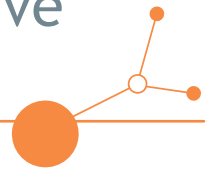
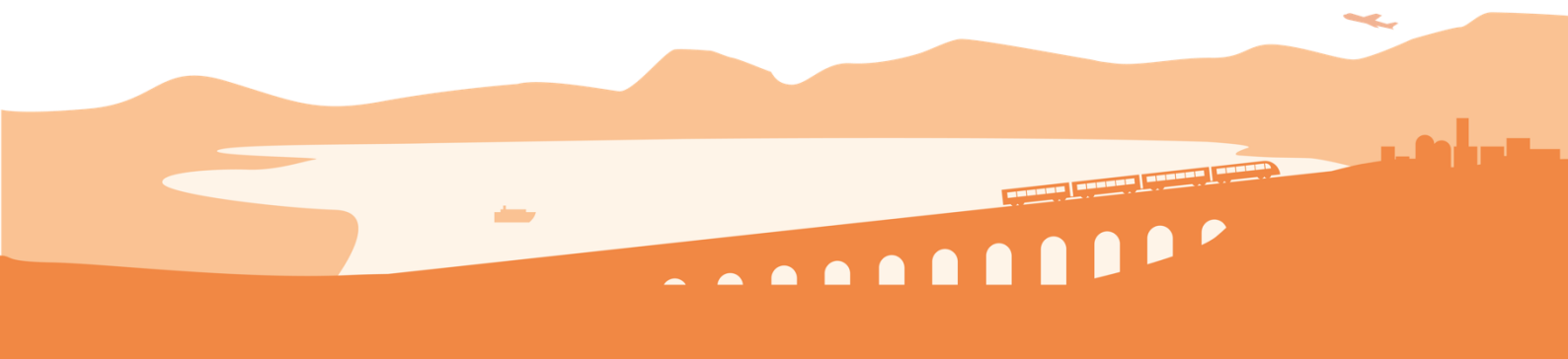


From Traditional Routes to Flexible Networks: A Strategic Approach to Demand Responsive Transport Development



Final Version
09/2025





Authors and change log of the document

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1. Introduction

Urban mobility systems are undergoing significant transformation in response to changing passenger needs, technological innovations, and sustainability goals. Traditional fixed-route services, while effective in high-demand corridors, often fail to provide efficient and attractive solutions in areas with dispersed travel patterns, low demand, or evolving urban structures. Demand Responsive Transport (DRT) offers an adaptive alternative, bridging the gap between conventional public transport and individual mobility.

Furthermore, its flexibility requires a rethinking of operational standards, especially in the design and placement of boarding and alighting points, as well as in the legal framework that governs them.

In Budapest, the introduction of DRT has highlighted the need for dedicated rules that differ from those applied to conventional bus services. Simplified stop infrastructure, flexible placement near intersections, and real-time passenger information tools all form part of a new approach that ensures accessibility, safety, and efficiency without the need for costly physical infrastructure. To enable these services, regulatory adjustments were made in cooperation between the BKK Centre for Budapest Transport and the Ministry of Construction and Transport, culminating in the inclusion of specific provisions in BKK's Service Regulations.

This document outlines the strategic approaches applied in Budapest to integrate flexible DRT solutions into the public transport system. It covers three key directions: the transformation of traditional fixed routes into demand-responsive services, the introduction of entirely new DRT lines in underserved neighbourhoods, and the enhancement of existing DRT services into more flexible and technologically supported solutions. The objective is to demonstrate how DRT can contribute to more efficient, sustainable, and passenger-oriented urban mobility, while aligning with long-term transport development strategies.

Chapter 7 provides an overview of how DRT and flexible-route DRT boarding points should be designed, located, and regulated, combining legal, operational, and passenger-oriented considerations into a coherent framework.

2. Data collection

In public transport, demand is strongly influenced by supply, particularly in urban areas. A frequent service, for example one with a higher level of service, generates more demand than a less frequent service. In urban areas, demand is ad-hoc and the travel chains are not quite preplanned. Digitalisation has made it possible to collect data completely, so we are able to determine exact demand. This fundamentally changed transport network and capacity planning and facilitate the widespread deployment of flexible systems. In Budapest the passenger number data comes from IRMA/DILAX passenger counters (infrared motion analyser). 60% of our buses, almost 100% of our trolleybuses are equipped with IRMA. With this method, detailed dataset can be collected, thus the constantly changing passenger demand is determined. This system can be used for annual traffic inspection on every bus line, trolleybus line and on some tram line. On these lines the cross-sectional passenger number, boarding and disembarking passenger numbers, vehicle utilisation are known through the whole line, every stop, full operation time.



