.

1.1. Population trend

Each city collects its population trend in the past 30 years and the changes in population are show in Figure 2. Despite the Grosuplje case study area does not having the population statistics before 2000, the scale and trend of the population can clearly be seen. Among the six study areas, Modena, Pécs and Osijek are the larger ones, with a population around 100,000 to 200,000. The other three cities are relatively smaller in scale, with the population between 10,000 to 25,000.

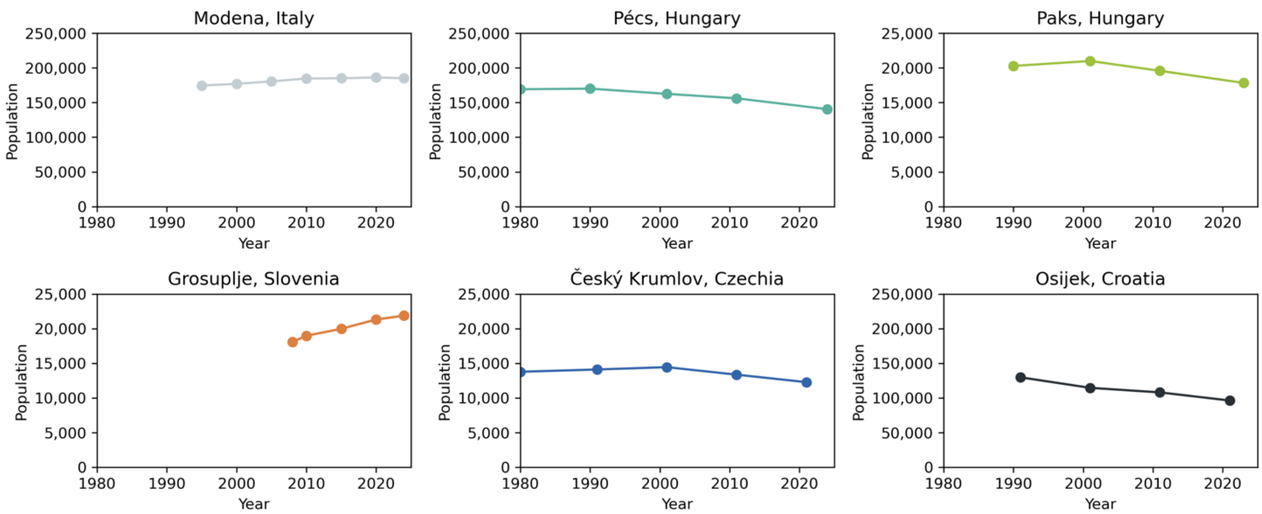

Figure 2: Population trend in the study areas

Table 2 shows the trend of population change (growth and decline) in the case study areas. **Among the six case study areas, only Modena and Grosuplje maintained a growing trend of population.** Pécs, Paks, Český Krumlov, and Osijek all sustained an overall population decline in the past three or four decades, especially after 2000. By 2021, Osijek has a decline of over a quarter of its population in the early 1990s.

Table 2: Population growth and decline in the study areas

	Modena	Pécs	Paks	Grosuplje	Český Krumlov	Osijek
Pop. change	1995 - 2024	1990 - 2024	1990 - 2023	2008 - 2024	1991 - 2021	1991 - 2021
Absolute	10,491	-29,617	-2,447	3,785	-1,830	-33,479
Percentage	6.0%	-17.4%	-12.1%	20.9%	-13.0%	-25.8%

1.2. Population structure by age and gender

Apart from the total population shown in Section 2.1, the population structure, particularly age and gender, also plays an important role in transport planning. This is because the PT system should consider the inequalities in the population and provide quality services to all population segments.

Figure 3 shows the population pyramid by gender for the six case study areas. Visually from this figure, the proportion of the senior population seems to be higher in Modena, Český Krumlov, and Osijek.

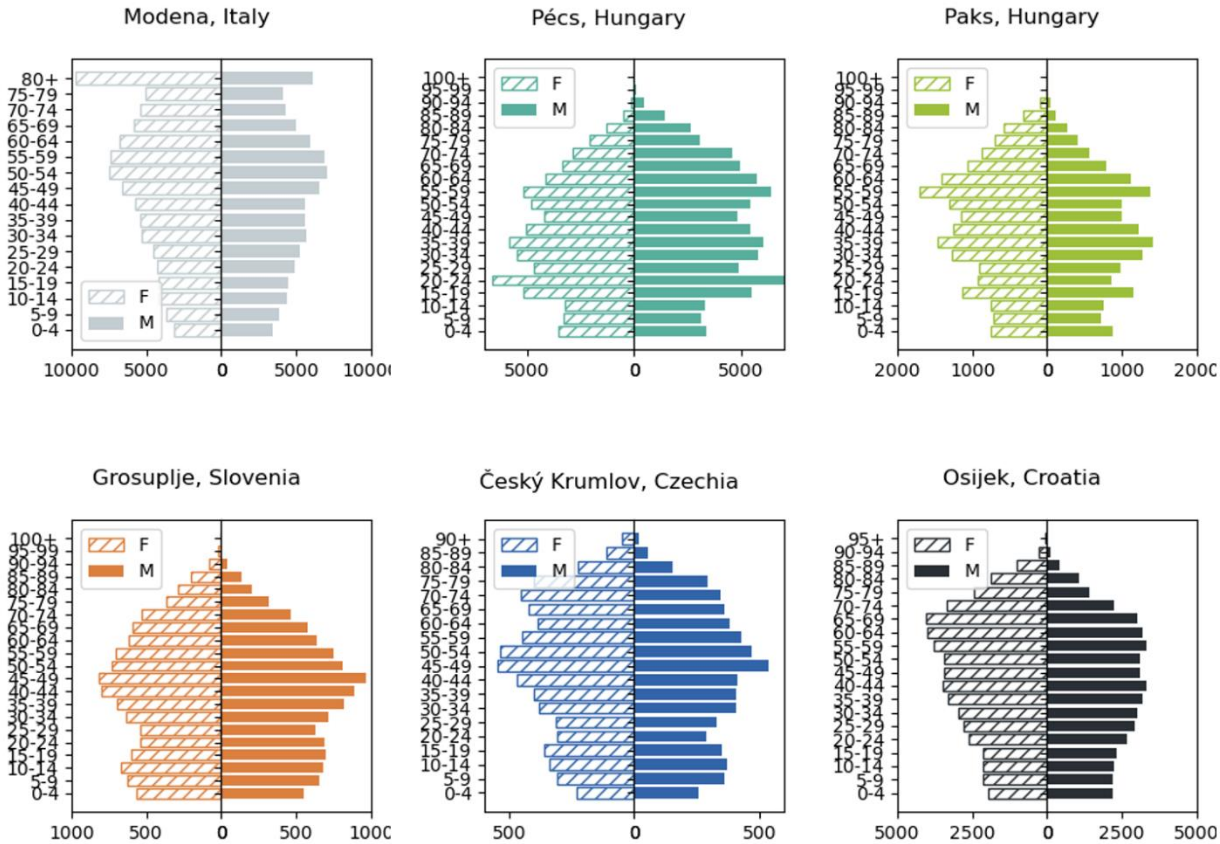

Figure 3: Population pyramid (age gender structure) in the six study areas

The intuitive results in Figure 3 are further supplemented by the statistics given in Table 3. Two groups of summary statistics are presented, the median age and the percentage of population in different age groups.

First, the median age is an important indicator used worldwide to measure population ageing. For example, in Europe, the median population age is 44.5, indicating half of the population is older than that (European Commission “Statistics Explained”, 2024). **For the six case study areas in OPTI-UP, the median age in Modena is older than the European average both for male and female, while the two Hungarian cities (Pécs and Paks), seem to be the youngest despite their steady population decline in the past three decades (Section 1.1).**

The median population age of Grosuplje is close to the European average (slightly younger). The median population ages in Český Krumlov and Osijek are also close to the European average (slightly older). In reference to the population trend (increase or decrease) described in Table 2, there seems to be no obvious correlation between the population trend in the past two or three decades and the current median age. For example, the median ages in 2023 for Grosuplje, Český Krumlov and Osijek are all close to each other as well as to the European average, there were nonetheless an increase in population for Grosuplje, a small decrease in population in Český Krumlov and a big decrease in population in Osijek (in terms of the absolute population) in the past two or three decades.

The second group of results in Table 3 is the percentage of population that is younger than 15 years old (children below working age), 16-64 years old (working population), and over 65 years old (retired people). From these statistics, **Modena, Grosuplje and Český Krumlov have the lowest percentages of working population (less than 65%).**

Modena, Český Krumlov, and Osijek also have the highest percentages of people over 65 years old (close to or more than 15%). It should be noted that all cities have less percentages of people over 65 years old than the European average (21.3%, or about one-fifth), which is not surprising as most of the case study areas are urban and regional cores in each country.

Table 3: Median age and population in age groups

	Modena	Pécs	Paks	Grosuplje	Český Krumlov	Osijek
Median age. Europe average is 44.5 on 1 January 2023.						
Male	45-49	40-44	35-39	40-44	40-45	40-44
Female	50-54	35-39	40-44	40-44	45-49	45-49
Population in age groups						
<= 15 years	17.0%	19.7%	20.0%	23.1%	19.9%	18.0%
16 - 64 years	64.1%	68.0%	68.5%	64.7%	63.7%	67.2%
>= 65 years	18.9%	12%	11.5%	12.2%	16.3%	14.8%

Note: orange indicates case study areas with relatively lower percentages of the working population (16-64 years), or relatively higher percentages of retired population (>=65 years).

1.3. Population density

The total population, area and density of each case study area are given in Table 4 and visualised in Figure 4. There are three medium-sized cities (Modena, Pécs and Osijek) in terms of the total population, and three small cities (Paks, Grosuplje, Český Krumlov) consistent with the results presented in Section 1.1.

In terms of the population density, Modena is the most densely populated, with the population density exceeding 1,000 pp/km^2. The population density of Pécs is also relatively high at 857 pp/km^2. The population densities of Český Krumlov and Osijek are similar, both at around 550 pp/km^2. Paks and Grosuplje are the least densely populated areas in all six cases, with the population density below 200 pp/km^2.

Table 4: Area and density in each case study area

	Modena	Pécs	Paks	Grosuplje	Český Krumlov	Osijek
Case study area						
Population (latest data)	185,009 (2024)	139,330 (2024)	17,801 (2022)	21,870 (2024)	12,278 (2021)	96,313 (2021)
Area (km^2)	183.2	162.6	154.1	133.8	22.2	174.9
Population density (pp/km^2)	1,010	857	116	163	554	551

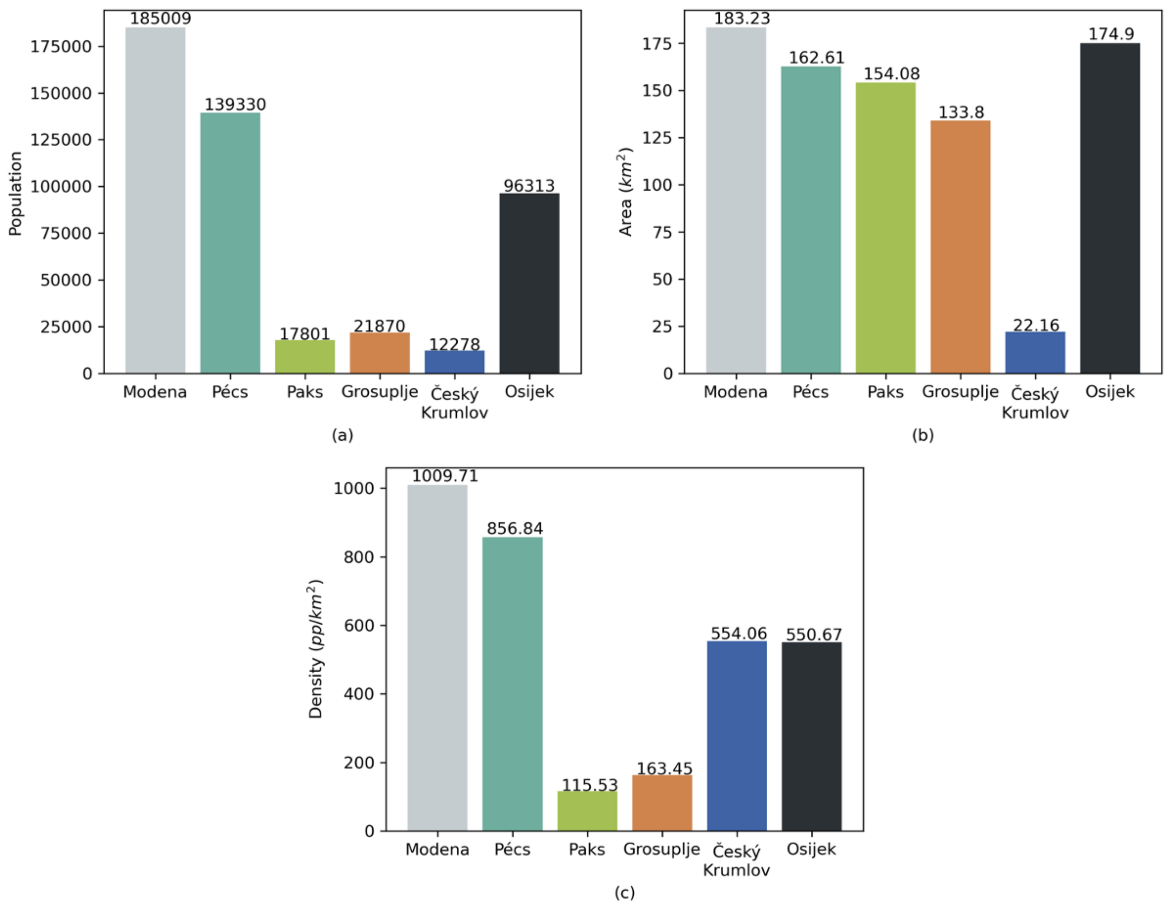

Figure 4: Population, area and density in each case study area

2. PT history and operation status in case study areas

In this section, the historical development and current status of PT services in each case study area are explored. First, an overview of historical milestones in terms of PT system development is provided in Section 2.1. Given that alternative fuel is a topic of study of OPTI-UP, the current fleet composition is summarised in Section 2.2. This is followed by the presentation of several key operational statistics, such as the numbers of lines, average turnaround time, dispatches per day, and annual vehicle kilometres in Section 2.3, and further derived indicators in Section 2.4.

2.1. The history of the PT services

Historically, Europe has been progressive in adopting PT to serve its population. Tram system has been introduced more than 100 years ago in many cities, followed by buses and trolleybuses a few decades later. A major movement of tram dismantling happened in decades following the war, while its importance was re-discovered, and the service reinstalled from 1970s. This trend was also embodied in the history of the six case study areas, as shown in the timeline in Figure 5.

Three out of the six cities have tramways nearly or more than 100 years ago (Modena, Pécs, and Osijek). It was evident that the development and continual usage of trams faced challenges in the decades of 1930s-1960s, where two cities documented the closure or dismantling of tramways in favour of trolley buses (Modena) or buses in (Pécs).

The offering of PT begins to show innovations and diversification from the past century in the recent two decades, where the cities documented the introduction of DRT (Modena, 2004; Grosuplje, 2022), P&R (Grosuplje, 2020), low-floor buses and trams (Osijek, 2019-2023), as well as dedicated operating companies (Pécs, 2012 and Paks, 2021).

The PT infrastructures are also renewed or extended, with four out of six cities documented major expansion or modernisation activities in the past decade (Modena, Pécs, Grosuplje, and Osijek).

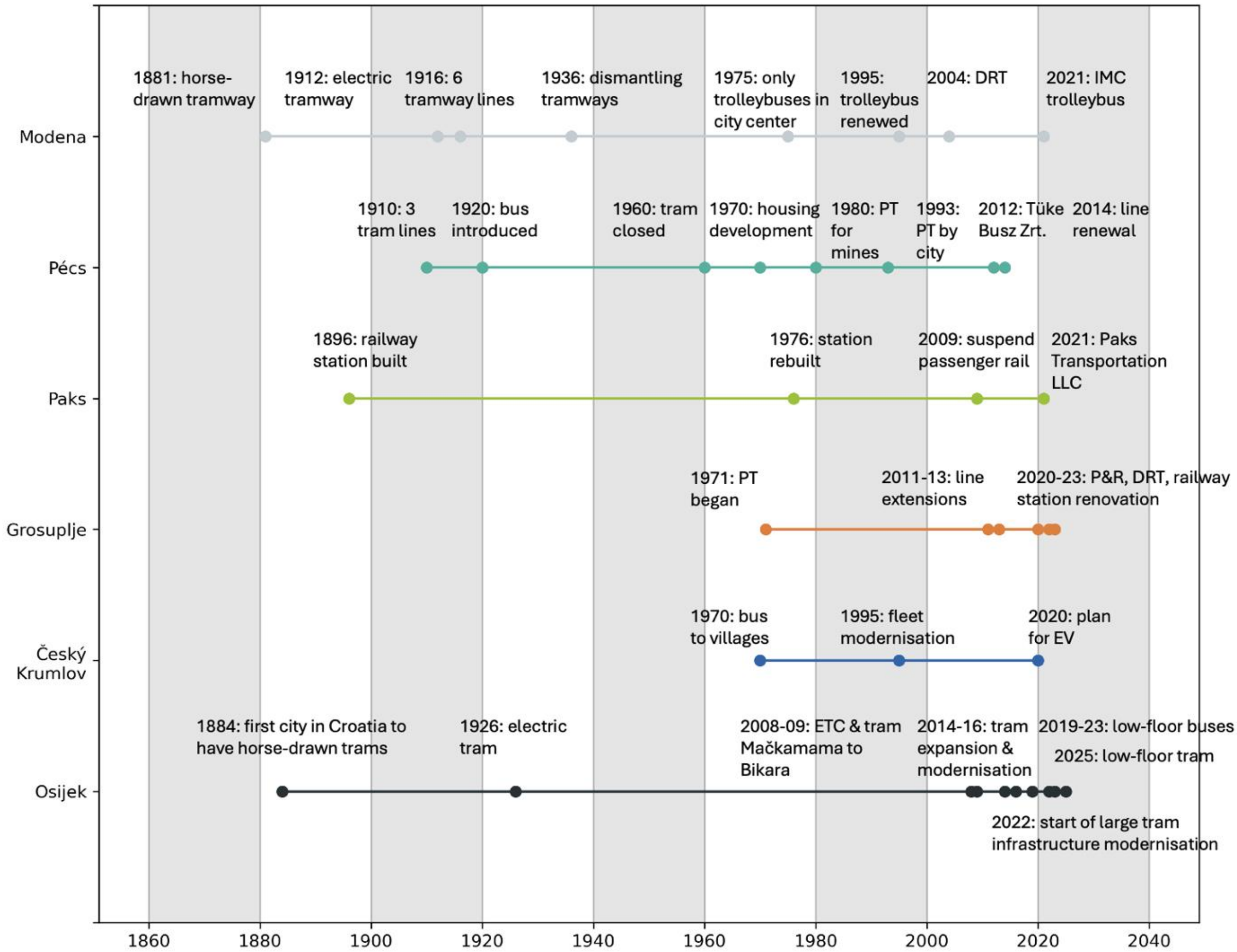

Figure 5: History of PT in six case study areas

2.2. Fleet composition

The PT fleet may use a variety of power sources from fossil fuels to electricity. The first section in Table 5 provides an overview of the fleet composition by energy type for each case study area.

The most used energy sources are diesel and electricity. The whole bus fleet in Paks (consists of 10 buses) is electrified. In the nearby city of Pécs, which a more extensive PT network, most of the buses are propelled by diesel, while 18 electric buses were introduced to the fleet at the end of 2023.

In Modena, the bus fleet is mainly powered by natural gas, while a small number of the buses and the four DRT minivans run on diesel. The trolleybuses are electricity powered.

In Grosuplje, where DRT services are also available, three electric cars are used for the "Zapeljivec" and the "Grosupeljčan" DRT line. The bus fleet (14 intercity buses and some additional minibuses or vans as school buses) run on diesel.

In Český Krumlov, the city currently has ten diesel buses, but plan to introduce five additional electric buses during the duration of this project.

In Osijek, the current bus fleet consists of 49 diesel buses as well as 18 electric tram vehicles.

Table 5: Bus fleet composition, capacity, and average age

	Modena	Pécs	Paks	Grosuplje	Český Krumlov	Osijek
Fuel type						
Diesel	7 (regular buses) and 4 minivans (DRT)	142 (solo and articulated buses)	-	14 (intercity buses); additional school bus	10 (buses)	49 (buses)
Natural gas	87 (regular buses)	-	-	-	-	-
Electric	22 (trolleybuses)	18 (solo buses)	10 (Midi and solo buses)	3 (car for DRT "Zapeljivec" and "Grosupeljčan")	5 (planned)	18 (trams)
Capacity						
	Articulated: 145 Standard: 83-97 DRT: 8	Average: 103 Diesel: 107 Electric: 72	Average: 55.4 Midi: 41-44 Solo: 60-63	Intercity buses: 50 DRT: 4 School buses: 8-20	Diesel: 50-70 Electric (planned): 40-60	Bus average: 87.6 Tram average: 128.3
Age (end of 2023)						
	Trolleybus: 13.5 Diesel bus: 18 CNG bus: 7.5 DRT: 9	Diesel: 16 Electric: 2.2	3 (newly purchased in Dec 2020)	City buses: 4-5 DRT: 1-2 School bus: no data	Diesel: 8 Electric: planned	Bus: 7 Tram: 17 since refurbishment in 2006-2007

The capacity and age of the vehicles are given in further sections in Table 5.

For the three relatively large case study areas (Modena, Pécs, and Osijek), the capacity of the PT vehicles is usually on the larger side at around 80-150 passengers per vehicle. The number vary slightly depending on if disability seats are used. For cities with a relatively smaller PT network (Paks, Grosuplje and Český Krumlov), usually solo or midi buses are used, with a capacity of 40-70 people per vehicle. Specifically, for DRT services, smaller vehicles such as minivans (Modena) or cars (Grosuplje) are used, which have a capacity of 4-8 people.

The PT fleet in several case study areas has a relatively young age. For example, evaluated at the end of 2023, the electric buses in Pécs and the whole fleet in Paks, Grosuplje are purchased within the last five years. The CNG buses in Modena and diesel buses in Český Krumlov and Osijek are around 7-8 years old. The age of the bus exceeds 10 years old only for the diesel buses in Modena and Pécs, which around 16-18 years old. The service life is longer for trolleybuses and trams. The trolleybuses in Modena are 13.5 years old on average by the end of 2023. The tram vehicles in Osijek were refurnished in 2006-2007, making them to be around 17 years old by the end of 2023.

2.3. Key operational statistics

2.3.1. Number and line length

Table 5 summarises the key operational statistics of the PT system in each case study area. While most cities have less than 20 lines, Pécs has 85 lines and Český Krumlov only has three lines.

The schematic maps of the PT in each city are given in Figure 7. On average, the length of each line is around 10 km in each way. This is the highest in Paks, where each line averages to be 16.9 km long (median is 14.1 km), while the average length of PT lines is 6 km in Český Krumlov (median is 5 km).

It is worth noting that the PT in Grosuplje is operated as part of the integrated service of the bigger PT network in the Ljubljana region. The numbers show in the table for Grosuplje are thus proportional to the length of the lines that fall within the municipality, rather than from the whole length.

2.3.2. Turnaround time and operational speed

The second group of indicators is the turnaround time and speed. The same statistics are also visualised in the bar charts in Figure 6 (a)-(b). The average turnaround time (back and forth) indicates the temporal length of each service. Three cities have relatively long turnaround times, where the average is 75-82 minutes (Modena, Paks and Osijek). For the other three cities, the average turnaround time is around or below 40-50 minutes (Pécs, Grosuplje and Český Krumlov).

The average speed roughly equals to the average length of the line times two (round trip distance) divided by the average turnaround time. For most of the cities (except Modena), the PT operates at the speed of normal traffic, without significant impact of congestion or other obstacles that slow down the buses or trams.

2.3.3. Number of departures

The third group of PT operation indicators concerns the total numbers of departures on a typical working day, Saturday, Sunday and holidays. **Pécs have the highest numbers of PT departures**, with nearly 2,000 departures on working days and more than 1,000 departures on the weekends. **However, considering that the number of lines in Pécs (85 lines, 228 route variations) is significantly higher than other case study areas, the numbers of departures per day per line are lower than those in other cities.**

Modena has the second highest numbers of PT departures, with more than 1,400 departures on weekdays and Saturdays, and over 400 departures on Sundays. **Since the number of lines in Modena is in the same range as those of other cities (and much lower than Pécs), Modena's PT offers the most frequent services.**

Osijek has the third highest numbers of service runs in all case study areas, with 465 departures on weekdays and more than 300 departures on weekends. For the smaller case study areas (Paks, Grosuplje and Český Krumlov), the total numbers of departures per day is around 100-200 on weekdays, and 20-75 on weekends.

2.3.4. Volume of service

The last group of PT operation indicators is the volume of service or annual bus- and tram-kilometres (BKM) of the PT service, excluding the distances to travel back to and from the depot.

Modena, Pécs and Osijek have high total BKM per line thanks to the frequent services. Pécs has the highest total BKM due to its large number of lines in operation, while the average BKM per line is on the lower side after averaged by the numbers of lines. Pécs, by segmenting the PT lines, maintains a high frequency of departures on the main urban corridors, but reduces the quality of service in the peripheral parts of the city.

Paks and Grosuplje have comparable statistics both in terms of the total BKM and average BKM per line. The total BKM is the smallest in Český Krumlov, given that it only has three lines.

Table 6: Key PT operational statistics in the case study areas.

	Modena	Pécs	Paks	Grosuplje	Český Krumlov	Osijek
Number of lines						
Bus lines	18	85 (228)	4 (7)	7	3	9* *1 bus line is planned to start operate end of 2024.*
DRT lines	2	0	0	2 ("Grosupeljčan", "Zapeljivec")	0	0
Tram lines	0	0	0	0	0	2
Total length (km)	179.7	850.4 (2,507)	81 (118.1)	99.6	18	154
Avg. length (km) -- one-way	10	11	16.9	14.2	6	14
Median line length (km) -- one-way	10.3	9.2	14.1	14	5	9.5
Time and speed, also shown in Figure 6 (a)-(b) Turnaround time = loop time; Avg speed ≈ length×2 /turnaround time						
Avg. turnaround time (min)	75.73	54.4	77.4	44	43.3	81.5
Avg. speed (km/h)	15.7-18.8	24.3	26.4	35.7	20	20.6
Number of departures, also shown in Figure 6 (c)-(d)						
Working day	1,489	1,893	118-130	187	75	465
Saturday	1,414	1,128	69-75	48	45	361
Sunday & holiday	436	1,137	69-75	34	23	327
Annual BKM, also shown in Figure 6 (e)-(f)						
Total	4,568,650	6,367,395	502,189	512,189	150,000	3,229,226
Avg. per line	253,814	27,927	73,170	73,170	50,000	293,566

Note: the numbers in brackets are the values considering line variations, i.e., the different routes associated with the same PT line.

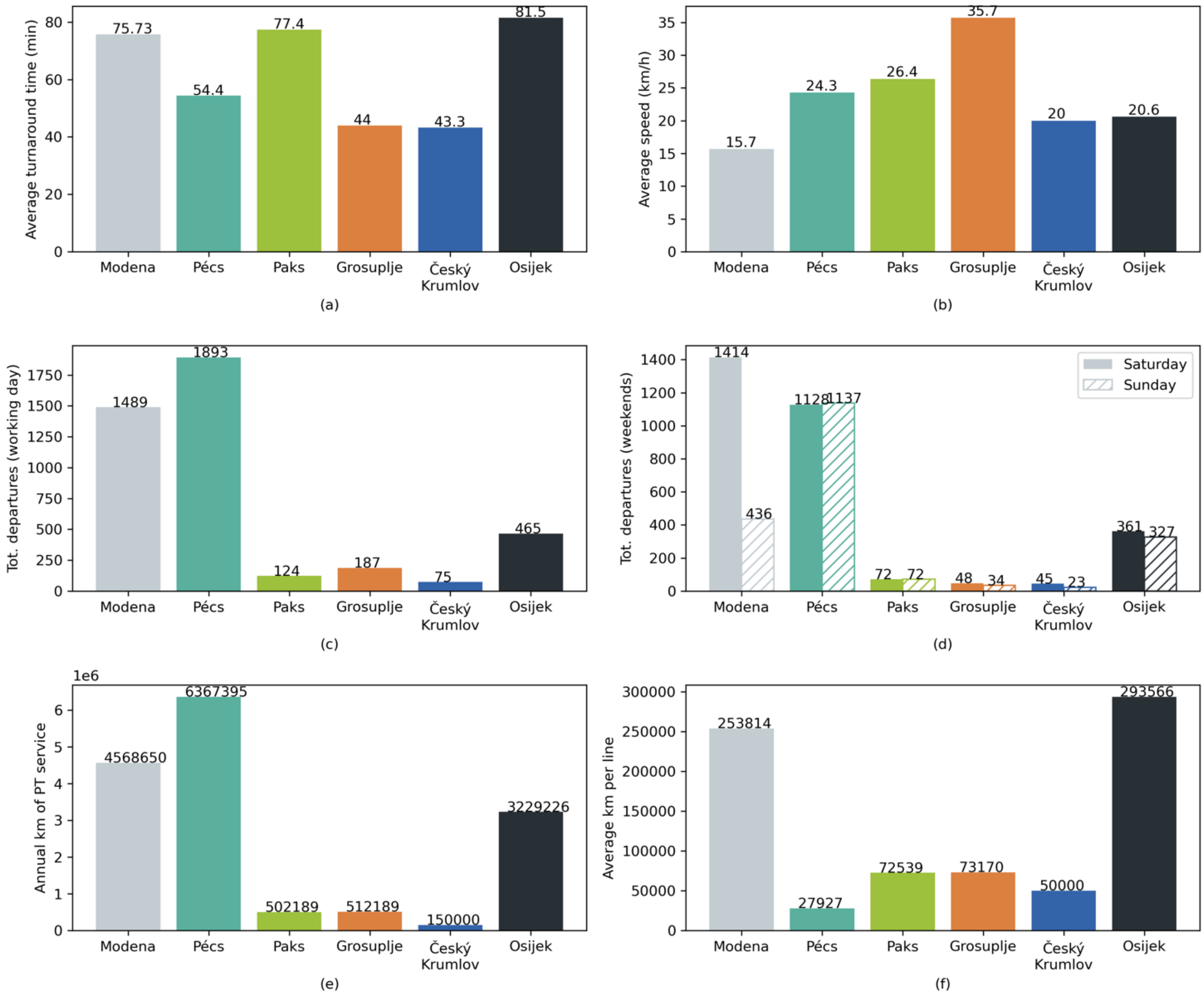

Figure 6: Visualization of key PT statistics in case study areas. (a) average turnaround time (min); (b) Average speed (km/h); (c) Total numbers of departures on weekdays; (d) total numbers of departures on weekends; (e) annual BKM of PT services; (f) average BKM of PT services per line.

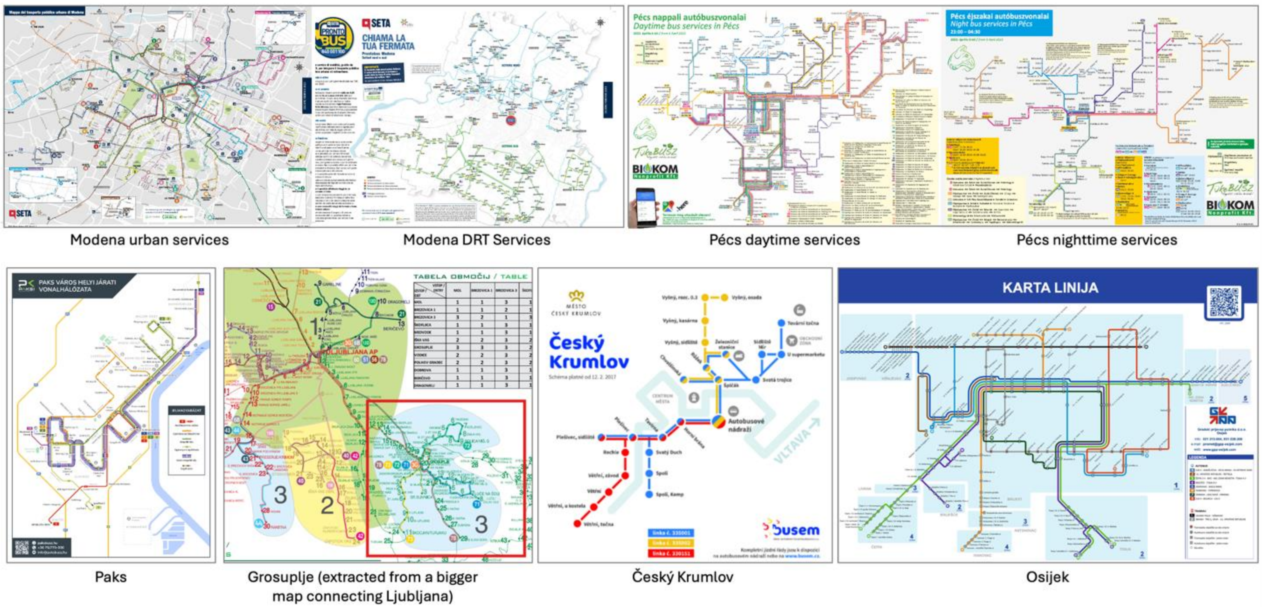

Figure 7: Schematic maps of the PT network in case study areas.

2.4. Derived operational statistics

Table 7 summarises additional derived operational statistics based on previous sections. This includes a recap of the demographics and PT service statistics (introduced in previous sections), as well as the newly derived indicators, namely the ratios between the population (or population density) and PT service provisions (number of lines, daily BKM, and number of departures on a working day).

Based on the results, Modena and Osijek's PT systems serve the highest numbers of population per line, while in Český Krumlov, the population density per line is the highest.

The ratios between population and the daily BKM or the departures per working day serve to measure the "potential demand" on PT from the population in each area, and higher ratios indicate a higher potential demand on the PT system – **in other words, high values potentially indicate room for improvement in the system to serve a larger number of users.**

In terms of these two indicators, the PT service is the most abundant in Pécs, which correspond to the previous sections given the high number of lines operating in the city. **It can be assumed that this indicates differences in the PT planning objectives, whether set intentionally or unintentionally, that such networks and operational indicators fulfil - maximize ridership or maximize coverage.**

Grosuplje and Pécs, for instance, exhibit a lower population density per line, which may suggest an oversupply of PT lines relative to the demand indicated by population density. Conversely, Český Krumlov presents a contrasting scenario with a high population density but a limited number of PT lines, indicating a potential undersupply.

The ratio of population (and population density) to weekday departures provides insight into the PT service's coverage within a city. While most cities demonstrate a proportionate level of service to their population densities, notable variations are observed. Osijek has the highest ratio of population to weekday departures, while Český Krumlov has the highest ratio between population density and weekday departures (Figure 8). **These findings suggest that while some cities may benefit from a reallocation of resources to optimize network efficiency, others, particularly Český Krumlov, may require an expansion of services to meet the higher demand of a densely populated urban area.**

Although these data point to interesting findings, it is important to note that this metric and conclusions should be considered in conjunction with other data and should not be viewed in isolation.

Table 7: Derived PT operational statistics in the case study areas.

	Modena	Pécs	Paks	Grosuplje	Český Krumlov	Osijek
Case study area						
Population (latest data)	185,009 (2024)	139,330 (2024)	17,801 (2022)	21,870 (2024)	12,278 (2021)	96,313 (2021)
Area (km²)	183.23	162.61	154.08	133.8	22.16	174.9
Population density (pp/ km²)	1,010	857	116	163	554	551
# PT lines	20 (incl. 2 DRT)	85	4	9 (incl. 2 DRT)	3	11 (incl. 2 tram lines) ** 1 bus line is planned to start operate end of 2024.*
Daily BKM (not incl. DRT)	12,517	17,445	1,391	1,403	411	8,847
# departures per weekday	1,489	1,893	118-130	187	75	465
Number of lines						
Population/line	9,250	1,639	4,450	2,430	4,093	8,756
Population density/line	51	10	29	18	185	50
Population/daily BKM	15	8	13	16	30	11
Population/departures working day	124	74	144	117	164	207
Population density/departures working day	0.68	0.45	0.94	0.87	7.39	1.18

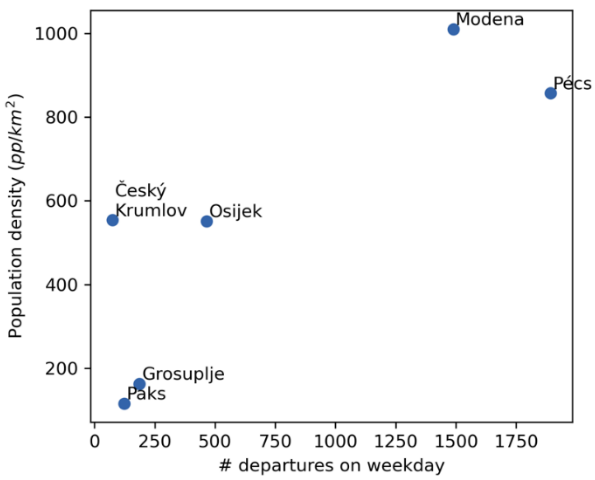

Figure 8. Correlation plot between population density and PT departures on weekdays

3. PT Demand Analysis

Like any transport systems, the PT services also need to consider the balance of supply and demand. In this section, the demand statistics of the case study areas is analysed, focusing on the demand trend over the past five years (Section 3.1), by month (Section 0), and by hour (Section 3.3). Further derived indicators related to the PT demand are given in Section 3.4, such as the ratio between the annual ridership and total length of the PT lines, numbers of vehicles, total capacity of the vehicles, total numbers of departures, kilometres of service, etc.

3.1. Demand trend in the past five years

Figure 9 shows the magnitudes and fluctuations of the total numbers of passengers in each case study city in the past five years. The data from Paks are only available starting from February 2021, as before that the PT in the city was still operated by the state bus company, *VOLÁNBUSZ*.

From the magnitude's perspective, Pécs has the highest numbers of passengers per year, serving 30-40 million trips. Modena and Osijek have the second and third highest numbers of passengers, both close to 10 million per year. Paks, Grosuplje, and Český Krumlov are next on the list, serving around or less than 1 million passengers per year.

Another visible feature in Figure 9 is the reduction of passenger volume around 2020-2022, for the reason of pandemic lockdowns. **Only Grosuplje and Český Krumlov have returned to the pre-pandemic level in terms of PT passenger volume by 2023, while Modena, Pécs and Osijek are still not recovered (by 2023).**

For Osijek, there is a large-scale infrastructure modernisation project started in 2022, which caused disruptions to PT services and might contribute to the low ridership in 2022 and 2023. There is not sufficient information to evaluate the impact of pandemic on the PT ridership in Paks, as the system was managed by the state-owned bus company and replaced by the current municipally owned operator Paks Transportation LLC in 2021. Passenger volume before February 2021 is thus not available.

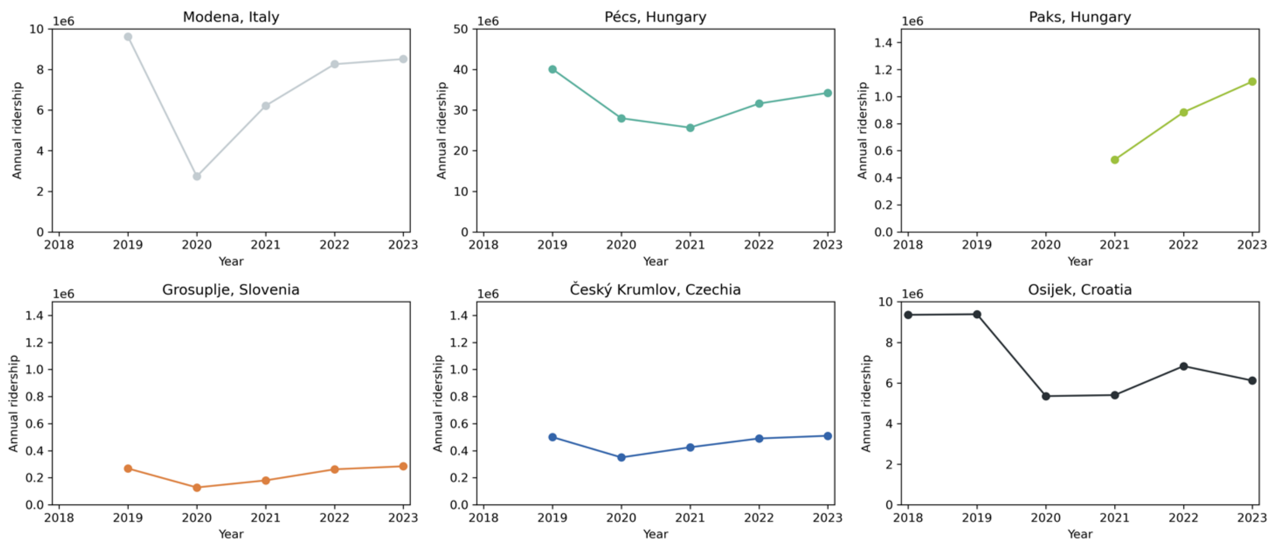

Figure 9: Annual PT ridership in the past five years in case study areas

3.2. Monthly demand

The variations in PT demand by month is shown in Figure 10. **For most of the cities, the higher monthly demand coincides with the school seasons (March-May, September-December).** The demand is the lowest in the summer break (July and August). For example, in Paks, the numbers of bus departures per day for Line 1 during summer months are one-third lower than other months, replaced by Line 1S which operates only in the summer.

This highlights the importance of customising the PT planning for school pupils. **It is also important not to neglect other potential groups of users of the PT system in planning, focusing only on schoolchildren.**

The profile of Český Krumlov is an outlier of the above-mentioned trend, where the demand peaks in August. This is because Český Krumlov attracts many tourists as well as sports enthusiasts during the summer months, thanks to its status as an important historical and cultural monument of UNESCO, as well as the offerings of leisure activities such as boating along the Vltava River.