1. Monthly passenger counting plan -30th day

Időszak	BKV	ARRIVABUS	VOLÁN
01.01. - 01.03. - IN	200E 277	25 33 34-106 150 151 196-196A 141-2508	169E
01.02-03. - SV	200E		
01.04-08. - HP	277 ^K	25 ^K 33 ^K 34-106 ^K 150 ^K 151 ^K 196-196A ^K 250-2508 ^K	
01.09-10. - SV			

2. Schedule making

-25th day

05.09.	05.09.	1020	VV								Nincs menetrendi teendő
05.09.	05.09.	1190	VV	AD	VHCNG	1	AD	MCONS	1		Operatív csere
05.09.	05.09.	1350	SZ	AD	VHCNG	2	AD	MCONS	2		F2, 3 Operatív csere
05.09.	05.09.	0950	SZ	AD	VHCNG	1	AD	MCONS	1		F84 Operatív csere
05.09.	05.09.	2360	SZ	AD	VHCNG	1	AD	MCONS	1		F1 Operatív csere
05.09.	05.09.	2005	VV								Nincs menetrendi teendő

3. Passenger counting

0 day



4. Processing & Validating

5. Analyzing

3-7th day



1. Figure: Passenger counting process

For successful passenger counting monthly passenger counting plan and schedules are needed approximately a month before. During this time the operators are making everything ready, allocating vehicles suitable for passenger counting and giving all the information to the drivers. During passenger counting period, the passenger counting function is verified and inspected to filter the errors. The infrared passenger data is transmitted through fourth generation wireless mobile telecommunication technology to our system. After 3 days the raw data can be is validated semi-automatically in ForTe software, where all the static dataset of Budapest transport is stored. The validated passenger data can be used for analysing purposes.



3. Transforming traditional lines into DRT

Based on these data and analysis, new DRT service can be introduced on regular lines. In order to make an efficient, useful and convenient the DRT, low passenger number (0-5) is needed on a section or during specific operation time on the line. The goals are reducing noise pollution and eliminating unnecessary vehicle performances.

Spatial (section) differences:

- DRT in the full length of the line
- DRT in a particular section of the line

Time of operation (interval):

- in full operation
- outside of peak hours
- at the weekends
- at the weekends during early and night hours etc.

Spatial and operation combined:

- e.g. late night outer sections of particular lines.

On these complementary DRT services fix departure times are given and the routes are not flexible on the 'on demand section' (usually no infrastructure for turning).

To indicate a request a journey there are 4 options:

1. in person (in the terminal station or on the bus if the only the outer service of the line is operated in a demand-responsive way)
2. via phone
3. on Telebusz.bkk.hu website
4. through BudapestGO application on Telebusz.bkk.hu website

During the operation the dispatcher always records in the system which route the current departure was on through the whole day. This is an important requirement for financial and accounting aspects, also provides precise data about all journey requests to make adjustments in the future. All DRT lines in Budapest are operated by our internal operator (BKV - Budapest Transport Company also fully owned by Municipality of Budapest like BKK), because external operator contract does not allow such flexibility.

On DRT lines It is mandatory for the driver to have an extra smartphone to get the notifications for the demand, the current OBU (on board unit) does not have this function.



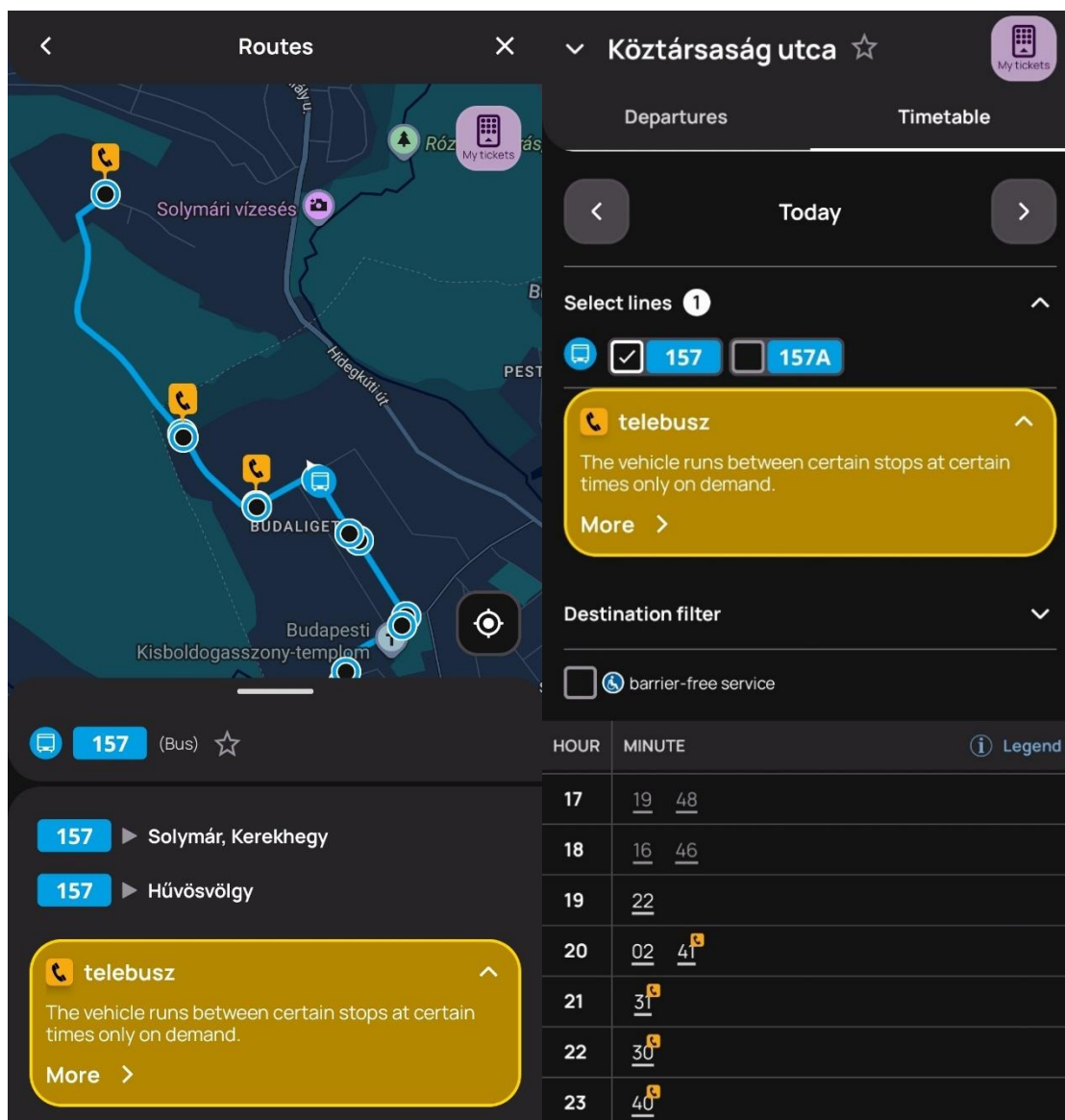
4. Introduction of an existing DRT line served by regular-sized buses: bus line 157