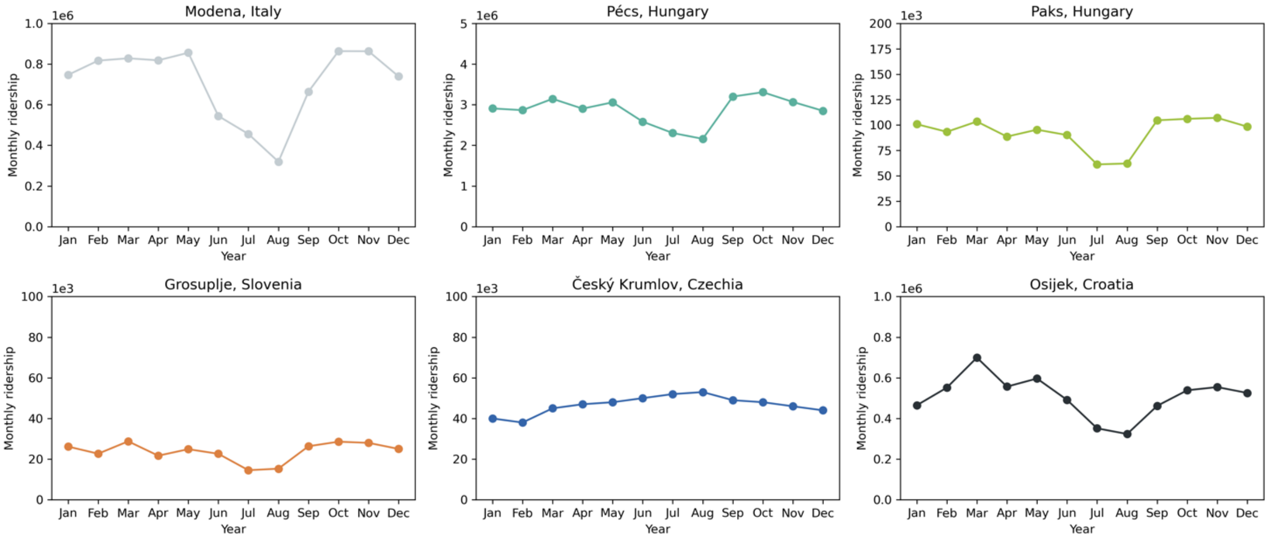

Figure 10: Monthly demand profiles in case study areas.

3.3. Hourly demand

The hourly demand profile for each study area is given in Figure 11. As can be seen from the figure, most cities have two distinct peaks, with the morning peak at 7:00-8:00 (6:00 for Grosuplje and Český Krumlov due to the early start of factory shifts) and afternoon peak at 15:00-18:00 (14:00 for Paks).

Grosuplje does not have an obvious afternoon peak, as the activities in the afternoon are more dispersed through the hours than the morning peak. This is probably the influence of Ljubljana as the capital, which, due to its offering of many different job or leisure activities, disperses afternoon returns to Grosuplje.

Modena and Pécs also exhibited a noon peak around 12:00-13:00. The noon-peak likely shows the student passengers who use the PT services after school.

For Český Krumlov, the PT usage of students, tourists, and ending factory shifts are all connected, contributing to a continuous high level of PT usage throughout the day.

The peak passenger count is the highest in Pécs at 7:00, with nearly 9,000 passengers recorded in a single hour. For Osijek, the hourly demand is the approximation using the school month data. It is estimated that there are around 6,500 passengers during the morning peak or the afternoon peak on a typical working day.

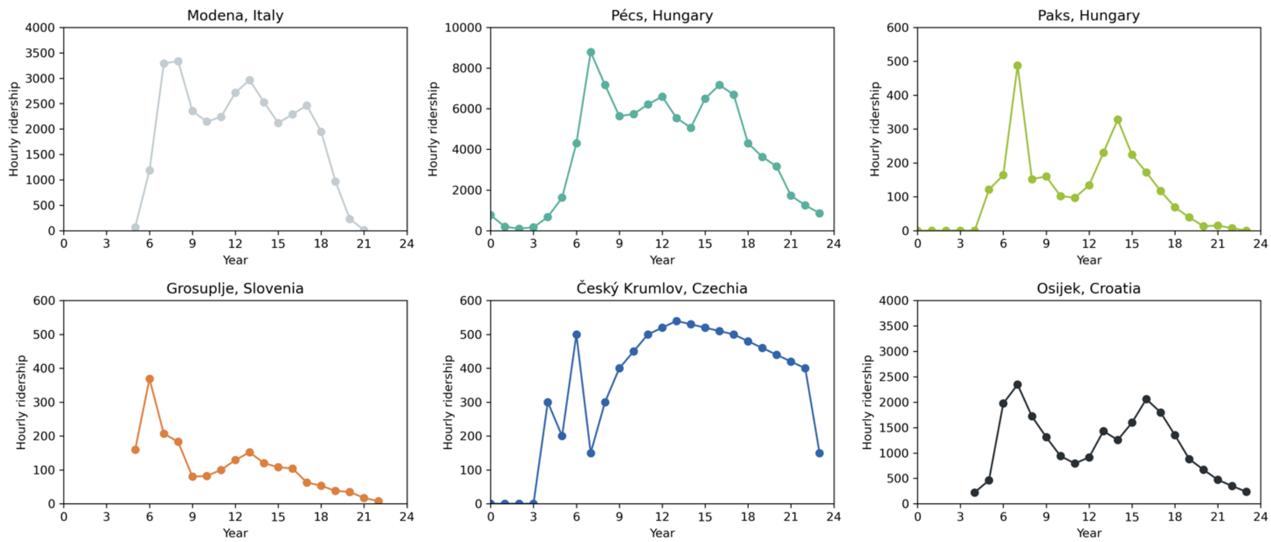

Figure 11: Hourly demand profiles

3.4. Derived demand statistics

Further statistics are derived regarding the ridership of the PT systems in the study area. These statistics are given in Table 8. The first section of Table 8, “Case study area”, lists the indicators related to the spatial-demographics, PT lines, length, annual BKM, vehicle counts, departures and total capacity. These indicators (some of which have been presented in previous sections but listed here for easy comparison) are used to derive the indicators in the second section “Indicators based on annual demand".

The average PT trips per person per year measures the utilisation of the PT system, and this indicator is the highest in Pécs at a value of 246. This shows that in Pécs, the residents make on average around five trips on PT per week. In fact, as a regional core, many of the riders of the PT system in Pécs may be visitors to the city. In other cities, the value of this indicator is around 40-60, while the lowest is in Grosuplje, with only 13 PT trips per person per year on average.

The ratio between the daily ridership and population density is a modification of the above indicator by taking the size of the study area into consideration. Given similar values in average PT trips per person per year (indicator above) in Modena, Paks, Český Krumlov and Osijek, the ratio between the ridership and population density in Český Krumlov is significantly lower than the other three cities. **This is because although Český Krumlov has the smallest area and highest population density, the PT ridership nevertheless does not grow proportionally with the increased urban density.**

The next few indicators all measure the efficiency or utilisation rate of PT services from different angles, by quantifying the numbers of PT riders served per vehicle capacity, service kilometres, per unit of line length, per service run, per vehicle and per available capacity on the vehicles.

For example, the "Avg. daily static PT capacity utilisation" represents how many times the daily demand exceeds the daily vehicle capacity (static). This metric is a ratio that indicates the average number of times a PT vehicle's capacity is utilized throughout the day.

These ratios help to understand the relative demand for PT in each area. A higher ratio indicates a higher frequency of seat turnover, which may suggest a need for more vehicles or higher capacity vehicles to meet the demand without causing overcrowding. Conversely, a lower ratio indicates that there is less demand relative to capacity, which might suggest that the current fleet size is adequate or even that there could be an opportunity to reduce the number of vehicles without negatively impacting service levels.

Pécs in general has the highest utilisation rate thanks to its high annual ridership. However, it is surpassed by Modena, Český Krumlov and Osijek in terms of the ridership per kilometre of PT line. This is because Pécs also has a very extensive PT network, and the total length of the 85 lines is several times higher than other cities.

In general, the utilisation of PT is the lowest in Grosuplje, with about five passengers served per departure and less than one passenger served per kilometre of PT service. Given the low ridership and PT utilisation, the municipality of Grosuplje will test and implement a pilot study that expands and optimises the existing DRT solutions the Polica settlement area (northeast of the municipality) in the OPTI-UP project, aiming to achieve lower cost, more flexible services to these settlements while maintaining the accessibility of these areas to sustainable PT services.

Table 8: Derived PT annual ridership statistics in the case study areas.

	Modena	Pécs	Paks	Grosuplje	Český Krumlov	Osijek
Case study area						
Population (latest data)	185,009 (2024)	139,330 (2024)	17,801 (2022)	21,870 (2024)	12,278 (2021)	96,313 (2021)
Area (km^2)	183.23	162.61	154.08	133.8	22.16	174.9
Population density (pp/ km^2)	1,010	857	116	163	554	551
# PT lines	20 (incl. 2 DRT)	85	4	9 (incl. 2 DRT)	4 (incl. 1 DRT)	11 (incl. 2 tram lines)* *1 bus line is planned to start operate end of 2024.*
Total PT line length (km)	179.7	2,507	118.1	99.6	18	154
Annual BKM (not incl. DRT) [in thousands]	4,568,650	6,367,395	507,773	512,189	150,000	3,229,226
Annual departures (52 weeks, 5 × weekday + Saturday + Sunday)	483,340	609,960	39,728	52,884	23,036	156,676
Total PT vehicles *(not incl. DRT)*	109	160	10	14	10	67
Total PT daily static capacity *(not incl. DRT)*	10,629	16,537	554	700	600	6,602
Indicators based on annual demand						
Annual ridership (2023)	8,517,130	34,252,000	1,111,286	284,511	510,000	6,117,714
Avg. PT trips per person per year (annual ridership/population)	46	246	62	13	42	64
Daily ridership /population density	23	110	26	5	3	30
Avg. daily static PT capacity utilisation	2.2	5.8	5.5	1.1	2.3	2.5
Annual ridership/annual BKM (pass. per BKM)	1.9	5.4	2.2	0.6	3.4	1.9
Annual ridership/total line length (pass. per line km)	47,396	13,663	9,410	2,857	28,333	39,725

Avg. PT ridership per departure (pass. per departure)	18	56	28	5	22	39
Annual ridership/# vehicles (pass. per vehicle)	78,139	214,075	111,129	20,322	51,000	91,309

4. PT Financial Indicator Analysis

In this section, the financial aspects of the PT systems are analysed for each case study area. **As in most places in the world, the costs of operating the PT systems in the case study areas exceed the revenues, and government subsidy is needed to cover the cost of staff, operation, and other spendings.**

In Section 4.1, an overview of the cost and revenue trend is presented for each city in the past five years. In Section 4.2, a detailed breakdown of the cost and revenue structure is presented with the most recent available data.

4.1. Cost and revenue trend

Figure 12 shows the cost and revenue trend of the PT system in each case study area. The revenue figures do not include government subsidy (i.e., only from the sales of tickets or passes).

For Paks, since the city bus company started to operate in February 2021 (took over from the state-owned operator then), data is only available from then onwards. The revenue from the farebox is only 7% of the total cost in 2023, which is the lowest in the study areas. This is explained by the very low tariff for PT in Paks (lowest in Hungary and across the six study areas) to encourage the mode shift away from driving.

However, various studies have proven that price is not the key factor in choosing a mode of travel, but rather the quality of service. Accordingly, it can be assumed that increasing the price will not result in a significant loss of users but will increase the system's revenue.

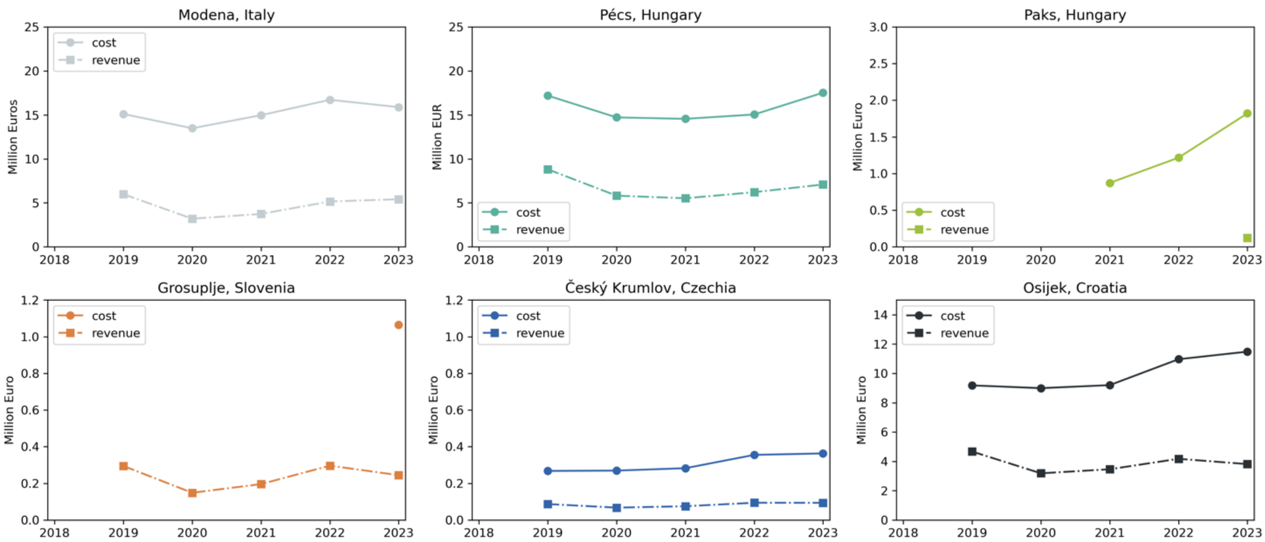

Figure 12: Cost and revenue trend in the past five years

By analysing the trend in the past 5 years, for most cities the revenue was negatively impacted by the COVID-19 pandemic in 2020 to 2022, though to various degrees. **Compared to the 2019 revenue, the 2021 fare revenue is 63% (Modena), 63% (Pécs), not available (Paks), 66% (Grosuplje), 86% (Český Krumlov), and 74% (Osijek).**

After the COVID-19 pandemic, the cost increased in general from 2022 to 2023 for the four cities where data are available. For Český Krumlov and Osijek, the cost of the PT system has reached a higher level than 2019-2021, while the revenue is about the same or still has not returned to the pre-pandemic level. Specifically for Osijek, as discussed in Section 3.1, there is a large-scale infrastructure modernisation project since 2022, which explains the increased cost and the lowered revenue in 2022 and 2023.

4.2. Cost and revenue structure

4.2.1. General observations

Figure 13 presents a detailed breakdown of the costs and revenues, which helps to understand the financial structure of the PT system in each city.

The reliance on government subsidies varies significantly across cities. **Paks has the highest dependency on government funding, with 93% of its total costs covered by subsidies, while Pécs has the lowest at 59%.** This indicates varying levels of financial sustainability and government support among the cities. The proportion of farebox revenue to total costs also shows diversity. Cities like Modena and Grosuplje have lower farebox revenue ratios, whereas Pécs and Osijek have higher ratios. This reflects different fare policies and user bases.

Cities with a higher proportion of revenue from passes, such as Modena, Pécs and Grosuplje, indicate a more committed user base, which can be beneficial for long-term financial stability. The distribution of operational costs also varies, with some cities having higher staff costs, like Modena, and others having higher operation costs, such as Český Krumlov. This variation can impact the overall financial health and efficiency of the public transport operators (PTOs).

In conclusion, the financial performance of PTOs is influenced by a combination of cost structures, revenue sources, and government support.

Standardizing databases at the EU level could help in creating more measurable comparisons and identifying best practices for financial sustainability in public transport. This standardization would allow for better benchmarking and the sharing of successful strategies across different regions, ultimately leading to more efficient and financially stable PT systems.

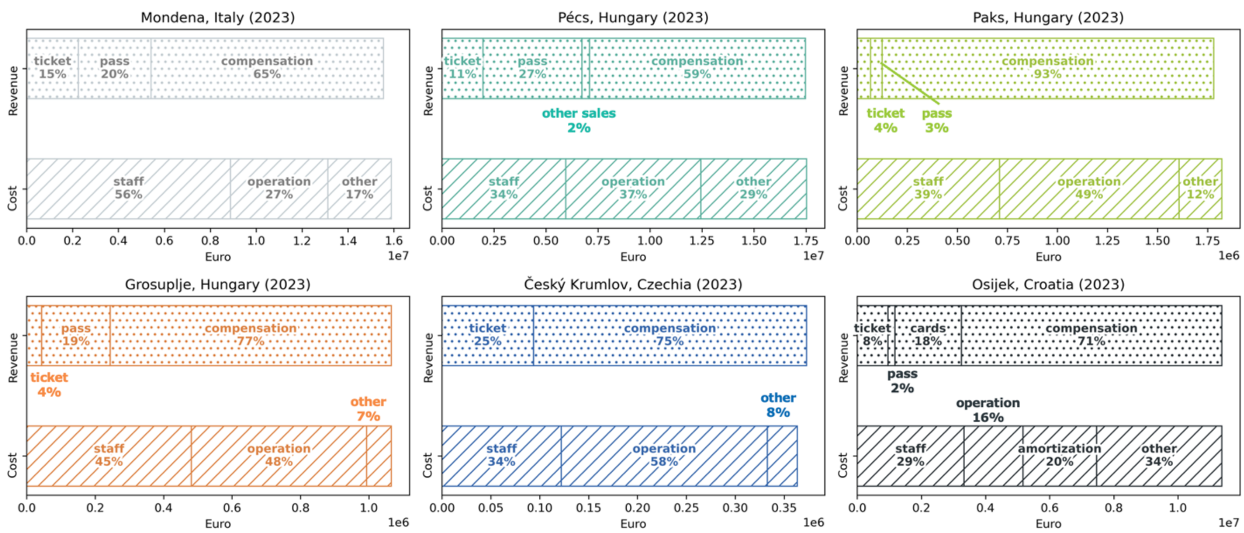

Figure 13: Breakdown of cost and revenue for each case study city

- **<u>Modena</u>**

   - The staff cost, operation cost, and other cost are 56%, 27% and 17% each of the total cost in Year 2023. The farebox revenue (tickets and passes) covers 34.1% of the total cost. The government compensation adds to another 63.8%. It should be noted that the PTO operates in three provinces, and the actual balances are calculated together for the three provinces. The numbers provided above for Modena depends on the criteria used for calculating the costs and benefits by areas and may not be exact for Modena. As a result, the sum of the revenues is slightly lower than the total cost.
   - More specifically regarding the farebox revenue, about two-thirds of them come from the sales of the annual (€140-260 per year) and monthly passes (€32 per month), while one-third comes from the sales of the single tickets (€1.5 per trip). This indicates a good amount of committed PT users in the system.
- <u>Pécs</u>
   - The staff cost, operation cost, and other cost are 34%, 37% and 29% each of the total cost in Year 2023. The farebox revenue (tickets and passes) covers 38% of the total cost. The government subsidy contributes to 59% of the total cost, while the remaining 2% are from the sales income other than tickets.
   - Most of the fare incomes consist of the sales of monthly or 30-day passes (7,300 HUF or ~€19; 42%), monthly student passes (3,900 HUF or ~€10; 20.5%), and single tickets (400 HUF or ~€1; 28.6%). In addition, the city also offers other flexible fare options, including 7-day pass, half-month pass, quarterly pass and discounted monthly pass for seniors, which all together consist of less than 10% of the total farebox revenue.
- <u>Paks</u>
   - The staff cost, operation cost, and other cost are 39%, 49% and 12% of the total cost in Year 2023. The farebox revenue (tickets and passes) covers 7% of the total cost. The government subsidy contributes to the rest 93%.
   - **Compared to other cities, the ratio of farebox income to the total cost is the lowest in Paks, due to the low cost of PT fares (lowest in Hungary as well as in our six case study areas).**
   - The revenues from the sales of single tickets (54%) and passes (46%) are about the same. For the single tickets (~€0.63), most are purchased on the bus, while only around one-tenth are purchased from the mobile app. For the various passes, the majority sold are the monthly passes (regular: ~€10.06; discounted: ~€4.53). The revenues of quarterly passes are around 2.6% of the total fare revenue.
- <u>Grosuplje</u>
   - The staff cost, operation cost, and other cost are 45%, 48% and 7% of the total cost in Year 2023. The farebox revenue (tickets and passes) covers 23% of the total cost, while government subsidies cover around 77%.
   - As for the demand and operational analysis in previous chapters, these financial figures are taken from the costs and revenues of the full system according to the proportion of the length of the lines within the Grosuplje municipality.
   - **Most of the revenue comes from the youth monthly pass (€10; 58.52%) and youth annual pass (€100; 8.27%), indicating that the main usage of the PT in the municipality is for school commuting.** The sales of single tickets (€1.3) constitute 12.31% of the total revenue.

  - These statistics are different compared to the revenue structure of the full length of the lines (also including the portions of lines not within the Municipality of Grosuplje), where the shares of revenues coming from university student passes and adult monthly or annual passes are higher, while the shares of the youth passes reduce to about a half.

- Český Krumlov
  - The staff cost, operation cost, and other cost are 34%, 58% and 8% of the total cost in Year 2023. The farebox revenue (tickets) covers 25.8% of the total cost, while the city funding covers the rest of the total cost. **In Český Krumlov, there is no public transport passes, so all farebox revenues come from the sales of the tickets.** For cities of smaller sizes, the staff cost is usually higher (e.g., 39% for Paks and 45% for Grosuplje). Český Krumlov has a lower share of personnel expenditure, which may need further validation in subsequent studies.

- Osijek
  - The staff cost, operation cost (including amortization), and other cost are 29%, 36% and 34% of the total cost in Year 2023. The farebox revenue (tickets and passes) covers 28.6% of the total cost, while the rest of the cost is covered by the government subsidy.
  - Among the share of the 36% operation cost, the cost of materials (energy, spare parts, goods, rent, ...) is 16%, while the other 20% are for the amortization of both tangible and intangible goods. The other costs include the costs of insurance, banking services, transportation allowances for the staff, etc.
  - Revenue mainly comes from passenger transport: about 64% of the revenues come from the usage of personalized cards for regular commuters, while 30% come from the usage of single (€1.46 - €3.50) and daily tickets (€4.65). The adult cards (€36.50 - €126.35 for monthly pass and €364.99 - €809.60 for annual pass), student cards (€15.93 – €70.00 per month), pupil cards (€7.30 – €126.35 per month) and senior cards (€2.65 – €25.00 per month) each contribute to 21%, 7.7%, 20% and 13.8% of the revenue.

4.2.2. Derived financial statistics

Table 9 compares the cost and revenue per BKM and per passenger, offering a perspective to evaluate the efficiency of each system.

Paks has the highest cost per BKM at €3.72. Modena has the second highest cost per BKM at €3.42, which is unusual for a relatively large system. This may be due to that the data come from the PTO which offer services to both urban and suburban areas, and their cost calculation method may not be exactly comparable with other cities. For all other cities, the cost per BKM is below €3. In terms of the cost per passenger, it is the highest in Grosuplje, even though Grosuplje has the lowest cost per BKM. This can be explained by the low ridership of the PT systems in Grosuplje: in all the six cities, Grosuplje has the lowest the ratio between the annual ridership and annual BKM.

In terms of the unit revenue, the three relatively large cities (Modena, Pécs and Osijek) have the highest revenue per BKM, which is slightly over €1. Intuitively, this could be because of the higher utilisation rate of the PT in these cities as shown in Table 8. Paks and Český Krumlov also have high PT utilisation rate (measured by the ratio between the PT ridership and BKM). However, as the average revenues per passenger in these two cities are among the lowest, the revenues per BKM are also on the lower end.

The numbers below are based on 2023 statistics for most cities except Osijek, which underwent a big infrastructure modernisation project in 2023. This project significantly increased the cost of the PT systems, and negatively impacted the ridership and revenue in 2023. As a result, the values from 2022 statistics are presented for Osijek in Table 9.

Table 9: Cost and revenue per BKM and passenger

	Modena	Pécs	Paks	Grosuplje	Český Krumlov	Osijek (2022)
Annual KM and passenger counts (2023)						
Annual BKM	4,628,218	6,367,395	507,773	512,189	150,000	3,617,785
Annual ridership	8,517,130	34,252,000	1,111,286	284,511	510,000	6,832,629
Cost (€): not including the amortisation cost						
Total (2023)	15,884,825	17,525,525	1,820,796	1,065,354	363,403	9,272,827
Per BKM	3.43	2.64	3.72	2.08	2.42	2.56 Bus: 2.44, Tram: 3.93
Per passenger	1.86	0.51	1.64	3.74	0.71	1.36
Revenue (€)						
Total (2023)	5,416,314	7,091,074	123,527	244,521	93,771	4,173,659
Per BKM	1.17	1.02	0.24	0.48	0.63	1.15
Per passenger	0.64	0.20	0.11	0.86	0.18	0.61

5. Methodology of PT Planning

Data are collected regarding the activities of PT planning, operations, and maintenance and the relative stakeholders involved in each step. An overview of the data collected is given in Figure 14. A horizontal bar indicates that the corresponding stakeholder (column header) is involved in the activity (row header).

From the overview, the involved stakeholders in different activities in the pilot cities are rather different. For example, the strategic and tactic planning of the PT systems involve stakeholders from almost all different categories. For other activities, e.g., the operation plan of the PT system and the financial investment of the vehicles, the operators are the main players in all case study cities.

In general, the PTOs and city departments are the most involved stakeholders. In Slovenia a special company as created after the COVID-19 pandemic to streamline the management and regulation of the PT (Družba za upravljanje javnega potniškega prometa, DUJPP). This special organisation (under the category "other transport authority") appears in almost all activities for the Grosuplje case, except from the spatial planning and operational planning of the PT systems.

Another key question in the OPTI-UP project is if (and to what degree) the transit planning and spatial planning are carried out in an integrated manner, such as transit-oriented development. **Responses from Modena, Český Krumlov and Osijek indicate that the two planning efforts only intersect in terms of reserving space for transit stops and road corridors, and transit-oriented development has not been widely realised.**

In Paks, the possibility of the integration of transit planning and spatial planning has been raised as the municipality considers ways to ensure the smooth commuting of more than 10,000 new residents/workers to the newly constructed nuclear power plant. During the OPTI-UP, Paks will thus evaluate and implement an optimised PT network through a data-driven and model-informed planning process, thus better serving the commute and travel needs in relation to the new nuclear power plant.

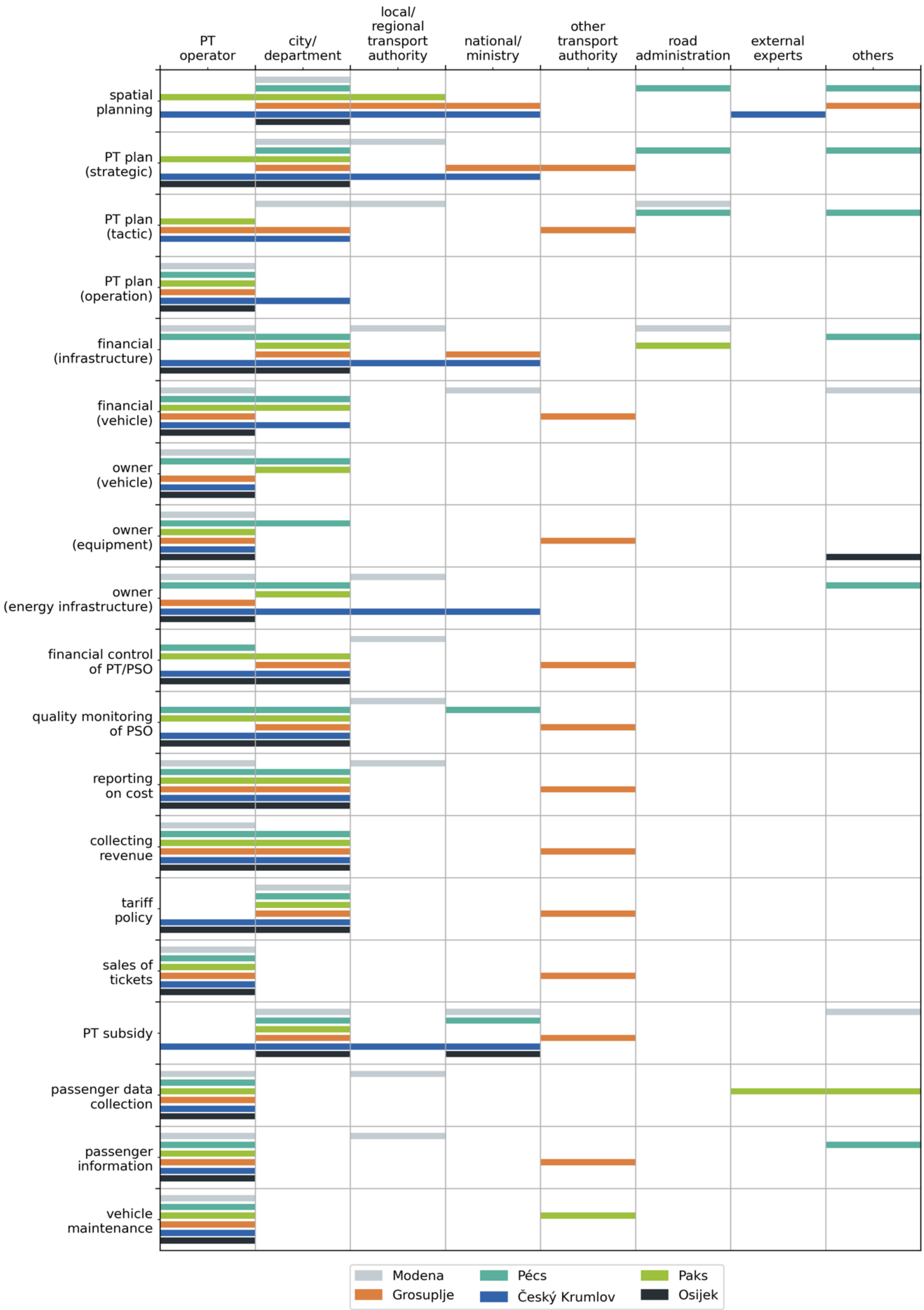

Figure 14: Overview of the stakeholders and activities related to PT planning, operations and maintenance in each case study city

B. Best Practices section

6. Best practice in PT improvement

Many small and medium-sized European communities still lack adequate public transport systems. Often, existing systems are outdated, which negatively impacts the environment and fails to meet the growing demand of expanding populations. As a result, residents are frequently forced to rely on private cars.

Effective urban transport planning in functional urban areas is crucial to address these challenges, ensuring more efficient commuting through well-developed public transport networks that align with the growth of urban and suburban regions. Moreover, guaranteeing access to services of general interest for those without private vehicles or the ability to drive is essential for fostering social cohesion, education, employment, and more.

6.1. Introduction and methodology

To support technical data collection, there are numerous examples of projects that have been successfully implemented in different contexts and can guide the development of OPTI-UP project pilots. These examples are referred to as Best Practices.

A Best Practice is a set of guidelines, approaches, or methodologies that, when applied effectively in a project, lead to optimal results.

In the context of public transport in medium to small-sized cities, Best Practices are particularly significant as they provide strategic and practical frameworks to address specific challenges, such as limited budgets, evolving demand patterns, and infrastructure constraints. These practices aim to enhance efficiency, accessibility, and sustainability while ensuring high-quality service for citizens.

Best Practices may include technical solutions, management models, and collaborative approaches that have been successfully tested elsewhere and can be replicated to improve overall service quality.

The objective of this section is to collect and analyse Best Practices related to the three OPTI-UP themes:

- public transport (PT) network optimization
- demand-responsive transport (DRT)
- and alternative fuels.

These themes will serve as a foundation for the development of six pilot projects, aiming to allow the replication of successful solutions in the diverse contexts involved.

Each project partner has therefore identified at least two or three Best Practices—examples of projects developed in other European regions, either near or distant from the pilot cities—that have produced valuable outcomes for OPTI-UP project and are relevant to the three themes chosen within the project.

The leaders of WP1 have created a template for collecting Best Practices, with the goal of facilitating the work of partners and gathering the necessary key information that aligns with the objectives of the OPTI-UP project.

The template is divided into three main sections:

- General Information about the Best Practice
- Description of the Best Practice

- Main Lessons Learned and Recommendations

This structured approach helped ensure a thorough analysis and enable the effective replication of successful initiatives across different urban settings.

Figure 15: Template for collecting Best Practices

Below are the Best Practices that were selected from the 6 pilot cities.

6.2. Selected Best Practices

The OPTI-UP partners collected 19 Best Practices to gain information and advice for the project pilot actions.

The Best Practices were grouped based on the type of Opti-up transport projects:

- Public Transport Routes/Network Optimization (PT OPTIMIZATION)
- Alternative Fuel (ALTERNATIVE FUEL)
- Demand Responsive Transport (DRT)
- Mixed (A combination of previous topics)

Figure 16: Map of the Best Practices for different themes

Mapping the selected Best Practices and placing them on a map of Central Europe is crucial for several reasons.

This visual representation helps project partners understand the geographical distribution of successful transport projects or initiatives, highlighting regional strengths and weaknesses. By visualizing where specific Best Practices have been implemented, partners can identify areas with similar characteristics, helping to adapt proven solutions to their own contexts.

The map provides valuable input by facilitating knowledge transfer, showcasing real-world examples that can be replicated or adapted to meet local needs. It allows partners to learn from neighbouring areas and fosters cross-border collaboration.

For each Best Practice, a few key concepts are listed in the table below as a reference.

The full description of each Best Practice can be found in the chapter 7. where additional details and links for further in-depth analysis are also provided. These key concepts can assist Partners in identifying examples of Best Practices throughout the deliverable.

6.2.1. Public Transport Routes/Network Optimization

Table 10: Important keywords related to PT Optimization

	Best Practice	Keywords
PO_1	Public transport reorganization in the city of Šibenik	• Organization and integration of public transport • Creation of a modern, efficient, and accessible public transport system • Reduction of car dependency • Efficient integration of new buses • Strategic planning and engagement with the community and multiple stakeholders
PO_2	Pula Public transport new lines	• 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
PO_3	Implementation of an Intermodal Junction in Kaposvár	• New intermodal hub • Joint platform between various transport branches • Public safety with cameras • Coordination of needs among the three transport companies
PO_4	Development of public transport by purchasing electric buses in Győr and its economic zone	• New buses • Eco-friendly new transport options • Involvement of citizens
PO_5	Improving urban mobility through self-driving electric shuttle	• Driverless electric shuttle • Self-driven, autonomous, electric small buses or shuttles • European cooperation program Interreg Italy-Switzerland • Involvement of stakeholders at different levels • Mobility on demand • Using an app
PO_6	Adjustment of Public Transport Routes in Strakonice	• Revision and optimization of existing public transport routes • Increasing the efficiency and accessibility of public transportation • Engaging and coordinating with various stakeholders

6.2.2. Alternative Fuel

Table 11: Important keywords related to Alternative Fuel

	Best Practice	Keywords
AF_1	**Car Sharing of Electric City Cars in Jyväskylä**	• Easily charging e-vehicles in the city centre required • Fixed parking spaces only in the centrum limits the radius of using the electric cars city-wide • The online application (App) for renting coordinated by an operator that offers other mobility services • A promotional campaign facilitates the uptake of the ongoing initiative. • Need for a well-planned service to function finance-wise • Properly defining the nature of the new transport service provided within the local public transport
AF_2	**Introduction of Electric Buses in Public Transport in České Budějovice**	• Initial high costs of purchasing and installing the charging infrastructure • Need for training drivers and technical personnel • Integrating new technologies into the existing system • Issues with the capacity of charging stations during peak hours • Having a well-planned and phased approach to implementation • Involve all relevant stakeholders • Ensuring adequate infrastructure support • Regularly monitor performance and adapt to changes
AF_3	**Modernization of the Vehicle Fleet with Partial Trolleybuses in Ústí nad Labem**	• High initial costs for purchasing trolleybuses and infrastructure • Technical issues in integrating the new vehicles into the existing system • Regular maintenance and monitoring of the batteries and charging stations • Training for technical personnel • Include all relevant stakeholders from the beginning of the project • Electric buses increased passenger satisfaction due to quieter and cleaner public transport, as well as the improvement in air quality in the city

6.2.3. Demand Responsive Transport (DRT)

Table 12: Important keywords related to DRT

	Best Practice	**Keywords**
D_1	ShuttleMare - free DRT service for summer season in Rimini	• Complementary to the PT service • Resources to ensure that the service was free for users • Dimensioning number of buses, drivers and expected trips • Changing mobility habits • Complementary land planning (e.g., Parking plan) • Interaction between the different bodies involved • Zone based service

D_2	Tuobus - Complementary DRT service for evening hours	• Optimal operational area • New agreement with driver' unions • Dimensioning number of buses • Analysing the demand • Ticket compatibility with standard PT
D_3	Colbus - New DRT service in Apennines Area	• Customized software • Stakeholder involvement • Accessibility to points of interest to all categories of users • Communication campaign/ new logo • Friendly tool for everyone • Flexible service
D_4	RUMOBIL - Optimize data collection related to DRT service	• Easy and intuitive tool • Data-driven improvement of the service
D_5	Prostofer - Free transport for the elderly	• Volunteering drivers • Need for sponsorships • Studying potential demand to avoid unreliable replacement of public transport • Strong demand for flexible, affordable, and accessible transportation options, particularly for elderly and people with disabilities • Help enhancing community connectivity • Sparsely populated areas
D_6	Mokumflex -Impacts of replacing a fixed public transport line by a demand responsive transport system: Case study of a rural area in Amsterdam	• DRTs carry less passengers than previous public transport • Require a level of digital literacy • Large timeframe around the desired departure time • Difficult to guarantee punctuality • Need to reserve trips with a digital system can be difficult • DRT more efficient that standard bus lines
D_7	Kutsuplus - Pursuing mobility on Demand	• High operational costs • Struggled with scalability • Insufficient long-term political and financial support • Difficulty to book trips, with no mobile app • Need for a large marketing campaign • Lack of awareness about the service • Software and routing algorithm using real time data

6.2.4. Mixed topic

Table 13: Important keywords related to Mixed Topic

Best Practice		Keywords
M_1	Citizen-oriented planning of public transport system in Rezekne city	• State or regional policies can harm local PT development • Design the service to overcome physical and cultural barriers • Receiving feedback from passengers via questionnaire • Needs new infrastructure • Needs investment/financial • Preparation of staff • E-bus operation proved successful

M_2	Zielona Góra public transport reorganization	• Failure to deliver some of the ordered vehicles • Ensure infrastructure readiness, particularly charging stations, to support electric buses • Resistance to change from drivers and a reluctance to drive electric buses • Invest in driver training and engagement • Optimize battery range and charging strategies
M_3	Mobility on demand	• Sustainable business model • Need public financial support and well-established governance • Areas where there is a shortage of easily available public transport

6.3. Best Practices summary results

By analysing the Best Practices identified by the partners, the projects they highlighted serve as valuable examples for the development of the pilot projects within the OPTI-UP initiative. These examples were tested in various European cities with characteristics and sizes similar to those where the OPTI-UP pilots will be implemented.

This makes the evaluation of these Best Practices crucial for the project partners, particularly in the development and testing of their own pilots. The examples provide practical insights that can be directly applied to the OPTI-UP project.

One key outcome of this Best Practice analysis is the identification of significant and relevant topics aligned with the project's objectives.

Another important aspect of the analysis was determining whether existing BP models were utilized and understanding the relationships between the different Best Practice examples and the OPTI-UP pilots:

- **PO_1** (Šibenik public transport reorganization): A perfect example of PT network/route optimization, relevant for the cities of Osijek and Paks.
- **PO_3**: A good example for Paks, where the city's dynamic growth and high number of daily commuters could benefit from improved coordination between urban transport and incoming external transport modes.
- **PO_5**: A valuable example for Pécs, as the Pécs pilot is linked to the electrification of the city's public transport bus fleet.
- **PO_6**: An excellent example for Český Krumlov, offering experience and data for planning and optimizing public transport, specifically for introducing new routes.
- **AF_1** (Jyväskylä BP): A useful reference for Pécs, where the pilot focuses on bus fleet electrification. The integration of electric cars in public low-emission transport systems for sustainable commuting adds further value.
- **AF_2** and **AF_3**: Good examples for Český Krumlov, demonstrating measures to improve sustainability and efficiency in public transport and infrastructure modernization.
- **M_1** (Rēzekne BP): Relevant for Pécs, focusing on the integration of new e-buses with ticketing innovation and route network optimization to better meet public demand, particularly during peak hours.
- **M_2**: A strong example for Osijek, showing how public transport network optimization can enhance route efficiency and integrate eco-friendly buses, contributing to sustainable transport development.
- **D_1**: A good example for all pilot projects related to DRT (Demand-Responsive Transport), showing how to develop app-managed services with no fixed routes.

- **D_2**: Relevant for both DRT pilots and transport network optimization pilots, as it demonstrates how DRT solutions can stem from revising evening transport services.
- **D_3** and **D_4**: Key examples for DRT pilots, highlighting important considerations for implementing on-demand services with software support, and understanding key performance indicators (KPIs) for monitoring and analysing a DRT service.
- **D_5**: A good reference for Pécs, demonstrating that non-timetable-based mobility services, such as public services with electric vehicles, can meet the mobility needs of new or underserved areas, even seasonally.
- **D_6**: A relevant example for Grosuplje, despite focusing on a marginal group of elderly individuals in rural Slovenia, as it addresses transport options where none exist.
- **D_7**: A highly useful example for Grosuplje, where a similar action is planned to connect the rural village of Polica with Grosuplje via a bus line.
- **D_8**: A strong reference for Grosuplje, exemplifying the technology and execution of DRT solutions, aligning perfectly with Grosuplje's pilot actions.

This reorganization makes it easier to see the connection between each Best Practice and the relevant OPTI-UP pilot city.

Two key aspects emerge from the analysis of the Best Practices collected in various European public transport projects. These aspects are crucial not only for the success of individual projects but also for guiding the development of the OPTI-UP pilot projects, particularly in areas such as public transport optimization, Demand-Responsive Transport (DRT), and the integration of alternative fuels.