Bus line 157 has an on-demand service on the outer section (dashed line on the map) on weekday-nights and on the weekend. This outer section located in a protected forest, so the relevance of maintaining calmness is relevant. The diagram above shows that weekday nights the average passenger number between 2-3 people, if the bus was operating on the outer section based on demand. Only a little bit more than half of the departures has been completed during this period.



4.1. Passenger information and communication

All information is given via BudapestGO application, BKK.hu website and on the spot in the bus stops. (English language is also available).



2. Figure: BudapestGO application



**157**

BKKtelebusz

A 157-es autóbusz Budaliget, Géza fejedelem útja és Solymár, Kerekhegy között munkanapokon kb. 20:00 után, valamint szombaton és munkaszüneti napokon csak akkor közlekedik, ha erre előzetes igénybejelentés érkezik. Utazási igényét a járművezetőnél személyesen, vagy előzetesen a telebusz.bkk.hu oldalon, a BudapestGO applikáción keresztül, illetve a BKK telefonos ügyfélszolgálatán, a 3-as gomb megnyomása után jelezheti, a busz indulása előtt legkorábban egy héttel, legkésőbb fél órával. Bus 157 runs past about 20:00 on workdays and all day at weekends and on public holidays between Budaliget, Géza fejedelem útja and Solymár, Kerekhegy only on demand, if a prior request has been received. You can report your travel request to the driver in person, or in advance via telebusz.bkk.hu, via the BudapestGO app, or to the BKK Call Centre by pressing option 3, at the earliest one week and at the latest half an hour before the bus departure.



BKKtelebusz

 telebusz.bkk.hu  BUDAPESTGO

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while our lines are open

! Az igénybejelentés során, kérjük, adja meg az utazás választott dátumát, időpontját, valamint a saját elérhetőségét, hogy a járással kapcsolatos esetleges forgalmi változásokról értesíteni tudjuk.
When making your request, please indicate the date and time of your journey and your contact details so that we can inform you of any changes to the service.

i A Telebusz járatokat a BKK normál díjszabású vonaljegyével, bérletével lehet igénybe venni, az arra jogosultak pedig ingyenesen utazhatnak. A jegyet felszállás után kell érvényesíteni, illetve szükség esetén a járművezetőnél is vásárolható. Amennyiben bérlettel utazik, kérjük, felszálláskor mutassa fel a járművezetőnek ellenőrzés céljából.
The on-demand Telebusz lines can be used with a BKK regular fare ticket or pass, and entitled persons can travel free of charge. The ticket must be validated after boarding and can also be purchased from the driver if necessary. If you are travelling with a pass, please present it to the driver for control when boarding.