The first important aspect is the involvement of stakeholders throughout the entire project lifecycle. This includes the planning, testing, deployment, maintenance, and monitoring phases. Engaging a broad range of stakeholders, from public and private operators to citizens, is consistently highlighted as essential for project success.

In most of the Best Practices analysed, local stakeholders—such as public and private transport operators—played an active role in planning, scheduling, optimizing, and testing public transport services, whether those services were traditional, on-demand, or fuelled by alternative energy sources.

In cases where public transport services are directly managed by national-level authorities, such as Ministries of Transport, technical experts from these bodies were involved to ensure that the project aligns with broader national transport policies and standards. Their participation has often contributed to smoother project implementation and greater alignment with long-term mobility strategies.

Equally important is the involvement of citizens and public transport users. Many projects incorporated feedback from the local population through surveys, online questionnaires, or in-person meetings. This input helped tailor services to actual user needs, fostering a sense of ownership and ensuring the services were both practical and user-friendly. Public engagement also serves to build trust in the new services, which is particularly important when introducing innovative solutions like DRT, which may be unfamiliar to the general population.

The second critical aspect that emerges from the Best Practices analysis is the importance of a well-executed external communication campaign. Promoting new or enhanced public transport services is vital to their success, particularly when these services involve significant changes or innovations, such as the adoption of alternative fuels or the introduction of DRT systems.

Effective communication strategies have included the widespread distribution of printed materials, such as leaflets and posters, as well as digital advertising on apps and local public transport websites. These campaigns have been instrumental in raising awareness of the new services among all age groups and across different segments of the population.

Such efforts are particularly valuable when introducing new services like DRT, which require public understanding and acceptance to function effectively. Without clear communication, many users may be unaware of the availability or benefits of such services, reducing their potential impact. The communication campaigns have also contributed significantly to long-term success by increasing ridership and ensuring that the public fully understands how to access and use the new services.

In conclusion, the experience of these European projects/BPs demonstrates that the optimization of public transport, DRT systems, and the use of alternative fuels benefit not only from technical expertise but also from strong stakeholder involvement and robust communication efforts. Evaluating these Best Practices provides insights for future projects, particularly those being developed within the OPTI-UP initiative. By incorporating these key elements, project partners can ensure that their pilots are well-designed, widely supported, and effectively utilized by the public."

7. Detailed overview of best practices

7.1. Public Transport Routes/Network Optimization

Six good practices of Public Transport Routes/Network Optimization have been collected:

Table 14: Summary of Public Transport Routes Best Practices

	Best Practice	City	Inhabitants	Country	Region	Partner
PO_1	Public transport reorganization in the city of Šibenik	Šibenik	31,000	Croatia	Šibenik-Knin County	GPP Osijek
PO_2	Pula Public transport new lines	Pula	52,220	Croatia	Istria County	GPP Osijek
PO_3	Implementation of an Intermodal Junction in Kaposvár	Kaposvár	59,000	Hungary	Kaposvár/South Transdanubia Region/Hungary	Paks LLC
PO_4	Development of public transport by purchasing electric buses in Győr and its economic zone	Győr	246,159	Hungary	Western Transdanubian Region	Paks LLC
PO_5	Improving urban mobility through self-driving electric shuttle	Alto Adige Province and Merano municipality	41,000	Italy	Trentino Alto-Adige	Pécs (STRIA)
PO_6	Adjustment of Public Transport Routes in Strakonice	Strakonice	23,000	Czechia	South Bohemian Region	Český Krumlov (VŠTE)

In this table significant data are reported, like inhabitants, City and Region. This information could be helpful for the Partners for pilots' development.

7.1.1. PO_1_ Public transport reorganization in the city of Šibenik

The city of Šibenik has initiated a major reorganisation of public buses to compensate for the inadequate service by purchasing 11 new buses. The study on the organisation and integration of public transport in Šibenik was the first step towards creating a modern, efficient and accessible public transport system, thus reducing car dependency and promoting sustainable mobility.

Figure 17: Šibenik PT lines map – Source: https://www.gradski-parking.hr/stranice/javni-gradski-prijevoz/86/hr.html

The main activities of the study were a comprehensive analysis of the existing transport system, field research on traffic and passenger demand, and the improvement of Sibenik's traffic model. A new public bus system, with over 60 route and stop variants, was designed, considering factors such as infrastructure, route speed and immediacy of travel. The new system provides simple routes with consistent intervals between buses and transfer points to facilitate line changes. Improvements have also been made to passenger information services and the fare collection system, making it simpler and easier to use. This reorganization led to a substantial increase in ridership, with passenger numbers rising by around 230%. The changes made public transport more attractive and accessible to residents and visitors, contributing to a shift in travel habits within the city.

Plans include expanding the network, increasing departure frequencies, and introducing environmentally friendly vehicles. This Best Practice has been successfully implemented and is currently operational in the city of Šibenik.

Stakeholders

In the implementation of this project in Šibenik, multiple stakeholders were engaged, including several departments within the city of Šibenik's administration and Gradski parking d.o.o., which functions as both the internal operator and the operator of the Main Bus Station. While other external bodies were not directly involved, the planning of bus timetables and routes was carefully coordinated with ferry service schedules and considered the standard working and school hours to ensure a harmonious integration of services and convenience for all users.

Timeframe

The timeline for upgrading the public transport system included several key steps:

- procurement process for the new buses: public tender, approximately four months;
- procurement phase;
- delivery of the buses, set at nine months from the date of contract award.

Parallel to the tendering phase and the subsequent delivery phase, an in-depth study was conducted over a period of eight months. The actual implementation of the reorganisation took place one month after the conclusion of the study, ensuring that the new buses were integrated into the system efficiently and in line with the recommendations of the study.

Use of Transport model

In the best practice implemented in Šibenik, an existing four-step transport model developed in PTV Visum software was utilized. However, upon initial review, it was identified that the model required corrections, updates, and calibration for both private and public transport due to outdated data and missing critical elements. The model was based on data from 2015 and to address these deficiencies, primary and secondary research was conducted. Primary research included manual traffic counts at key locations and passenger counts on public transport lines. Secondary research involved analyzing existing and publicly available traffic data. Following this comprehensive research, the transport model was updated and calibrated, allowing for the simulation of various new traffic organization scenarios.

Main challenges / issues encountered

The implementation of Best Practice in Šibenik faced several challenges, including difficulties with the existing private transport operator, the recruitment of a sufficient number of drivers and staff, and the preparation of all legislative and promotional documentation of the new system to obtain public approval. In addition, infrastructural constraints made it necessary to reroute some lines, while others required an adjustment of timetables for greater efficiency.

In addition, political pressures tried to influence organisational changes and there were problems with cars blocking designated parking spaces. **Addressing these challenges through strategic planning and community engagement could lead to enhanced results.**

Main lessons learnt / recommendations

The above underlines the importance of comprehensive planning and community involvement in public transport projects.

The main message of this BP is that **a change in public transport** is possible and beneficial if guided by expert analysis and planning. The example of Šibenik shows that a well-designed reorganisation can bring great benefits to both the city and its citizens. This success story underlines the potential for positive change in urban mobility when it is driven by informed expertise.

The main recommendations from Šibenik's BP for other pilot areas in OPTI-UP include:

- **Engage in comprehensive planning and analysis** to understand current transport inefficiencies.
- Prioritize the **procurement of an adequate fleet** to ensure service reliability and reduce subcontracting needs.
- **Design clear, user-friendly routes** with consistent intervals and integrate schedules with other transport services.
- Implement robust passenger information systems and streamline fare structures for user convenience.
- Anticipate and address infrastructure challenges by being prepared to adjust routes and timetables as needed.
- Foster public engagement and **transparent communication** to build support for the reorganization.
- **Remain adaptable to fine-tune the system post-implementation, based on real-world performance and feedback.**

Web links

PT Homepage: https://www.gradski-parking.hr/stranice/javni-gradski-prijevoz/86/hr.html

Timetables: https://www.gradski-parking.hr/stranice/gradske-linije-vozni-red/100/hr.html

Suburban Timetables: https://www.gradski-parking.hr/stranice/prigradski-prijevoz-vozni-red/101.html

Pricelist: https://www.gradski-parking.hr/stranice/cjenik/99.html

Ticketing: https://www.gradski-parking.hr/stranice/vrste-putnih-karata/94.html

7.1.2. PO_2_ Pula Public transport new lines

The Best Practice developed in the city of Gregovica has been introduced night bus line, no. 71, during the 2023 summer school holidays, with a reduced service in December 2023. Its main objective was to ensure connectivity between the suburban areas of the city and the city centre in late hours - night hours. The implementation was smooth, and no significant difficulties were encountered. It made 380 departures, covering 6,817 km and carrying 9,528 passengers, averaging 25.07 passengers per departure. Planning methods included consultations with users and the city, considering city events. The success led to the addition of two more lines in 2024 and the establishment of the Park & Ride service in Gregovica.

Figure 18: Urban lines- Source: https://www.pulapromet.hr/linije

Stakeholders

The stakeholders involved in this Best Practice were the city administration, responsible for spatial planning and public transport coordination, and the users of the public transport system. **Direct consultations with users** allowed for a service design that met the specific needs and preferences of residents, particularly during the summer months when city events likely increased the demand for late-night transportation. This collaborative effort between city planners and users was key to the successful implementation and optimization of the night bus routes.

Timeframe

The planning involved consultations with the city and users, particularly considering the various events happening in the city during the summer. The success of line 71 led to the introduction of two additional lines (72 and 73) for the summer school holidays of 2024, further enhancing connectivity. Additionally, a Park & Ride (P&R) service was introduced at the Gregovica stop from June 1, 2024.

Use of Transport model

In this Best Practice, a formal transport model, such as the 4-step model or Land Use and Transport Integration (LUTI), was not utilized. Instead, the approach was more pragmatic, focusing on **direct**

consultations with the city and users to assess needs and preferences. To inform and engage passengers, flyers were distributed, serving as an effective communication tool to raise awareness about the new night bus service. This straightforward method of **user engagement and information** dissemination was chosen over complex modelling, which suggests a focus on practicality and immediate implementation rather than predictive analytics or long-term planning simulations. While this approach may lack the predictive insights of formal models, it allowed for rapid deployment and direct responsiveness to user feedback.

Main challenges / issues encountered

The introduction of the night bus route 71, took place without any significant problems being reported. The service has been positively received by the community and this positive result suggests that the service has effectively met the needs and expectations of users. The **collaborative approach** adopted by the **municipal administration and public transport operators** in their consultation with the community resulted in a seamless integration of the new night bus line into the existing transport network.

Main lessons learnt / recommendations

The main lessons learned from the Best Practice include the **value of directly engaging with users and city officials** to tailor public transport services to community needs, particularly for special services like night routes. The smooth implementation with no significant challenges highlights the **importance of clear communication**, as achieved through the distribution of informative flyers. Additionally, the positive reception by the community underscores the necessity of **aligning new services with the actual demand** and ensuring they **complement the existing transport network**. This approach can lead to successful adoption and operation of new public transport initiatives.

The main message is that tailored public transport services, developed through community engagement, can be seamlessly integrated and widely accepted.

The main recommendations are:

- Engage with the community and city administration early to align services with user needs and urban events.
- Use simple, effective communication tools like flyers to inform users about new services.
- Monitor the service's acceptance and usage to gauge success and inform future expansions.
- Recognize that even small changes, when well-executed, can significantly enhance public transport without encountering major resistance or challenges.

Web links

https://www.pulapromet.hr/vozni-red/

7.1.3. PO_3_ Implementation of an Intermodal Junction in Kaposvár

The aim of the project was to further develop the **cooperation of public transport modes** in the city center of the County City of Kaposvár. The creation of a **new intermodal hub** that optimally utilizes the spaces available for existing terminals and stations, brings a qualitative change to the life of the city center, which is basically organized for pedestrian and bicycle traffic, enables the construction of the bus station, which is currently overloaded and causes bottlenecks, with a more favourable capacity, modern information it provides connections for those taking part in rail, local and intercity bus traffic, and at the same time ensures their cultured transfer, waiting and stopping conditions.

With the creation of the traffic centre, following the curve correction of the four-lane main road, the bus station serving local, intercity and long-distance bus services was moved to the area directly next to the railway. What's more, the **joint platform between the various transport branches** was realized here for the first time in Hungary. Passengers are served by a coordinated timetable and passenger information system. More than two hundred new P+R and fifty B+R parking spaces have been created in the vicinity of the transport centre, with the aim of encouraging as many people as possible to choose public transport. Public safety is protected by a hundred surveillance cameras.

Figure 19: Intermodal hub - Source: Photos by Tamás Dernovics/magyarepitok.hu

Although the territorially extensive urban rehabilitation development originally serves transport, it goes far beyond the modernization of transport. After long and thorough preparations, a city and area rehabilitation investment were completed in about two years, during which unnecessary buildings in Kaposvár were demolished, the bus station planned thirty years ago as a temporary one was dismantled, and public areas were also modernized: a new urban collector road, road and pedestrian overpass they built.

Stakeholders

The development of the project involved: the Kaposvár bus company (local transport), the state bus company (intercity transport), the State Railway Company, the owners of part of the land, the city of Kaposvár and the Hungarian State.

Timeframe

The project started in 2017 and ended in November 2023, the preparation and implementation took 4 years.

Use of Transport model

For the purposes of carrying out and testing the project, no transport model is relevant.

Main challenges / issues encountered

The greatest challenge was the **coordination of the needs of the three transport companies** (the railway company and the two bus companies). Not only when defining the connection points, but e.g. also in the case of the design of the new office building used together.

The built intermodal junction has been in continuous operation for three years, minor tuning processes were necessary during operation, but basically no major problems or dysfunctions have been revealed so far. With the development of the city, projections may come to the fore that the designers had not yet thought of during the planning process.

Main lessons learnt / recommendation

The following innovative solution implemented in the project is an excellent example of how the challenges of urban development can be co-ordinated with the development of transport, reaping important benefits: in this case, the reconnection of two parts of the city.

During the project, the steel 'Esterházy' bridge for pedestrian and bicycle traffic was built, connecting the two parts of the city, the centre and the Donner, separated by the railway for 140 years. The footbridge is filled with planters, rest areas and benches. The bridge also touches the office building of the transport centre. Lifts, ramps and stairs facilitate transport for the disabled and elderly.

The Kaposvár intermodal hub has introduced several solutions that help coordinate the actors of the transport system.

Based on the case study examined, the following recommendations can be made:

- organize in-depth consultations with other public transport providers when planning pilot projects, i.e. in the pre-project stages
- define project solutions as well as possible as they can help other urban development problems, even if their objectives are not directly related to the pilot's expectations
- try to meet mandatory horizontal requirements with innovative, unique and aesthetic solutions.

Web links

https://www.kaposbusz.hu/

https://magyarepitok.hu/aktualis/2020/11/atalakult-kaposvar-atadtak-az-orszag-elso-uj-intermodalis-csomopontjat

https://www.palyazat.gov.hu/eredmenyek/tamogatott-projektek/739730201

https://iho.hu/hirek/atadtak-kaposvar-intermodalis-csomopontjat-201111

7.1.4. PO_4_Development of public transport by purchasing electric buses in Győr and its economic zone

In terms of infrastructural developments, an important national economic and environmental protection goal is the development in the direction of "green transport". By implementing this development, the city of Győr wanted **to improve public transport**, which contributes to the development of the economy and to raising the standard of the region. The revision of the current transport network, as well as the development of the bus stops and the related passenger information system were also carried out in the project. The current bus schedule was examined, as well as a zero-emission zone and a P+R and a B+R parking concept. A survey of the city's public transport hubs has been carried out, and a technical concept for the purchase of 30 electric buses will be developed.

Figure 20: E-Bus - Source: https://www.busworldeurope.org/news/first-fully-electric-credobus-presented

Stakeholders

The beneficiary of the project was the Ministry of Construction and Transport, as from November 22, 2022, the Ministry is also responsible for transport matters, including the development of the transport network infrastructure (in the role of an investor), the development of railways and the ordering of intercity passenger transport services to be carried out as part of the public service. In addition to the Ministry, the City of Gőr was the Beneficiary of the project, another member of the consortium. Hungarian Railway Plc. (hereinafter: MÁV) is the company with the largest number of employees in the MÁV group, it deals entirely with the tasks of operation, traffic management, maintenance and partly renovation. Since 15 July 2020, MÁV has exercised ownership rights over Volánbusz Zrt. (Hungarian State Autobus Co.), and since January 2021 the bus company has become part of the MÁV Group. This created the largest employer in Hungary with 57,000 employees.The private limited liability railway company Győr-Sopron-Ebenfurt ensures traffic conditions essential for safe and fast rail transport in its Hungarian operations. GYSEV's Traffic Organization plans and manages rail traffic on the company's lines, as well as the services advertised in our Network Operation Regulations. The company is controlled by the Hungarian Ministry of Transport on the part of Hungary and by the Ministry of Austrian transport by Austria.

Timeframe

The project lasted 18 months.

Use of Transport model

No information.

Main challenges / issues encountered

The main challenge was the assessment of the traffic needs, followed by the determination of the technical parameters, which exact solution should be chosen for the operation of the new buses, where the filling stations should be and what further infrastructural development is required for these.

This Best Practice serves as the basis for the development of transport in the city, the population is satisfied with the development, as local transport is transformed in an environmentally friendly manner. Since the specific implementation and tendering started a year ago, no long-term conclusions can be drawn about the operation, either positive or negative.

Main lessons learnt / recommendations

The city of Paks has to solve slightly smaller but similar tasks in the field of transport as Győr. (Servicing significant industrial facilities. Reaching a large proportion of outlying areas. Saturation of education and other public services resulting from a central regional role.) In this case, the development of transport must consider complex needs and find the most effective answer, so that the lives of residents improve, and all this does not cause environmental overload. It was a positive experience to see that both cities have the same goals in terms of transport development, as well as similar methods and solutions.

In addition, the project considered environmental aspects and the real needs of the residents during the preparation, thus gaining much greater support and utilization. The residents of the city are happy to use the new vehicles.

Web links

https://gytp.hu/2022/10/05/ikop-3-2-0-15-2022-00042-kozossegi-kozlekedes-fejlesztese-elektromos-autobuszok-beszerzesevel-gyorben-es-gazdasagi-ovezeteben/

7.1.5. PO_5_Improving urban mobility through self-driving shuttle

The experience illustrated herein aimed at **testing** possible transport services based on the use of **driverless electric shuttle**. The initiative falls within the Alto Adige Province and Merano municipality strategies to introduce innovative modalities of public transport, complementary to other initiatives more related to private transport means.

The mission can be summarised, in short, as improving urban mobility through self-driving shuttles, by developing solutions for the mobility of the first and last mile – (both for people and goods). A shuttle with fifteen seats - eleven seated and four standing - but no steering wheel for the driver, who is not there. This is achieved by artificial intelligence assisted by seventeen satellites and a wealth of sensors and cameras. Thanks to these, the small electric self-driving shuttle, produced by the French company Navya, has been able to read the route and "notice" the presence of sudden and unexpected obstacles.

Figure 21: Electric bus without driver under test in Merano - Source: https://www.electricmotorengineering.com/electric-bus-without-driver-under-test-in-merano/

At the time of piloting in Merano, the pilot initiative was backed by the Mentor project, funded with 1.5 million Euros by the European cooperation programme Interreg V/A Italy-Switzerland. The test was also supported by the Italian company i-Mobility Garage, (which has an exclusive agreement to promote NAVYA technology in Italy). In order to carry out this experiment, the route had to be completely cordoned off and no other vehicles or users allowed to circulate during the trial period. The barriers were rented from an external provider, at a cost of 915 Euro.

Stakeholders

The stakeholders of the Italian best practice are:

- regional authority: Alto Adige Province,
- local authority: Merano Municipality,
- large private companies (Navia: Self-Driving Made Easy),
- private companies (who make us of self-driven transportation of goods in the pilot city/area),
- regional innovation agency (of Trentino-Alto Adige Region),
- business incubator (no further information on that),
- transport operators (such as the public transport operator in Merano).

Timeframe

25 November 2019 – 1 December 2019 (7 days).

Use of Transport model

The solution is not based on any transport model.

Main challenges / issues encountered

The experiment officially started on Monday 25.11.2019 with an on-site press conference, but the preparation activities had already begun the weekend before, with the installation of a GNSS antenna on the roof of a nearby building and especially the mapping activities of the route.

It was very difficult to proceed with these activities due to the presence of onlookers on the route and troops of journalists, including from major national newspapers, on site to document the vehicle's first steps on the road.

After the test drive, confidence in the driverless technology (and in the vehicle in general) improved considerably Among the perplexities and doubts, the issues raised were possible loss of work by drivers, security against hacker attacks, inappropriate behaviour on board.

Much attention was paid to the availability of municipal mobility 'on demand'.

Instead, the initiative has had an extraordinary impact not only at local level but also and above all at national level. Thanks also to the impetus given by this experiment, a revision of the Italian Smart Road Decree has been carried out in order to allow these vehicles to be tested on the road and thus create the conditions for their use for on-demand transport services of the future.

Main lessons learnt / recommendation

Self-driven, autonomous, electric small buses or shuttles can testify the importance of the hardware-software side of urban public transport when linking the public transport network more closely to urban planning practice. The issues of sensors and smart roads have high importance in the successful planning and delivery of similar initiatives.