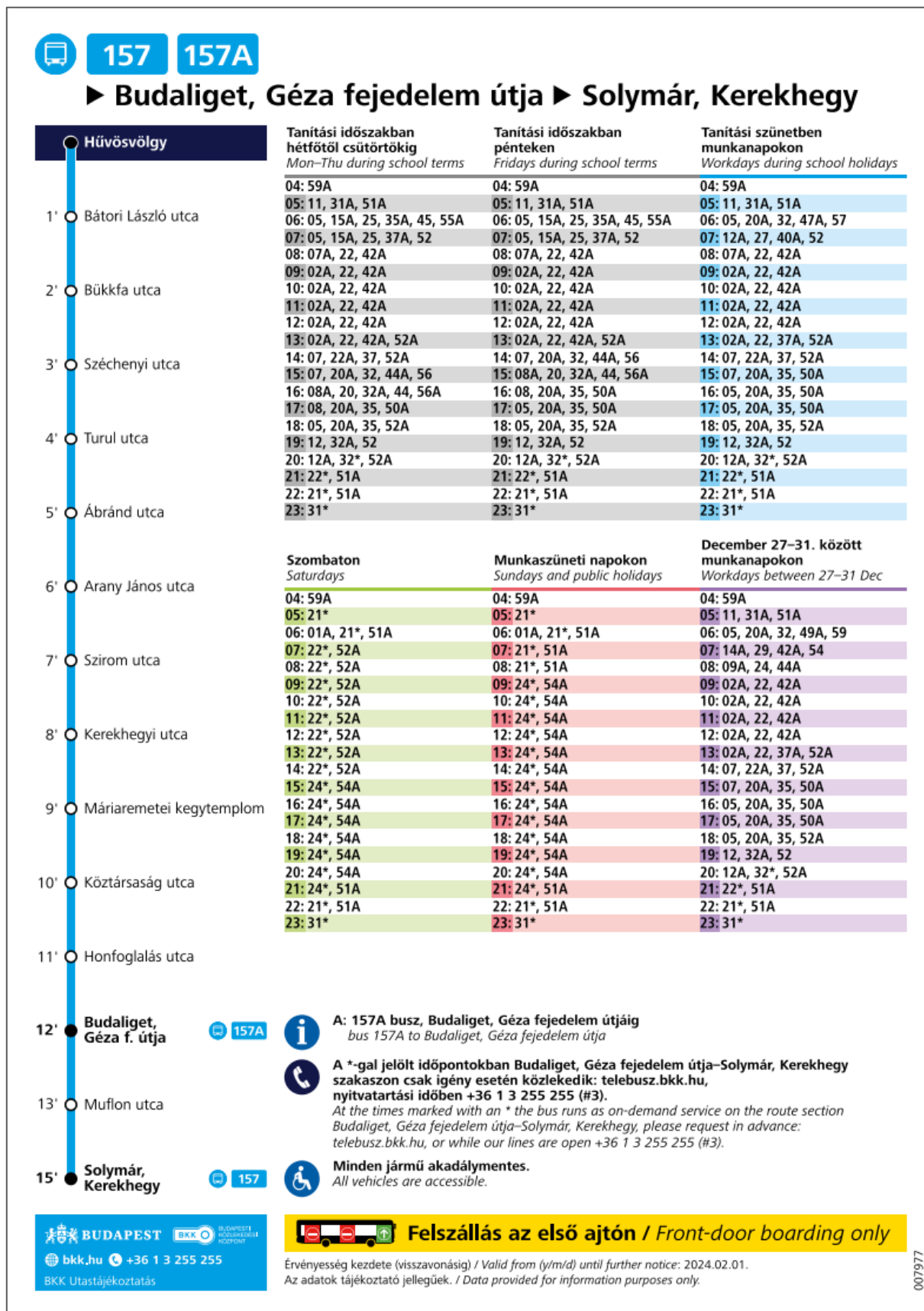
i A járat menetrendjéről a BudapestGO applikációban, vagy a bkk.hu/menetrendek oldalon tájékozódhat. Az esetleges forgalmi változásokról a bkkinfo.hu weboldalon talál információkat.
Please check the timetable in the BudapestGO app or online at bkk.hu/en/timetables. For information on any service changes, please visit bkkinfo.hu.

BKK Utastájékoztató

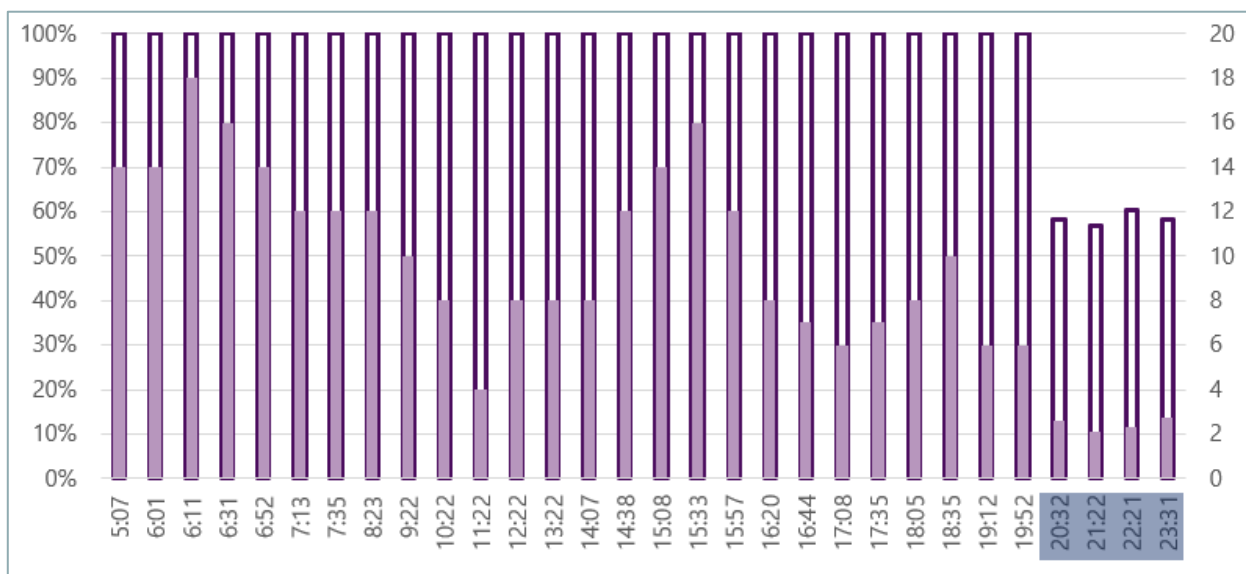
 **BUDAPEST**  BUDAPESTI KÖZLEKEDÉSI KÖZPONT

www.bkk.hu | **bkk@bkk.hu** | **+36 1 3 255 255**
bkkbudapest | **@bkkbudapest**

3. Figure: Website and bus stop information I.



4. Figure: Website and bus stop information II.



5. Figure: Passenger traffic and demand percentage of bus line 157 on weekdays - on the outer section

Departure times marked in blue are demand-responsive ones

The empty purple columns are showing the average demand percentage (fix departures are 100%)

The magenta columns are showing the average passenger number on each departure



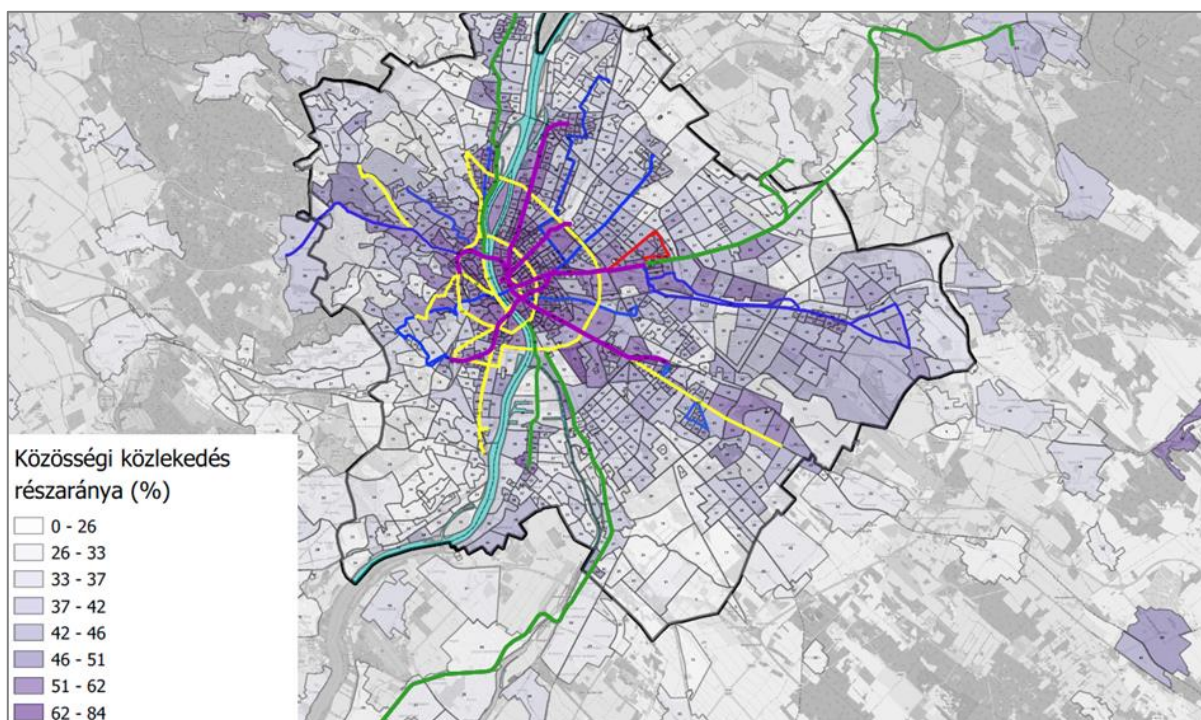
5. Developing new DRT lines

Changing, developing and introducing new public transport network is a long and complex process. In this section focuses are on the introduction of new service.