This experiment has been the 1st Italian Open-Road Test. The driverless e-bus shuttle is just one element in a project to test the possibility of developing and promoting mobility in the Alpine region that is not linked to private transport. The idea is that an app can be used to access various offers from smartphones, ranging from bike sharing to car-pooling.

Electric driven, small buses with autonomous (self-)driving levels could be extended to major cities and towns in Europe. This would have positive effects on public transport planning and route optimisation, too.

Web links

https://www.electricmotorengineering.com/electric-bus-without-driver-under-test-in-merano/

https://www.navya.tech/fr/solutions/transport-de-personnes/navette-autonome-pour-le-transport-de-passagers/

7.1.6. PO_6_ Adjustment of the Public Transport Routes in Strakonice

The **route adjustment** involved the revision and optimization of existing public transport routes with the goal of **increasing the efficiency and accessibility of public transportation**. Key features included rerouting several major lines, introducing new connections to less accessible areas, reducing intervals during peak hours, and integrating with other modes of transport. The project also included the implementation of a modern passenger information system and training for drivers.

This practice was implemented in the city of Strakonice and is functioning successfully. During the testing period, data and feedback from passengers were collected and used for further adjustments and optimization.

Figure 22: Bus in Strakonice - Source: https://strakonicky.denik.cz/zpravy_region/st_20100426_linky_zmeny.html

Stakeholders

The stakeholders involved were the municipal urban planning department and the public transport operators ČSAD ST trans.

Timeframe

The implementation of the public transport route adjustments in Strakonice **took 12 months**. The project included an analysis of the existing routes, the design of a new layout, public consultations, the implementation of new routes and timetables, testing, and final optimization based on feedback from passengers and transport operators.

Use of Transport model

A four-step transportation model was used for the analysis and optimization of routes. This model helped identify areas with insufficient service coverage and optimize routes and timetable intervals.

Main challenges / issues encountered

The main challenges included **coordinating with various stakeholders**, addressing the technical and logistical challenges associated with rerouting and integrating new connections, and **gathering passenger feedback and effectively incorporating it into the final solution**.

Some of the new routes were not well received by passengers due to insufficient awareness. It is recommended to improve communication strategies and involve the public in the planning process from the very beginning.

Main lessons learnt / recommendation

It is important to engage a wide range of stakeholders from the start of the project, regularly **communicate** changes and benefits to the public, and **remain flexible** in adjusting based on feedback.

The main success story is the increased passenger satisfaction and the rise in the number of people using public transport, thanks to improved accessibility and reliability.

It is recommended to **conduct regular analysis and optimization of routes**, **actively involve the public** and all relevant stakeholders, and remain **open to innovations** and modern technologies in transportation.

Web links

https://strakonicky.denik.cz/zpravy_region/st_20100426_linky_zmeny.html

https://www.strakonice.eu/content/mestska-hromadna-doprava-0

7.2. Alternative Fuel

Three good practices of Alternative Fuel have been collected:

Table 15: Summary of Alternative fuel Best Practices

	Best Practice	City	Inhabitants	Country	Region	Partner
AF_1	Car Sharing of Electric City Cars in Jyväskylä	Jyväskylä	148,000	Finland	Central Finland	Pécs (STRIA)
AF_2	Introduction of Electric Buses in Public Transport in České Budějovice	České Budějovice	93,000	Czechia	South Bohemian Region	Český Krumlov (VŠTE)
AF_3	Modernization of the Vehicle Fleet with Partial Trolleybuses in Ústí nad Labem	Ústí nad Labem	92,000	Czechia	Ústí Region	Český Krumlov (VŠTE)

7.2.1. AF_1_ Car Sharing of Electric City Cars in Jyväskylä

City of Jyväskylä has started working in 2017 to promote sustainable commuting in the city. In 2020 a study was elaborated on how the employees of the city commute and what incentives would reduce their use of own car. The target was to reduce need for parking spaces and bring down the private car traffic in the city center as well as significantly reduce emissions from commuting. The starting point for the planning was, that the city cars that are electric should be procured and the total service including the cars, charging and required software could be bought as a service.

The study was followed by a purchase process, plus measures implemented in the city organization in 2020:

- for-pay parking for city employees
- support for public transport

- procurement of city cars and bicycles
- promotion campaigns for sustainable travel and bike repair shop events.

The cars are in the city center, close to the public transport hub, being easy to use for people by using public transport.

Figure 23: Commuting car – Source: https://www.jyvaskyla.fi/en/living-building-and-traffic/shared-cars

To use the city cars, **employees and citizens download an app and reserve the car.** They open the car using a code and the car is immediately ready to go. The plan in the beginning was to have 10 cars for the city, but due to Covid, only 3 have been ordered so far. Contract management is done by one city official as part of their regular responsibilities. Contract follow-up meetings are organized regularly with the service supplier. Marketing, training of city employees and communication has taken resources in the beginning, but not anymore. Human resource need is one traffic coordinator. Management is done as part of their other responsibilities.

Stakeholders

The city administration is the owner and the most important stakeholder at the same time of the Jyväskylä best practice.

The study that prepared the foundation of the practice found that some employees require a car during workday, so they didn't have an option to commute by bike or public transport. The responsible manager had learned, that Göteborg had had city cars which could be rented by the citizens outside of the office hours, and there came the idea to offer the city cars for people of Jyväskylä.

To close the loop, the initial idea was municipal, the municipality itself learnt it from another municipality, and finally the municipality decided to extend the use of the service by opening that to people living in Jyväskylä.

Timeframe

Setting up the process - 2020. The best practice is ongoing since the year indicated above.

Use of Transport model

The solution is not based on any transport model.

Main challenges / issues encountered

The energy production side, i.e. option of **easily charging the e-vehicles** in the city centre is **still missing**.

Fixed **parking spaces are available only next to the city** of Jyväskylä buildings in the **centrum**. This limits the radius of using the electric cars city-wide (no remote pick-up and returning points).

The **online application** (App) for renting functions well for reserving the cars. The operation is **coordinated by** Omago Oy, a **mobility operator** that offers shared cars for tenants, companies and city employees, and as a monthly service to the people living in Finland.

The issue of fast local charging should be solved and the extension of the physical network in the city centre should be solved by purchasing more vehicles.

A promotion campaign would also facilitate the uptake of the ongoing initiative.

Main lessons learnt /recommendation

Providing low emission electric cars as a publicly available means of individual transport assisting local municipal staff and local inhabitants needs to be:

- - well **planned to function well finance-wise** (the business model behind does count),
- - well **promoted and visible** among its potential users,
- - **properly defining the nature of the transport service** provided to contribute to local public transport and electrification of local transport as well.

Individual transport initiatives in service of the public could be part of local public transport in a low emission way.

Web links

https://www.jyvaskyla.fi/en/living-building-and-traffic/shared-cars

7.2.2. AF_2_ Introduction of Electric Buses in Public Transport in České Budějovice

This Best Practise has been implemented in České Budějovice, where it is already operational, and data is being collected for further improvements.

The implementation included the purchase of 11 electric buses, the installation of fast-charging stations at key stops, and creation of new timetables to optimize the use of electric buses. The project also involved pilot testing and date collection for further operational optimization.

Electric buses with the designation Škoda 29 BB use cyclic recharging using a pantograph directly from the trolleys at the final stops, thus enabling them to have essentially unlimited range. These are low floor midibuses with a length of 9 m with a total capacity of 45 people, of which 21 are seated.

These modern and completely emission-free vehicles will make it possible to fundamentally improve traffic services in important parts of České Budějovice, but also significantly reduce the emission burden of the city center.

Figure 24: 8: E-buses in České Budějovice – Source: https://www.dpmcb.cz/o-nas/novinky/elektrobusy-nove-generace-v-ceskych-budejovicich-285.html

Stakeholders

The stakeholders included the municipal planning administration, the public transport authority, public transport operators (DPMČB), chambers of commerce, and non-governmental organizations focused on sustainability.

Timeframe

The implementation of electric buses took 18 months and included the preparatory phase, the purchase of electric buses, the installation of charging infrastructure, and driver training.

Use of Transport model

Yes, a 4-step transport model as used to optimize routes and timetables. The model helped identify the most suitable routes and timings for the efficient use of electric buses.

Main challenges / issues encountered

- Initial high costs of purchasing and installing the charging infrastructure
- Need for training drivers and technical personnel
- Integrating new technologies into the existing system
- Issues with the capacity of charging stations during peak hours

Main lessons learnt/recommendation

- Having a well-planned and phased approach to implementation
- Involve all relevant stakeholders
- Ensuring adequate infrastructure support
- Regularly monitor performance and adapt to changes
- The main success story is the significant reduction in CO2 emissions and the improvement in quality of life in the city due to quieter and cleaner public transport.

Web links

https://www.dpmd.cz/elektrobusy

https://www.dpmcb.cz/o-nas/novinky/elektrobusy-nove-generace-v-ceskych-budejovicich-285.html

https://www.busportal.cz/clanek/do-ceskych-budejovic-zamiri-35-novych-trolejbusu-skoda-33tr-s-bateriemi-19761

https://busportal.cz/clanek/mild-hybridni-clankove-autobusy-pro-ceske-budejovice-19831

7.2.3. AF_3_Modernization of the Vehicle Fleet with Partial Trolleybuses in Ústí nad Labem

This practice was implemented in Ústí nad Labem, where it is already functioning successfully and delivering positive results. Data and feedback from passengers are continuously collected for further system optimization.

The modernization included the purchase of 33 new partial trolleybuses, which allow for operation on battery power outside of the overhead trolley lines. The main features included the installation of new charging stations, optimization of routes and schedules, and integration of the new trolleybuses into the existing system. The project also focused on improving air quality and reducing noise pollution in the city.

The delivery of 33 large-capacity partial trolleybuses has led to a major modernization of the fleet of this traction. Following the retirement of the last trolleybus 15 Tr, all vehicles on public transport are **low floor.**

Figure 25: New buses in Ústí nad Labem – Source: https://www.busportal.cz/clanek/mestska-doprava-v-usti-nad-labem-od-kvetna-s-novymi-linkami-i-vozidly-19954 - Photo DPMÚL

After 17 years, the transport company has **changed the routes and numbering** of public transport lines. From January 2024, it has also introduced **front-door boarding** at most stops. These major measures were made possible by the purchase of new vehicles. In addition to the Skoda 27 Tr trolleybuses, it has also put five new SOR NS 18 articulated buses into service.

However, the **entry through the front door met the main objectives of improving the safety and quality of travel** in the city. In addition, the new battery-powered trolleybuses have replaced buses on some routes and allowed the **introduction of longer routes without transfers**.

Stakeholders

The stakeholders involved were the municipal administration for urban planning, the public transport authority, public transport operators (DPMÚL), chambers of commerce, and non-governmental organizations focused on sustainability and air quality improvement.

Timeframe

The implementation of the fleet modernization took 18 months, including the preparatory phase, the purchase of new partial trolleybuses, the installation of the necessary infrastructure, and driver training. The project started in January 2022 and was completed in June 2023.

Use of Transport model

Yes, a four-step transport model was used for the analysis and optimization of routes. This model helped identify optimal locations for new charging stations and optimize the routes and schedule intervals for the partial trolleybuses.

Main challenges /issues encountered

- High initial costs for purchasing trolleybuses and infrastructure
- Technical issues in integrating the new vehicles into the existing system,
- Coordination among various stakeholders.
- Regular maintenance and monitoring of the batteries and charging stations are recommended
- Training for technical personnel.

Main lessons learnt /recommendation

- A robust maintenance and monitoring plan

- Include all relevant stakeholders from the beginning of the project
- Technical challenges that may arise during the implementation of new technologies.
- Electric buses increased passenger satisfaction due to quieter and cleaner public transport, as well as the improvement in air quality in the city.
- Thorough planning and preparation before implementation, regular monitoring and maintenance of technologies, active engagement of the public and all stakeholders, and the use of modern technologies to improve the efficiency and sustainability of public transport are recommended.

Web links

https://dopravacek.eu/2023/12/11/v-usti-nad-labem-byl-pokrten-prvni-parcialni-trolejbus-skoda-27-tr-z-ocekavane-flotily-33-vozu/#google_vignette

https://www.sdp-cr.cz/systext/41/6/785/v-usti-nad-labem-se-predstavil-novy-parcialni-trolejbus-skoda-27tr/

https://www.busportal.cz/clanek/mestska-doprava-v-usti-nad-labem-od-kvetna-s-novymi-linkami-i-vozidly-19954

https://sever.rozhlas.cz/po-usti-nad-labem-budou-jezdit-parcialni-trolejbusy-celkem-jich-ve-meste-bude-33-9132241

http://www.zastavka.net/fd-cr/ustinadlabem22.phtml

7.3. Demand Responsive Transport (DRT)

Eight good practices of Hybrid: Public Transport Routes/Network Optimization and Alternative Fuel have been collected:

Table 16: Summary of Demand responsive Transport Best Practices

	Best Practice	City	Inhabitants	Country	Region	Partner
D_1	ShuttleMare - free DRT service for summer season in Rimini	Rimini	150,504	Italy	Emilia-Romagna Region	Modena (aMo)
D_2	Tuobus - Complementary DRT service for evening hours	Piacenza	103,345	Italy	Emilia-RomagnaRegion	Modena (aMo)
D_3	Colbus - New DRT service in Apennines Area	Bologna	40,000	Italy	Emilia-Romagna Region	Modena (aMo)
D_4	RUMOBIL - Optimize data collection related to DRT service	Castelfranco Emili	33,400	Italy	Emilia-Romagna Region	Modena (aMo)
D_5	Prostofer - Free transport for the elderly	105 municipalities in Slovenia	1 million	Sloveni	-	Grosuplje (PIL)
D_6	Mokumflex -Impacts of replacing a fixed public transport line by a demand responsive transport system: Case	North Amsterdam	90,000	Netherlands	North Amsterdam	Grosuplje (PIL)

	study of a rural area in Amsterdam					
D_7	Kutsuplus - Pursuing mobility on Demand	Helsinski	620,715	Finland	The Helsinki Capital Region	Grosuplje (PIL)

7.3.1. D_1_ ShuttleMare - free DRT service for summer season in Rimin

Rimini is a famous tourist city along the Adriatic coast in Italy and every summer hosts thousands of tourists.

The main purpose of ShuttleMare is to serve residents and tourists who live upstream from the railway and far from the beaches to be able to access the seaside without the need to use their car. But using a flexible DRT system instead, just by choosing a departure stop, a destination stops and the time of the trip.

The system is many-to-many but has some restrictions. They created 2 areas, and you can use the service just to move from one to the other. Start and end points are bus stops used for the standard PT service

The main target of this project is tourists, so for the municipality was crucial to give this new service for free, considering it as a last-mile service for tourists.

The days of availability of the service have increased over the years, covering needs not only related to tourists but also solving mobility needs of residents related to free time; the service is active on spring weekends and in 2023 over 5,000 people used the service between April and June

Figure 26: New service Shuttlemare 2024 – Source: https://www.startromagna.it/shuttle-mare/

This Pilot can be inspiring for pilots linked to DRT services because it provides an example of how to develop a service managed via an app that does not have fixed routes but for which an application can manage reservations and optimize trips based on the booked times and stops.

Moreover, in this case, the service is active together with the standard service so can give us important advice on how not to cannibalize the PT service.

Other interesting aspects to analyse are the integration with parking lots, willingness of the user to use two modes of transport for a trip and the impact of the free service (especially useful for tourism-related contexts).

Stakeholders

- Municipality: main promoter of the project aimed to solve a problem for the city
- PTA: Planner of the new system and manager of the public procurement related to PTO and the software provider
- PTO: It operates the service with its drivers and manage the use of the new minibuses
- Ufficio del turismo (Visit Rimini): communicate and promote the new project for the tourists
- Emilia-Romagna Region: part of the costs is covered by the Region
- Rimini Fiera: offer its parking lots as a starting point for the Shuttlemare service

Timeframe

It needed approximately 6 months to plan the service, 1 year to define a provider, develop the application, define an agreement with the PTO to operate the new service, get buses.

Use of Transport model

The service wasn't design by using a transport model.

Main challenges / issues encountered

- Planning it to be **complementary to the PT** service
- Finding the necessary resources to ensure that the service was **free for users**. Over the years it has been possible to benefit various state and regional funding.
- **Planning the correct number of buses, drivers and expected trips** needed, since the number of users among tourists would be difficult to evaluate
- Residents are used to move by their own private cars and scooters, so it is not easy to make them **change mobility habits**
- A **new parking plan** along the seaside would give a boost to this service, but of course, would also bring new complaints from the citizens.

Main lessons learnt / recommendations

- Good **interaction between the different bodies involved** in the project encourages implementing a convenient and easy-to-use system.
- The use of **different zones** guarantees that the service is used properly and according to its aim.
- A well-designed service can become useful even for **purposes not initially foreseen**, integrating the current PT offer.
- Being a very tourist-focused service, an excellent idea was to include tourism office staff inside the city's main ticket office, located near the train station.
- The success of the project can only occur with **collaboration between different stakeholders**.

Web links

https://www.startromagna.it/shuttle-mare/

7.3.2. D_2_Tuobus - Complementary DRT service for evening hours

Tuobus is based on a DRT service, operated with **3 minibuses**, managed via specific software and with the possibility to reserve trips using a **smartphone app**.

The purpose of the service is to cover the mobility needs of citizens in the **evening hours** (from 8.30 pm to 12.00 am), when the urban service is not available or provides few trips which are not able to cover the entire territory properly. The project is going well, and everybody is satisfied with it, so that the operational time was increased until 1 am during the weekend.

The software can **optimize routes** and trips according to the reservations received. Trips can be booked in advance or in real time, to get a bus as soon as possible. Trips can start and end at existing PT bus stops. All existing passes allowed to be used for this new service.

Figure 27: New DRT night service - Source: https://www.setaweb.it/pc/tuobus

The service became operational throughout the entire area of the municipality of Piacenza, excluding the rural or peripheral areas. It is a many-to-many system that allows you to connect not only to the historic centre or to the main points of interest but also to any destination point, if it is served by traditional public transport.

It was launched in 2022 to reduce operational cost for the PTO, but also to increase PT offer for Piacenza's citizenship. Since then, the service is still functioning.

For DRT Pilots, the usage of a specific tool to manage the optimization of bus usage according to users' needs is crucial.

It is also very interesting to know about drivers' feedback on the tool since the latter is the only interface they have. There is no need to communicate with a call centre.

Stakeholders

Municipality, PTO.

Timeframe

The project required one year to plan the service, select a provider and develop an app. Six more months were required to have buses to operate the service.

Use of Transport model

The service wasn't design by using a transport model.

Main challenges / issues encountered

- Defining the optimal operational area to guarantee the service to an adequate number of people while avoiding possible service inefficiencies linked to trips that are too long or poorly connected.
- Finding a new agreement with driver' unions, that is required to introduce a "night" service
- Figuring out the correct number of buses needed for this service, since the demand was not known.
- Considering whether to let people use the same tickets and passes used for the standard PT service, while operating cost per passenger for this service are presumably different for the standard PT service.

Main lessons learnt / recommendations

- For DRT services design and operation, it is important to define **functional areas** to make the various vehicles available operate optimally, assigning an area to each of them, reducing potential inefficiencies.
- **Redefining the PT standard service** to reduce operational costs and the number of drivers would be an important solution for an area, in which the lack of drivers is becoming more and more problematic.
- Citizens needs are changing, and PT need to meet them, but in a new way. Usual PT is crucial, but **analysing the demand** and the offer, solutions that are cheaper for the operator and more appealing for the users can be found.

Web links

https://piacenza-api.municipiumapp.it/s3/5141/allegati/argomenti/trasporto-pubblico/presentazione.pdf

https://www.setaweb.it/pc/tuobus

7.3.3. D_3_Colbus - New DRT service in Apennines Area

The main aspects of this pilot are linked to making the tourist areas of the Bolognese Apennines more attractive, providing a connection between some of the main centres of the Apennines and promoting accessibility.

A new service promotes these venues for local tourists, serving as a last-mile service. Indeed, it links small villages with some of the railway stations located in the area, connected to the central station in the city of Bologna.

They implemented two different "lines" in two distinct zones and managed the service through software capable of **optimizing timetables** for different trips. Timetables are automatically created not to overlap standard PT service. Trip reservations are available by **smartphone app and website**.

Figure 28: New DRT service in Apennines Area - Source: https://www.bolognametropolitana.it/Home_Page/Archivio_news/001/ColBus_attiva_dal_1_dicembre_una_nuova_linea_in_Appennino

This best practice refers to DRT service pilot projects because it can help understand what aspects to consider for the correct implementation of an on-demand service that works thanks to the support of software.

It can give feedback on how users like the integration of an app to reserve trips.

It also allows to understand what the costs may be for a DRT service to replace a standard scheduled service and what the best model to implement may be (In this case the new service had a fixed route).

It is also useful for pilot project that involve **hilly areas**, so that it's possible to study which are their solutions to operate on such difficult roads in terms of bus features, etc.

Two different services and apps have been developed for the summer season and for the winter season.

In **different seasons**, POIs and the type of tourists may also change.

For summertime, just on Saturdays and Sundays, the aim is to link small villages with nearby railway stations. This connection guarantees a good link with Bologna central station, a node of the core TEN-T network.

For wintertime instead, the main goal was to connect Porretta Terme, the most important village in the area, with the ski resorts present in Corno Alle Scale during the weekend.

Colbus pilot project ended in 2022

Stakeholders

The main stakeholders are:

- the local administrations to analyze the needs of the area
- the Public Transport Authority, which developed the concept
- the institutional body for the tourism promotion of the region that promoted the tourist areas involved in the project and managing communications
- the service operator which had to integrate the service within its offer
- the railway transport operator that has updated information on the service to integrate the DRT with the railway service
- the local population involved that provided feedback
- tourist operators in general which promoted the service through their channels.

Timeframe

There were three main phases:

- Preparation and planning (6 months) to define de pilot area, collect feedback, ensuring the availability of the PTO in terms of buses and drivers, tendering and contracting stages
- First testing (18 months) when they carried out the day-to-day operations and monitoring
- Follow up to introduce adjustments

Use of Transport model

The project was developed based on the needs of the territory, expressed directly by local Administrations, and through surveys created by local communities. No specific modelling tools have been used to plan the new service. During the pilot project also **on-field real-time surveys** have been collected to better tailor the service with users' suggestions.

Main challenges/ issues encountered

- Difficulties in finding a proper software that fits the aim of the project.
- The pandemic produced some delays and difficulties to carry out the pilot project, shifting its start from 2020 to 2021.

Main lessons learnt / recommendations

- Involving the main **stakeholders** right from the start of the service planning phase help to be clear about the solutions for users' current mobility problems. Involving the specific Local Mobility Forum allowed to plan meetings during all different phases of the project with all the stakeholders, such local administrators, tourism operators and so on.

- Ensuring **accessibility to the main points of interest to all categories of users** and citizens and avoiding the dependence of some categories on the help of their relatives about travelling.
- Importance of **communication** to reach the intended target of users (with different tools based on the typologies) and the importance of taking into consideration the skills and habits of all categories of users to allow a convenient and **friendly tool for everyone** and not just for some of them (i.e. considering the importance of a call-centre for booking a ride).
- Creating a specific **new logo** to identify the service and make it more appealing should be considered, especially if a **communication campaign** is expected to launch the service.
- A more **flexible service** would have increased the availability of the buses and the number of users.

Web links

https://www.smacker-toolbox.eu/

https://ascom.bo.it/wp-content/uploads/formidable/34/Colbus_pieghevole_web.pdf

https://www.bolognametropolitana.it/Home_Page/Archivio_news/001/ColBus_attiva_dal_1_dicembre_una_nuova_linea_in_Appennino

7.3.4. D_4_ RUMOBIL - Optimize data collection related to DRT service

The project's main objective was to provide a new **tool for monitoring the DRT** service, therefore managing reservations.

Through the RUMOBIL project, a web tool was provided to the call centre, already active for the Castelfranco Emilia DRT service to computerize the user travel booking process. Through this tool the call centre can collect the user's data, the date and time of the booking, and the departure and arrival stop. It also provides a useful database to analyze the use of the DRT service and helps the call centre to estimate the distances travelled and collect travel booking practices.

Then, other new features were implemented.

A new app for drivers was developed to monitor their trip schedule updated in real time directly on board, thanks to a tablet installed in the vehicle. This way, they don’t need to contact the call centre for every new reservation.

Moreover, an app for users was developed, as well as a website, where they can see the current scheduling of reserved trips.

Figure 29:New DRT service - Source: https://www.rumobil-modena.eu/

This pilot project provides great help in understanding which are the main KPIs to monitor and analyze a DRT service. The parameters may in some cases be like those of standard public transport. Still, in this case, having a smaller number of users and more information per single journey, it is easy to collect useful data to understand, for example, the number of passengers on board, the number of empty kilometres and more to optimize these parameters and provide a more efficient service.

The project initially involved a small municipality in the Province of Modena, Castelfranco Emilia, where the software has been used since 2016. Being a tool provided to the Call center, which in addition to the service in this municipality also manages reservations for other 4 DRT services present in the province, given the successful outcome of the experiment, its use has been extended to all DRT services. Other new tablets for drivers were provided for these services, and an update to the user app were needed, of course.

Stakeholders

- Municipality of Castelfranco Emilia
- Call center service
- PTO
- PTA.

Timeframe

2 years (duration of Central Europe RUMOBIL project).

Use of Transport model

The project tool supported managing reservations: Transport models were not used.

Main challenges / issues encountered

The main challenge was to **create a new tool from scratch**, so it was crucial to define what its functions should be and create an easy-to-use interface for call center operators and drivers. To reach this objective it was important to **study the state-of-the-art DRT services**, looking for others that have tools of this type and **identify the main KPIs** related to this to have an exhaustive picture of the quality of a DRT service and main features for users and drivers.

The tool was very useful for providing a backend to the call center that deals with booking services, but it does not help optimise routes. A potential **improvement** could regard **route optimizations** and **a new tool for users to reserve and plan a trip** for this DRT service.

Main lessons learnt / recommendations

- Creating an **easy and intuitive tool** that doesn't require much training and capable of providing data that would otherwise be difficult to collect.
- Integrating the services provided with technological tools capable of **collecting data** useful to make **data-driven improvement** to the service.
- Envisage projects that can then be updated or improved or would permit an expansion of the service into other areas.

Web links

https://www.rumobil-modena.eu/

7.3.5. D_5_ Prostofer - Free transport for the elderly

Prostofer is a free transportation service for elderly citizens who do not have relatives nearby or access to public transportation. Prostofer takes them to essential errands and public institutions, such as health centres, hospitals, pharmacies, banks, post offices, and administrative offices. Drivers are volunteers who help the elderly in their free time. The transport is provided with municipal cars, which are properly insured.

Figure 30: Service for elderly citizens - Source: https://prostofer.si/

This demand responsive transport (DRT) service covers the rural areas of Slovenia, that is a country with many small villages and isolated houses with poor public transport links. Many of them are inhabited by elderly people, including those without driving skills, who are dependent on their relatives. Some of them have no relatives or live far away, and Prostofer is the solution for such cases. Based on a request, a transport is organized, and a volunteer comes to pick up the client directly at home at an agreed time. The transport is therefore completely flexible, both in terms of location and time.

This practice or a similar version of it is implemented across Slovenia. Initiatives like this address the issue of inadequate public transportation in regions with low population density. Transport can be ordered by all those seniors who do not drive themselves, do not have relatives, have low monthly incomes, as well as poor connections with public transport. Prostofer will only take care of transportation to urgent errands and to public institutions, e.g. to a health center or hospital, pharmacy, bank, post office, administrative unit, etc. Transportation must be ordered at least 3 days in advance to ensure a driver.

In urban centers, this option is being replaced by other forms of on-demand transport for the elderly and people with reduced mobility. Ljubljana has had an electric vehicle system in place for many years, which can help with visits to the city center, the cemetery and the medical center. This solution is powered by the public transportation company in Ljubljana and is not voluntary.

Stakeholders

Partner of the project is Slovenian Traffic Safety Agency. Since it is a voluntary service, the project receives support from donors, including the Highways Company of the Republic of Slovenia (DARS) and various sponsoring companies. In addition, in each municipality where the project is implemented, close collaboration with the municipality representatives is essential.

Timeframe

Project Prostofer was founded over 10 years ago. In the last past few years, it spread across Slovenia.

Use of Transport model

There was no transport model used in this Best Practise.

Main challenges / issues encountered

- **Securing volunteering drivers** willing to donate their free time and cover transportation expenses.
- Initially, there was a **lack of sponsors** to support these costs. Although municipalities eventually joined, providing vehicles and meals for the drivers, the challenge of recruiting enough drivers persisted.
- The demand for transportation consistently exceeded the supply of available volunteers, highlighting an ongoing issue in balancing needs with available resources, which makes it an **unreliable replacement for public transport**.
- The flexible, taxi-like nature of the service, often catering to just one person at a time, is **not scalable or sustainable** as a primary mode of transportation.

Main lessons learnt/ recommendations

- There is a strong demand for flexible, affordable, and accessible transportation options, particularly for elderly and people with disabilities. The implementation of such solutions can help alleviate the burden on relatives and promote greater independence for these groups. This initiative shows that community-driven solutions can effectively address transportation gaps and improve quality of life for the elderly
- Enhancing community connectivity and independence for users. Users appreciate the transportation options, which reduce loneliness and foster intergenerational bonding, demonstrating the project's significant social impact.
- In sparsely populated areas, it is often impossible to include efficiently all villages in traditional PT routes, making some form of DRT essential to ensure coverage and accessibility.

Web links

https://prostofer.si/

7.3.6. D_6_ Mokumflex - Impacts of replacing a fixed public transport line by a demand responsive transport system: Case study of a rural area in Amsterdam

The municipality of Amsterdam launched a pilot program called Mokumflex. The pilot motivation was to reduce costs, while maintaining accessibility in a low-demand area, investigating demand responsive transport and evaluating the integration of paratransit and non-paratransit demands. The pilot project was executed in two areas, based on their limited public transport offer and low efficiency. One of the areas that were chosen for the test was Amsterdam Noord, where Mokumflex completely replaced the public transport previously provided by lines 30 and 31.

Figure 31: DRT service in Amsterdam – Source: https://www.staxi.nl/en/mokumflex-taxi/

The project aimed to assess the effects of replacing a fixed public transport line with a demand-responsive transport (DRT) system. An empirical before-and-after comparison was performed to analyse the impact of DRT systems across various dimensions, including travel distances, ridership, costs, greenhouse gas emissions and public perception.

As part of the project, the theme of alternative fuels was integrated. The previous conventional fuel mini-buses were replaced with CNG Combis and electric e-Crafters. These changes influenced the greenhouse gas emissions and cost analysis.

The Best Practise was a pilot project, implemented in North Amsterdam. The fixed public transport lines were replaced with DRT. In the present, the lines 30 and 31 are still replaced with a form of DRT, it is called Mokumflex taxi. There are several options to order a taxi: via website, through taxi fare finder to calculate costs, with Staxi App, through a WhatsApp message or by phone. The costs of the transport are usually lower than regular taxi, as it is a replacement for public transport.

Stakeholders

Mokumflex was operated by RMC, a private enterprise, which also operated the paratransit of the region. Additionally, the municipality of Amsterdam played a regulatory role, overseeing the paratransit services. Unlike the original fixed bus lines, which were operated by GVB (the local public transport operator) and regulated by Vervoerregio Amsterdam (the transport authority), Mokumflex's governance was primarily under the municipality's purview.

Timeframe

The pilot DRT project ran between February 2018 and December 2018. In the present, the replacement of fixed PT lines with DRT is still in practise.

Use of Transport model

The solution is not based on any transport model.

Main challenges / issues encountered

- The **previous public transport** replaced by DRT was carrying **more passengers**, even though DRT was free of charge.
- Smartphone-based services **require a level of digital literacy** that the population often lacks, especially among elders who are a vulnerable group in terms of mobility and tend to live in rural areas.
- The **large timeframe** of 15 min around the **desired departure time**, that required customers to organize their schedules for a 30-min basis.
- **Punctuality** was a major issue for Mokumflex, 22 % of all trips were not on time.
- **Necessity of interacting with a system**, instead of simply showing up in the stop.

Main lessons learnt / recommendations

- Mokumflex was **more efficient that standard bus lines** in terms of vehicular mileage per passenger, as the distance reduced more than 46%, from 16 km/passenger to 8.6 km/passenger.
- To improve results refining scheduling windows and streamlining user interaction could be beneficial.
- The regular fixed bus line was less cost-effective than the demand-responsive offer. Despite the drop in demand, Mokumflex proved to be more efficient due to two reasons: the higher daily mileage (that caused more expenditure regarding fuel and other distance-dependent indicators, such as maintenance), but also due to the larger number of working hours per week for fixed bus line compared to the DRT.
- The **lower emissions** of the Mokumflex were achieved **through cleaner fuel technology and higher efficiency**. Most of the emission reduction in Mokumflex primarily resulted from the decreased mileage compared to the previous system, making it an eco-friendlier choice compared to the fixed bus system.
- User perception was positive (nearly 94% of "on time" trips were rated as "very satisfying" or "satisfying").

Web links

https://www.sciencedirect.com/science/article/pii/S0739885920301086

https://www.staxi.nl/en/mokumflex-taxi/

7.3.7. D_7_Kutsuplus - Pursuing mobility on Demand

Kutsuplus transportation service was an on-demand, city-run system of dynamically routed minibuses that residents could hail via smartphone. It was an advanced form of flexible micro transit service that relied on a combination of technologies, including automated vehicle location, trip combination optimization, vehicle routing, and travel time estimates.

Kutsuplus strategic objective was to support modal shift from car to public transport.

The service matched passengers who were headed roughly in the same direction with a minibus driver, allowing them to share a ride that cost more than a regular city bus but less than a taxi.

Figure 32: Kutsuplus DRT Service in Helsinki – Source: https://sharedusemobilitycenter.org/killed-kutsuplus-3-takeaways-cities-pursing-mobility-demand/

Kutsuplus was established as an automated urban DRT service, operated by taxi companies. By offering a flexible and responsive solution that adapts to users' needs, it enhances urban mobility and provides a model for other cities aiming to implement or improve their DRT services. Although Kutsuplus is primarily a DRT service, its implementation showcased significant advancements in route optimization technology. The system dynamically adjusted routes in real-time based on passenger demand, thereby setting a precedent for conventional public transport systems to adopt similar technologies. This integration of advanced route optimization can lead to more efficient and responsive public transportation networks.

Kutsuplus was a stop-to-stop DRT service based on an algorithm to connect origin and destination of several passengers. When submitting the trip request, the user defined origin and destination, number of needed seats, and earliest departure time possible (maximum 45 min before). After requesting a trip, the user would immediately receive one or more trip offers, including pick-up and drop-off stop, walking route, estimated pickup time, arrival time window and a predefined price. While boarding, the user was requested to provide a driver with a short alphanumeric verification code. Kutsuplus vehicle had capacity of nine seats, without standing.

The professional taxi driver received real-time driving instructions, as stop-to-stop route was using the high-density HSL fixed public transport network and smaller number of additional virtual stops added to some low-density urban areas. At the launch of Kutsuplus ten buses were running the services, and five microbuses were added later to operate on weekdays. Their initial schedule was from 9:00 to 17:00, before being extended from 6:00 to 24:00. Buses were featured with side steps, Wi-Fi, as well as real time passenger info with estimated time of arrival.

Stakeholders

The concept of Kutsuplus grew out of research conducted at Aalto University. This institution provided the academic foundation and initial research necessary for developing the technology used in the service. Through the DecoNet project, the Academy of Finland partially funded further research on Kutsuplus. As the public transport authority, Helsinki Region Transport (HSL) launched and managed Kutsuplus. HSL is responsible for overseeing and integrating public transport services across Helsinki and surrounding regions, ensuring that Kutsuplus aligned with broader public transport goals. Finally, Kutsuplus relied on collaboration with taxi companies and other PT operators who provided the on-ground transportation services.

Timeframe

The Kutsuplus service has been operational between 2012 and 2015.

Use of Transport model

The technology of the Best Practise did not rely on any specific traditional transport model. Instead, it utilized a dynamic routing algorithm to optimize routs in real-time based on traffic data and passenger requests.

Main challenges / issues encountered

- **High operational costs** that led to significant public subsidies, making the service economically unsustainable. Often happened that there was only one passenger riding the Kutsuplus, which also meant that each trip was more **expensive to operate**.
- The project also **struggled with scalability**, as it couldn't expand its fleet sufficiently to optimize trip matching and reduce costs.
- **Insufficient long-term political and financial support** led to the project's termination, as it didn't receive the necessary investment to reach a sustainable and scalable model.
- The key reasons stated by users for ceasing to use the service included the use of other **public transport alternatives**, the **cost of the service** (especially for lower income categories) and the **difficulty to book trips**, with no mobile app and a cumbersome payment system.
- From the non-user perspective, the main reason for not using the service was the **lack of awareness about the service** itself. This can be linked to Kutsuplus' marketing strategy, which focused on smart and futuristic aspects of the service but did not mention the price of the service on the communication material or on the vans.
- To improve results, these issues should be addressed by integrating a more user-friendly mobile app and streamlining the payment process.

Main lessons learnt / recommendations

- The service never achieved the density needed to truly function as its creators had intended.
- Improving marketing campaign. Instead of mild marketing used in Kutsuplus, Transit agencies should follow the example of the private sector's marketing.
- Need for **long term investments**, it is impossible to expect that implementing a DRT solution would be proven viable in the first years.
- Kutsuplus has involved a significant technological development, combining various data sources in real time. The **software and a routing algorithm** can take in data about a fleet of buses, traffic and trips requested, and calculate optimal routes, which could be beneficial for PT routes planning.

Web links

https://sharedusemobilitycenter.org/killed-kutsuplus-3-takeaways-cities-pursing-mobility-demand/

https://www.sciencedirect.com/science/article/pii/S2210539518300348

7.4. Mixed topic

Two good practices of Mixed topic have been collected:

Table 17: Summary of Mixed Topic Best Practices

	Best Practice	City	Inhabitants	Country	Region	Partner
M_1	Citizen-oriented planning of public transport system in Rezekne city	Rezekne	26,131	Latvia	Latgale	Pécs (STRIA)
M_2	Zielona Góra public transport reorganization	Zielona Góra	140,000	Poland	Województwo lubuskie	Osijek (GPP)
M_3	MOBILITY ON DEMAND	Toscana	76,330	Italy	Province of Livorno, Tuscany Region	Pécs (STRIA)

7.4.1. M_1_ Citizen-oriented planning of public transport system in Rezekne city

Rēzekne city as the 7th largest city in Latvia faces acute pressures due to increased motorization and urbanization. Citizen-oriented planning of public transport system can help to reduce use of private cars, air pollution and traffic congestion in the streets during peak hours. Targeted urban transport planning system can fuel healthy city and provide transport logistic even to areas outside of the city center according citizen's needs.

Figure 33: New PT service and buses in Rēzekne city - Source: https://rezekne.lv/2022/10/rezekne-testes-vel-vienu-elektroautobusu/

RS is corresponding to the needs of the whole community, including women and vulnerable groups such as children, people with reduced mobility, older persons, low-income households etc.

RS has developed the "Rēzekner's card" system to improve the quality of the public transport service. "Rēzekner's card" is the document certifying the fare reduction not only in public transport, but also buying tickets for cultural and sports events.

The project aimed to evaluate the effects of replacing a fixed public transport line with a DRT system. The impact of DRT systems on various dimensions was analysed, including travel distances, passenger numbers, costs, greenhouse gas emissions and public perception. As part of the project, the theme of alternative fuels was integrated. The previous conventional fuel mini-buses were replaced with CNG Combis and electric e-Crafters. These changes influenced the greenhouse gas emissions and cost analysis.

In 2023, 29 buses were used to provide the service; they are equipped to be used by people with special needs.

Stakeholders

Two main stakeholders: City Municipality of Rēzekne and SIA "Rēzeknes satiksme" – RS, the public transport organisation.

Timeframe

It is an ongoing project from 2011 on.

Use of Transport model

The solution is not based on any transport model.

Main challenges / issues encountered

The public transport service providing is based on **Cabinet of Ministers regulations**. The fare for the trip, including fare concessions, is determined by the decisions of the Rēzekne City Council, therefore RS has no influence on the determination of prices and tariffs.

To make public transport an attractive and everyday choice for residents, cities must design the service well and **overcome physical and cultural barriers. Received feedback of passengers via questionnaire** - very important for company and provided service to make changes to existing or new routes, as well as determine different route schedules based on the needs of passengers in the summer and winter seasons.

E-buses have proven themselves **very well** regarding service quality RS provide and the working environment for bus drivers - less noise and vibrations. Furthermore, service costs are reduced.

Main lessons learnt / recommendations

The implementation of green and smart solutions in the management of transport infrastructure, security solutions and development of priority areas is being developed in local governments. But also, it must be environmentally friendly and energy efficient the use of solutions in the development of engineering infrastructure to reduce environmental pollution and costs.

Adopting locally any similar practices such as this one from Rēzekne requires:

- Surveying – to identify citizen needs,
- Infrastructure
- Investment/financial
- Preparation of staff
- E-bus operation.

Web links

http://www.rezeknessatiksme.lv/lv/

https://www.facebook.com/rezeknessatiksme.lv/

https://rezekne.lv/2024/04/apstiprinats-sia-rezeknes-satiksme-2023-gada-darbibas-parskats/

https://rezekne.lv/2022/10/rezekne-testes-vel-vienu-elektroautobusu/

https://docs.google.com/forms/d/e/1FAIpQLSczp2JQ3G0mJSie-Y9PHz8ZOHSQWuQm24t-fkPpvMHX8_rHoA/viewform

https://www.youtube.com/watch?v=HQZOmT7PYXM

https://www.youtube.com/watch?v=JGU1KldYsqg

7.4.2. M_2_ Zielona Góra public transport reorganization

The Best Practice in Zielona Góra encompasses a comprehensive public transport overhaul, expanding from 4 initial routes to 24, serving both the city and Zabór rural borough with a fleet of 89 buses, 43 of which are electric. This initiative is a multifaceted approach aimed at enhancing public transport efficiency and reducing emissions. Key features include the adoption of electric buses, expansion of routes, and integration of eco-friendly technologies, reflecting the city's commitment to sustainable development and improved urban mobility.