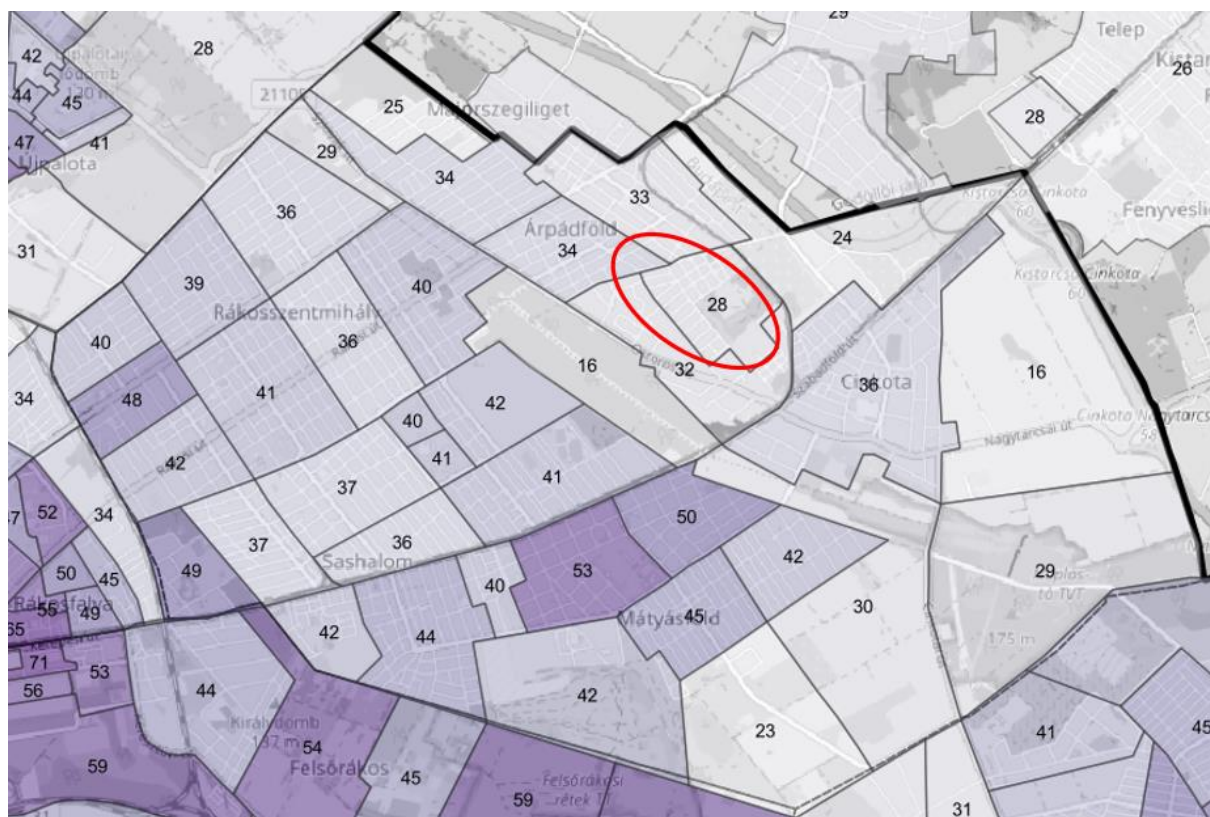
The Budapest Mobility Plan precisely states the direction of the public transport development. It is necessary and possible to expand and refine the bus network. The public transport network in Budapest is generally of good quality, but there are a significant number of neighbourhoods in the capital (e.g. suburbs or even new residential areas) where there is no competitive public transport service. In these areas, restructuring of existing capacity or new capacity by creating new bus lines, a measurable change can be achieved. In terms of the network, urban transport development in the past three decades has not been flexible enough to follow urban developments, and real estate developments have not taken into account network accessibility aspects and changes outside the transport system in general. Private car use is high and access to the city from outlying areas by public transport is generally more difficult. In the case of the public transport network, this means improvements to reinforce its integrity: connecting isolated parts of the network, while improving operational efficiency and the cityscape.

When designing the public transport network, the aim is to reduce the number of transfers per trip. But transfers and mode changes cannot be eliminated completely, so Budapest is striving to create simple, fast, transparent, passenger-friendly intermodal hubs that provide convenient customer movement. In designing transfer hubs, Budapest takes into account passenger flow characteristics, reducing the number of transfers per passenger, increasing the number of connecting transfers points along with the comfort level of transfers, reducing walking distances and differences in height level.

For complex network planning BKK has the opportunity to use its macroscopic transport planning and simulation software, called EFM ("Egységes Forgalmi Modell = Unified Traffic Model" based on PTV Visum). This software has several inputs: public transport GTFS, public transport passenger numbers, surveys (e.g. household surveys), road traffic data, regional statistics data, Hungarian Central Statistical Office data, infrastructure. Based on this dataset detailed analytics are available.



6. Figure: Public transport modal split in Budapest (White: low, dark purple: high)



7. Figure: Public transport modal split in Csobaj-bánya (DREAM_PACE pilot)

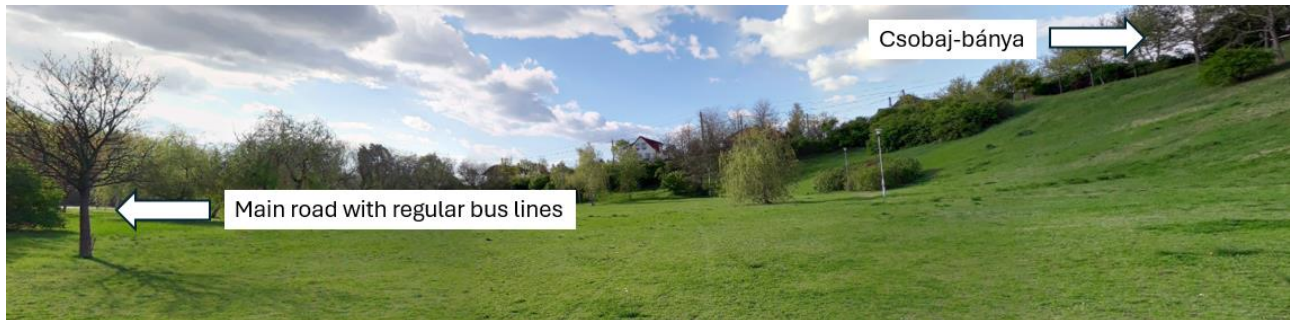


8. Figure: Public transport stops accessibility within 250 metres

In the particular area of the district XVI., called „Csobaj-bánya”, new housing areas have been established in the previous years. The public transport coverage is poor, bus stops are hardly accessible, this is why public transport modal split is the lowest in this area of district XVI. and the car dependency is really high.



It is considered good accessibility if public transport reachable within 5-minute-walk (200-400 meters), but it also depends on terrain, people's physical condition, size of the luggage etc.



9. Figure: Csobaj-bánya is on a little hill

This area is underserved by public transport and due to the green residential area, the narrow streets with high occupancy parking and complex city structure, regular-sized buses are not suitable for the operation.



10. Figure: Csobaj-bánya street parking and the new DRT line

Considering the complex situation here a new demand-reponsively operated bus line was introduced in the area with flexible route options and boarding points, connecting the neighbourhood with the local suburban railway station of Cinkota.

Those who travelling by private cars they often oppose bus transportation, considering as dirty, noisy, pollutant, dangerous for children and destroys the good condition of the roads. In this situation a demand-reponsively operated bus can positively influence the opinions and people are accepting faster the new service this way.



6. Transforming existing DRT lines into flexible DRT lines

Transforming an existing line is not that complex like introducing a new one. To make a line spatially flexible, the following are needed:

- Analysing passenger numbers, too high demand is not suitable for flexible DRT
- Designating new boarding points and turning points,
- A flexible DRT software like in DREAM_PACE project,
- New hardware on board:
 - changing, making smarter the current OBU and its system on the vehicles or
 - buying more portable smart OBU like in DREAM_PACE project,
- Training more bus drivers to use this flexible system,
- Financial, accounting and SLA (service level agreement) clarification in accordance with operator contracts (currently we are using a temporary method* during the DREAM_PACE project, it is also possible that this solution can be permanent in the future).

(*every departure marked as “cancelled” because we can’t assign kilometres to it, and on the end of the day summary document is uploaded containing total daily kilometres.)



7. Designing, locating and regulating stops for demand responsive and flexible DRT services

This section provides an overview of how DRT and flexible-route DRT boarding points should be designed, located, and regulated, combining legal, operational, and passenger-oriented considerations into a coherent framework.

7.1. Regulatory framework

According to Hungarian legislation (Act XLI of 2012 on Passenger Transport), demand-responsive transport is defined as a licensed public service operated under a Service Contract or a route licence, supported by information technology, and functioning on a variable route, a variable timetable, or both. The BKK Telebus service in Budapest is one such demand-responsive system, legally recognised under this framework, and operated with IT-based request and scheduling mechanisms.

To enable these services, a specific regulatory environment had to be established. The BKK Centre for Budapest Transport, in coordination with the Ministry of Construction and Transport, developed rules and incorporated them into BKK's official Service Regulations. These provisions define the design and operation of DRT stops, ensuring safety, accessibility, and compliance with traffic regulations.

7.2. Boarding points design principles

Unlike traditional public transport stops, DRT boarding and alighting points do not require built infrastructure such as shelters or designated bus bays. Instead, they are identified by simplified "Telebus" signs, which do not qualify as standard traffic signs under the Hungarian Road Traffic Code (KRESZ). To distinguish them from traditional stops, we call them boarding and alighting points. These simplified signs indicate the location where passengers may board or alight on demand.

For flexible-route DRT, the same type of simplified stops is applied, but with added considerations due to the variability of vehicle approach directions. Because vehicles may arrive from multiple directions, stops are preferably located near intersections.

7.2.1. Boarding points placement guidelines

- **Intersection-based placement:** Stops should be designated near intersections, allowing vehicles to approach from multiple directions.
- **Avoid clustering of signs:** To prevent passenger confusion and urban clutter, only one stop sign should be placed at each intersection. Installing multiple signs at the same junction is discouraged, as it complicates wayfinding.
- **Passenger awareness:** Information materials (sign plates, system guides, digital platforms) must clearly state that the stop sign does not necessarily mark the exact boarding location, as vehicles may stop at different points around the intersection depending on the approach direction.
- **Safety considerations:** Passengers must be advised to cross the street carefully, as vehicles can arrive from more than one direction. This design is particularly suited for low-traffic residential streets, where safe crossing is feasible.