Figure 34: Buses charging at the transfer centre – Source: MZK Zielona Góra materials

The service expansion has improved connectivity and accessibility for both city residents and those in the Zabór rural borough, ensuring more efficient and optimized public transit coverage. In terms of Alternative fuel, nearly half of the bus fleet changes to electric power. With 43 out of 89 buses now electric, the initiative has made substantial strides in reducing emissions and promoting sustainable transport. This shift not only aligns with environmental goals but also sets a precedent for future developments in public transportation within the region.

Stakeholders

In 2015, a technical dialogue was held. It was attended by suppliers of vehicles, equipment, and IT systems.

Public administration: organizer of public transport in Zielona Góra – City Hall, Department of Entrepreneurship and Municipal Economy.

CUPT – Center for EU Transport Projects.

Timeframe

MZK Zielona Góra, the sole public transport operator with 91 buses, began reorganizing in 2011 with the first electric bus. By 2015, they adopted a charging model for electric buses. In 2016, they prepared for an "Integrated low-emission public transport system," securing EU funds. From 2017 to 2022, they introduced new electric and diesel buses, reconstructed the depot, built charging stations, and updated infrastructure. This included passenger information systems, ticket vending machines, and the expansion of the dynamic passenger information system.

Use of Transport model

A transport model was not used. The cost-benefit analysis considered different types of drives.

Main challenges / issues encountered

- **Infrastructure under construction**: charging stations at the bus loops were launched in stages during bus deliveries.
- Replacement of discharged vehicles in the first months of operation, due to the **lack of fast charging stations** at the bus loops.
- **Failure to deliver some of the ordered vehicles:** Ursus delivered 43 out of 47 ordered buses.
- Learning to operate the plug-in charging connector flap opened while driving if it was not locked.
- **Resistance to change from drivers and a reluctance to drive electric buses**.

Currently, buses with larger batteries are ordering and the charging stations are using to the maximum. The current challenge is to redesign the process of operating electric buses on communication lines in such a way that the vehicles arrive at the depot as discharged as possible and to strive for further improvement of the accessibility of the developing city's public transport. (**Optimization of charge use**)

Main lessons learnt / recommendations

- Ensure infrastructure readiness, particularly charging stations, to support electric buses, and plan for strategic placement in line with route reorganization
- Need for reliable supplier partnerships
- Plan for contingencies, such as vehicle delivery delays
- Invest in driver training and engagement
- Optimize battery range and charging strategies
- Utilize renewable energy sources
- Continuously adapt and improve operational processes.

Web links

Adam NOWAK Czcionka Times New Roman (TNR) 13 (polsl.pl)

https://visitzielonagora.pl/en/municipal-public-transport/

https://www.mzk.zgora.pl/

7.4.3. M_3_ MOBILITY ON DEMAND - Toscana

This Best Practice is related to Component 2 of P.E.R.L.A. project – MICROLOTTO.

Objectives of the project Component are:

- Improve the fruition of heritage, even in peripheral and island areas (difficult to connect)
- Mitigate the impact of seasonal tourism
- Facilitate access to Tuscany scenic attractions, distributed throughout the whole territory

- Introduce "experiential tourism" which enhances the journey and not just the destination.

Activities involved:

- Expanding local public transport, with particular attention to people with reduced mobility
- Improving the accessibility of coastal areas and roads of major tourist interest
- Defining a system of routes for a greater usability of the territory but protecting environment
- Developing and implementing an App for disseminating services to citizens and tourists.

Figure 35: Microlotto – Source: https://ec.europa.eu/regional_policy/en/projects/italy/perla-accessibilite-et-securite-des-plages-sur-la-cote-mediterraneenne-dans-le-cadre-dune-cooperation-territoriale

It is a typical “demand response transport” project. As the PERLA project title suggests: “Accessibility and safety of beaches on the Mediterranean coast within the framework of territorial cooperation”.

The frequent problem of mobility to and from Disco/Dance Clubs located on the coastal area was alleviated by implementing a night bus service directly to Discos. This has resulted in increased safety of movements for the young people. Connection services between hotels, camping and other hospitality facilities with the beach areas has alleviated traffic congestion, parking needs as well as other indirect effects such as air pollution by private vehicles.

Previous year’s prices were also confirmed until 2020 (arrangements for continuing the service in the following year are always subject of negotiations): tickets for all summer services cost 1 euro (1.50 if purchased on board only for the Castagneto and Vada trains) for a trip on the trains and 1.20 euro for the shuttles.

Finally, there are daily tickets (3 euros), three-day tickets (6 euros), which are particularly suitable for weekends, weekly passes (12 euros) and monthly passes (27 euros). All types of tickets and passes can be used on the entire 'Microlotto' network.

At the same time, this best practice from Tuscany is also relevant for “alternative fuel” topic, although not in its entire scope. The reason is that it includes a series of 12 transport service packages, addressed to different target groups and in different localities, some of which making use of electric transport means.

The service provision requires annual allocation of funds by the Municipalities concerned and by Livorno Province. Recurrent financial support is being requested from Tuscany Regional administration as well. The service has proved so far to be sustainable and is supported by the local communities and visitors.

(Within the P.E.R.L.A. project, 850,188 Euro was dedicated for this best practice, and Microlotto has been initially prepared by co-financing of the Italy-France Maritime Interregional Cooperation Programme 2007-2013.).

Stakeholders

The best practice has stakeholders' linkages with:

- the local municipalities concerned,
- financing institutions / EU programmes behind Microlotto,
- private companies who contribute to passenger transport within the Microlotto,
- transport operators which serve the named settlements of Livorno Province.

This mix of different actors allows the flexible delivery of the 12 service packages best fitting the needs of different target groups (local people-tourists) depending on the type of mobility demand requested.

Timeframe

The Microlotto best practice started in 2020 and it is still ongoing.

Use of Transport model

The solution is not based on any transport model.

Main challenges encountered

- The recurrent question was how to **sustain the service provision** in such a way that the initiative is maintained over time
- The **sustainable business model** behind the Microlotto still needs to be elaborated and widely applied by the different stakeholders
- With **public financial support** the service has proved so far to be sustainable, in view of the above support and considering its popularity with the local communities and visitors.

Main lessons learnt

- Demand response transport solutions could be especially relevant for areas where there is a **shortage of easily available public transport** and at the same time transport service is needed by wider audiences to arrive at locations not following any timetables for transport.
- The practice is transferable without the need of any adaptation to other regional contexts where similar demands are being expressed.
- More than 135,000 passengers were transported in the summer of 2011. The following year, 40,000 additional passengers were transported during the three-month summer period in Marina di Castagneto Carducci service alone. These numbers were exceeded in the following years.
- The main recommendation, but rather the main concern is that behind the BP there is an established governance of the system that is well settled and is coordinated by Livorno Province. At the same time, it is participated by the other public and private bodies on an annual basis.

Web links

https://www.sanvincenzo.com/en/news-shuttle-bus-and-rubberized-train.aspx
https://www.visitcastagneto.com/en/the-little-marina-train-2020/
*PERLA project https://ec.europa.eu/regional_policy/en/projects/italy/perla-accessibilite-et-securite-des-plages-sur-la-cote-mediterraneenne-dans-le-cadre-dune-cooperation-territoriale , accessed on 30 July 2024

C. Stakeholders consultations

8. Introduction

The aim of this chapter is to gather and analyse the outcomes of meetings held between the various project partners and their local stakeholders, to effectively develop the pilot projects designed within the OPTI-UP initiative. These meetings play a critical role in shaping the pilots by ensuring they are tailored to the specific needs and conditions of each local context.

Each partner identified and selected stakeholders relevant to the development of their pilot project. These stakeholders included a diverse range of actors, such as local public or private transport operators, municipal and regional authorities, and, in some cases, citizens and end-users of public transport services. The inclusion of such a broad spectrum of stakeholders is essential because it allows the pilot projects to benefit from a variety of perspectives, ensuring a more comprehensive and inclusive approach.

Stakeholder meetings are one of the most important phases of the project development process. Through these meetings, project partners receive valuable support, feedback, and insights from local actors, which are instrumental in refining the pilots to meet local needs. These interactions allow for a deeper understanding of the specific challenges and opportunities present in each partner's region, enabling the development of practical, actionable solutions that are directly aligned with the objectives outlined in each partner's Action Plan.

The contributions gathered from local stakeholders help ensure that the pilots are not only innovative but also feasible and well-integrated into the local transport ecosystem. For instance, the participation of local public transport operators or municipal authorities provides essential technical insights and logistical support, while the involvement of citizens and transport users offers a user-centered perspective, making sure that the new services meet real needs and are easy to adopt.

9. Methodology

In recognition of the importance of these meetings, Poliedra and TUW collaboratively developed a template that project partners could use to document and report the key outcomes of their discussions with stakeholders. Although its use was optional, the template provided a structured way to capture the most relevant information, ensuring that the insights gained from each meeting were systematically recorded and could be effectively utilized in the subsequent stages of the project.

Ultimately, the success of the OPTI-UP pilots depends on this continuous dialogue between project partners and local stakeholders. Their feedback not only shapes the initial design but also plays a crucial role during the testing and implementation phases, helping to ensure that the solutions developed are both innovative and well-adapted to the local context. By actively involving these key actors, the project fosters a sense of ownership and collaboration, increasing the likelihood of long-term success and sustainability of the new public transport solutions.

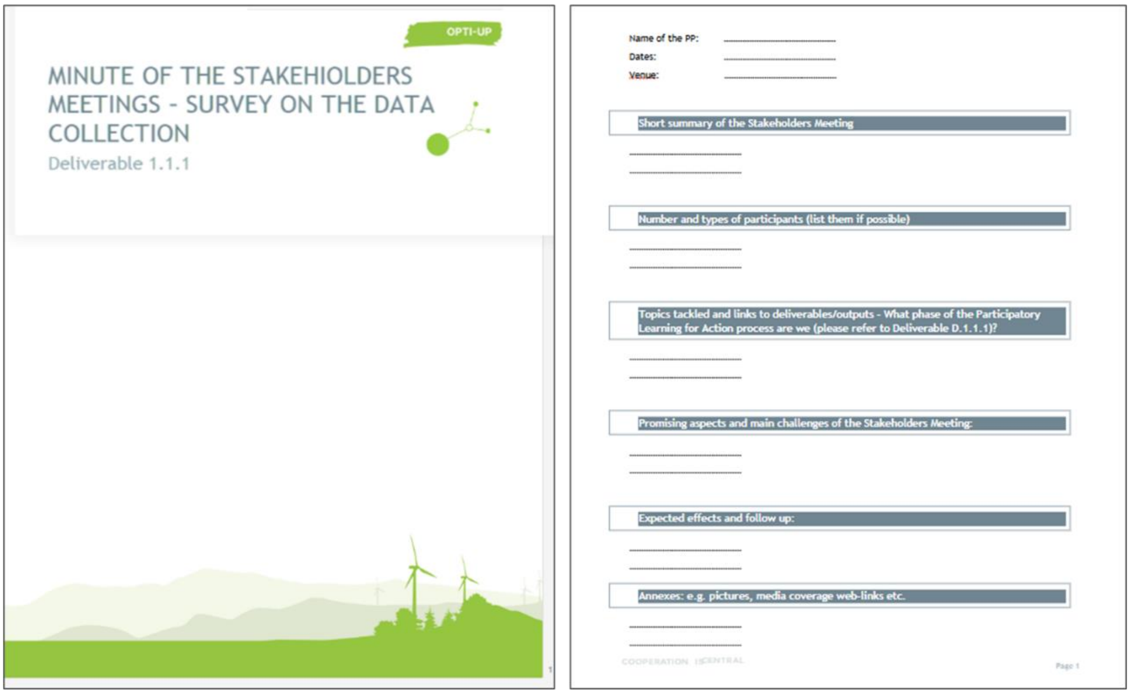

Figure 36: Stakeholders meeting template

Each partner had at least two meetings with different stakeholders and in particular:

Table 18: Stakeholders' meeting table summary Stakeholders Meetings' Results

Stakeholders Meetings						
Partner/ Meeting date	Modena (aMo)	Grosuplje (PIL)	Osijek (GPP)	Paks (PAKS LLC)	Pécs (STRIA)	Český Krumlov (VŠTE)
7 May 2024		*Municipality of Grosuplje*				
28 May 2024		*National transport model developer PNZ*				
6 June 2024		*National transport model administrator NCUP*	*Internal Meeting (GPP & EY)*			
20 June 2024		*National PT manager (DUJPP)*				
21 June 2024		*Personal meeting at PTA*				
27 June 2024						*Transport Company of the City of České Budějovice (DP města České Budějovice)*
1 July 2024						*Internal meeting at VŠTE*
2 July 2024					*BIOKOM Nonprofit Ltd*	
3 July 2024					*Pécs Urban Development Nonprofit Ltd.*	
5 July 2024					*The Municipality of the City of Pécs*	
9 July 2024			*Internal Meeting (GPP & EY)*			
15 Jul 24				*City of Szekszárd*		
16 July 2024	*Transport company of Modena (SETA)*					
19 Jul 24				*City of Paks - project department*		
23 July 2024	*Municipality of Modena*					

From the collection of all the templates related to the stakeholder meetings, it emerges as the first thing that all partners shared with the respondents, ranging from public transport operators, local municipalities, private operators of recharging stations to, finally, specialised in-house technicians working on the OPTI-UP project, either the PT data they collected, or the difficulties they had in collecting it, or finally they explained what data was missing and discussed how to find it.

All the stakeholders approached showed willingness to collaborate and give useful information to the project also because the success and achievement of the OPTI-UP objectives will be very useful for the improvement of the public transport system and thus for meeting the needs of citizens.

D. Conclusions and next steps

The main findings from the data and analysis are consolidated and presented below.

This deliverable is based on official data provided or collected by project partners and other relevant project stakeholders. Given that more detailed technical analyses and modelling are planned during the project, there is a possibility that this deliverable will need to be updated in the coming periods in accordance with new findings and potentially more accurate data.

1. Spatial demographic

First, based on an analysis of the spatial-demographic characteristics of the cities, there are three medium-sized cities (Modena, Pécs and Osijek) and three small cities (Paks, Grosuplje and Český Krumlov). **Only Modena and Grosuplje were able to maintain a population growth in the past two or three decades, while the population decreases in all other case study areas.**

The analysis of the population age and gender structure reveals that, although some cities have slightly higher median age (Modena) while others have slightly younger median age (Pécs and Paks) than the European average, all the six case study areas have less people over 65 years old when compared to the European average (21.3%).

The analysis of population density reveals three categories of cities: Modena and Pécs are mostly populated (800-1,000 pp/km^2), followed by Český Krumlov and Osijek (~500 pp/km^2), and Paks and Grosuplje are least populated (<200 pp/km^2).

2. Public transport history and fleet

Four out of the six cities have PT services for more than a century (Modena, Pécs, Paks and Osijek).

The PT development faced challenges and decline in the 1930s-1960s, while more innovations started to appear again in the past two decades (e.g., DRT, electric buses, new governance structures).

At the time of the analysis, almost all cities already have, or plan to implement soon, electric modes of PT. Paks already have a fully electrified bus fleet, and Grosuplje is operating three DRT lines with electric cars.

Bigger cities usually have larger fleets (average capacity at 80-100 passengers per vehicle), while the average capacity of PT fleet in smaller cities is around 40-70. The age of the fleet also ranges from less than five years old (DRT and electric vehicles) to a bit older (7-18 years old) for more conventional buses and trams.

3. Key operational statistics

Analysis of the operational indicators also reveal diverse status quo in PT operation: while most cities have less than 20 lines, Pécs has 85 lines and 228 route variations in operation. Considering the size and structure of the city, it is assumed that the network of lines can be organized more efficiently, with fewer variations in lines, while maintaining the same coverage.

Additionally, considering the size and structure of the city, Osijek has a relatively small number of bus lines of above-average lengths, which makes it more difficult to maintain a reliable and accurate timetable. A similar situation exists in the city of Paks, where the lines connect more distant surrounding settlements with low population density.

The PT system runs mostly at the normal traffic speed (21 km/h average with MIN 15km/h to MAX 35 km/h). **The operational speed is the lowest in Modena. This may be due to the characteristics of the lines, which mainly operate in urban areas, while in other systems, there are more lines outside densely populated areas with faster sections (greater distance between stops, fewer intersections, etc.).**

Further research will attempt to investigate the correlation between population density per line and its operational speed.

The average turn-around time ranges from 40 minutes (Grosuplje and Český Krumlov) to 82 minutes (Osijek).

The analysis of further derived operational indicators reveals two potential objectives of the PT planning: 1) maximize ridership and 2) maximize coverage. For example, Pécs and Grosuplje exhibit a lower population density per line, which may indicate an oversupply of the PT services (number of lines for Pécs and PT offer overall for Grosuplje). Conversely, Český Krumlov has the highest population density served by a limited number of PT lines, indicating a potential undersupply.

4. Key demand statistics

The demand of the PT system is also presented for the six case study areas, shown as the annual demand, monthly demand, and hourly demand, respectively. Overall, the trend of the data is in accordance with the general understanding, such as the impact of the COVID-19 pandemic in 2020-2022 for the annual data, the low ridership in summer months, and the distinct morning and afternoon peaks associated with school trips and commuters.

Pécs has by far the highest annual ridership and high utilisation rate of the PT system. However, due to its extensive network, it averaged ridership per unit length of the bus lines is below the average among the six case study areas. *Additionally, it is necessary to determine the validity of the official methodology for recording the number of passengers, as such high values for a city like Pécs are not common.*

The utilisation of PT is the lowest in Grosuplje, with about 5 passengers served per departure and less than 1 passenger served per kilometre of PT service.

Paks, considering its size and population density, demonstrates very efficient public transport in the context of the number of passengers.

5. Key financial statistics

The financial indicators of the PT operation are presented, including the trend of the costs and revenues in the last five years, and a breakdown of the cost and revenue structures.

As in most PT systems around the world, the farebox revenue is not enough to cover the cost of the PT services. For example, in Paks, 93% of the cost is subsidised, due to the low-ticket price (to encourage mode shift away from the cars). Pécs, regardless of high ridership, still has 59% of its cost covered by the government subsidies.

Modena and Pécs also have a higher proportion of income from passes, indicating a more committed user base. **The cost per BKM ranges between €2.1- €3.7, and the revenue per passenger ranges between €0.11- €0.86.**

6. PT Planning practice

Data are also collected regarding the stakeholders involved in various PT planning tasks. In general, the operators, city departments, or specially created PT management agencies are the most involved parties, involved in almost the full process of PT planning, management and operations.

However, the data collected from the six case study areas indicate a lack of transit-oriented development. The spatial planning and transport planning are usually treated as separate tasks, and these two efforts only intersect in terms of reserving space for PT stops and corridors.

During the collection of the technical data, challenges are encountered due to the lack of a consistent, central data repository of PT operations across Europe. This sometimes makes it hard to collect comparable data (missing data, or data given in different definitions). **The creation of a standard reporting format and platform could greatly facilitate future cross-comparison and cross-pollination of ideas by PT operators and authorities in Central Europe.**

7. Best practice key insights

The collection and analysis of Best Practices offers several advantages and insights to the OPTI-UP project partners. By examining successful European public transport projects, partners gain practical insights that can be directly applied to their pilot projects, facilitating more effective development and implementation. **The analysis highlights two critical success factors: the importance of stakeholder involvement in all project phases and the need for a well-executed external communication strategy.**

The involvement of different stakeholders, from local operators to citizens and national authorities, will enable the partners, in the later stages of pilot implementation, to consider local needs and regional or national standards, ensuring a smoother implementation. In addition, public involvement promotes trust and encourages adaptation to innovative solutions such as DRT.

Clear and targeted communication campaigns raise public awareness and understanding of new transport services, increasing passenger numbers and user satisfaction. These BPs emphasise the value of innovative projects and tested strategies, which OPTI-UP partners can replicate and adapt, improving the effectiveness of their pilot projects and promoting long-term sustainability.

8. Stakeholder meetings insights

The stakeholder meetings between OPTI-UP partners and local Stakeholders produced positive results. **Stakeholders showed a strong willingness to contribute information and support the project, motivated by the potential improvements in the public transport system and the benefits for citizens.** These meetings foster trust in PT users and operators, and this collaboration not only strengthens the foundations of the project and continued cooperation for the next project phases, but also increases the potential for impactful and citizen-centred results.

Next steps

After an extensive review of the current state in the cities within the scope of the OPTI-UP project, the next steps involve the analysis of traffic models that will be used to validate future solutions. Following the review of the traffic modeling methodology, more detailed local analyses will be conducted, based on which local public transport improvement plans will be developed.

Additionally, through the synergy of new local insights and best practice conclusions, the partnership will develop a comprehensive public transport development strategy for small and medium-sized cities in Central Europe, which will serve as a guide for creating local plans. The next steps also include work on the database (D.1.1.2.), which will be improved and supplemented with new data and findings throughout the project.

As previously mentioned, this deliverable may also be updated with new conclusions and data as they are collected in the future.