- **Digital support:** Real-time vehicle tracking via the BudapestGO application mitigates uncertainty, allowing passengers to follow the vehicle's exact approach and arrival time.



11. Figure: Sign indicating the boarding and alighting point of the new DRT line



12. Figure: Passenger information at the DRT boarding points

7.2.2. Accessibility requirements

All stops and vehicles used in DRT services must ensure accessibility for passengers with reduced mobility. Vehicles must be equipped with deployable ramps, designed to avoid excessive steepness, so that boarding with wheelchairs or strollers is possible. This ensures that flexible and demand-driven services are inclusive and meet universal design standards.



i

274

BKKtelebusz

Augusztus 26-ától (kedd) / From 26 August (Tuesday)

i A 274-es busz Cinkota HÉV-állomást köti össze Csobajbányával és Árpádfölddel. Reggel és délután a HÉV indulásához igazítva, míg délutánként a HÉV érkezéséhez. A járat csak akkor közlekedik, ha erre előzetes igénybejelentés érkezik, és csak azoknál a megállópontoknál áll meg, ahová a szolgáltatást megrendelték. Ennek megfelelően az autóbusz útvonalra, valamint a felszállóponthoz való érkezési ideje nem fix. Bus 274 connects Cinkota suburban railway station with Csobajbánya and Árpádföld. In the early and late morning, buses run adjusted to the train departures, and to arrivals in the afternoon. The bus only operates if a prior request is received, and it only serves the stops where the service was ordered. The bus route and the arrival times at the boarding points are not fixed.

! A járat az egyes megállópontokhoz több irányból is érkezhetsz. Kérjük, a busz érkezésekor nézzetek körbe és győződjétek meg róla, hogy biztonságosan meg tudjátok közelíteni a buszt. A járat egyes megállópontjait nincsenek kiegészítve, ezért vigyázzanak a le- és felszálláskor. Please note that the service can arrive at each stop from several directions. Therefore please pay attention when the bus arrives and approach it with caution. Some bus stops are not built-up, so please be very careful when boarding and exiting the bus.

i Utazási igényt előzetesen a csobajbusz.bkk.hu oldalon, a BudapestGO alkalmazáson keresztül, illetve a BKK telefonos ügyfélszolgálatán, a 3-as gomb megnyomása után jelezheti, a busz indulása előtt legkorábban egy héttel, legkésőbb fél órával. Cinkota H végállomáson az indulás előtt 2 perccel a járművezetőnél is jelezhetik az igényt. Kizárólag az adott indulásra, jövőbeli igényleadásra nincs lehetőség. You can request a departure in advance online at csobajbusz.bkk.hu, via the BudapestGO app or the BKK Call Centre by pressing option 3, at the earliest one week and at the latest 30 minutes before departure. At the Cinkota H terminus you can also make a stop request to the driver 2 minutes before departure, only for the given departure; there is no possibility to submit a request for a future time.

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04: 51	05: 21, 56	06: 26, 56	07: 26, 56	08: 26, 57	09: 27, 57	10: 27, 57	11: 27, 57	12: 34
13: 04, 34	14: 04, 33	15: 03, 33	16: 03, 33	17: 03, 33	18: 03, 33	19: 09, 39	20: 09, 51	

Szombaton és munkaszüneti napokon nem közlekedik.
No service at weekends and public holidays.

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csobajbusz.bkk.hu

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BKK Utasfélszolgálat

13. Figure: Website and bus stop information of the new DRT line



7.2.3. Regulatory definition of DRT boarding and alighting points

As stated in the BKK Service Regulations (developed in agreement with the Ministry of Construction and Transport):

“Boarding and alighting points are locations marked by signs that are not recognised as KRESZ traffic signs, where BKK vehicles may stop within the framework of demand-responsive services. Unlike traditional bus stops, boarding and alighting may take place directly from the roadway. The route of the service within the operating area includes only those points where a concrete, pre-announced travel request has been made. These points are located at road junctions, with vehicles stopping before the junction, in the direction of arrival.”

The BKK Service Regulations are available on the BKK website: <https://bkk.hu/downloads/31691/>





8. Conclusion

The transition towards flexible and demand-responsive services represents an important step in reshaping public transport to meet 21st-century challenges. The case studies and experiences presented in this document highlight three complementary pathways: adapting traditional low-demand routes into DRT services, developing new flexible lines in growing residential areas, and upgrading existing DRT lines with enhanced flexibility and digital support.

Together, these approaches illustrate how demand-responsive transport can increase efficiency, reduce unnecessary vehicle kilometres, and improve accessibility in areas where traditional public transport solutions are insufficient. Beyond operational efficiency, DRT services also address broader strategic objectives such as reducing car dependency, lowering environmental impacts, and improving the perceived quality of public mobility.

The lessons learned point towards the importance of combining data-driven planning, flexible service design, and modern digital tools to achieve a balanced, sustainable, and customer-friendly mobility system. Demand Responsive Transport is not only a supplementary service but also a strategic enabler for the future of integrated and resilient urban transport networks.