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Forms of Booking on-demand Transport

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Abstract: This paper examines the interaction between passengers and flexible transport systems, as well as the characteristics of flexible transport systems that are important to users. It presents flexible transport systems introduced in the Czech Republic since 2023 and defines their key parameters. Based on these parameters, evaluation criteria are established and weighted using the Saaty method. The criteria are then categorized according to shared characteristics and weights. The outputs of the Saaty method provide a framework for evaluating and implementing flexible transport systems. To analyse a given area, the authors recommend conducting a SWOT analysis, whose findings can be used for the considered areas of on-demand transport implementation. Subsequently, the findings of the paper can be applied. The paper addresses operations in peripheral areas and during off-peak hours. The aim is to assess the differences between the interaction of individual transport systems with users, and to propose recommendations for optimizing both existing and emerging flexible transport systems.

Keywords: Flexible transport systems, on-demand transport, peripheral areas, scheduled bus services, transport services

1. Introduction

Public transport, like other sectors of the economy, is undergoing continuous development and is adapting to emerging trends. In the context of public transport, Europe is considered a highly developed region, with current trends in the Czech Republic often influenced by developments in Western and Northern Europe to a certain extent. Since 2020, there has been a significant expansion of long-distance routes, especially around Prague, connecting the city and other major urban centers with more distant settlements such as Kadaň, Žatec, or Karlovy Vary. The trend of long-distance

routes funded by regional budgets can also be observed in other regions, such as the connection between Domažlice and Plzeň [1,2].

The first attempts to implement on-demand transport systems emerged after the global pandemic in 2020. Since 2023, several regions have introduced plans to integrate elements of these systems into on-demand public transport services. The year 2024 saw the adoption of flexible transportation systems and on-demand transport in general in the Czech transportation market. The Czech legislative environment had long overlooked on-demand transport [3]. Emerging elements and systems were often adopted from abroad and found their legal basis in existing transportation frameworks applied in the Czech Republic. In 2024, a legislative amendment to Act No. 111/1994 Sb. on Road Transport was introduced to regulate on-demand transport [4]. This amendment stipulates that on-demand transport operations are not required to follow a fixed timetable but can instead be based on the served area. Public transport vehicles will be permitted to stop at virtual stops that are not physically marked, significantly increasing the number of possible stops. Vehicles with a capacity of up to nine seats will be allowed and identified by a green light [4]. Since 2023, several on-demand transportation systems have been developed in the Czech Republic [5-7]. The methods for ordering these services vary depending on the specific requirements of the ordering entities, which include cities and regions. Some of these systems will be analyzed in the following chapters.

The aim of this paper is to analyze the options for ordering on-demand transportation services.

2. Flexible Transportation Systems in the Czech Republic

A flexible transportation system is characterized by its ability to adapt operations to meet real-time user demand. These systems can be classified into urban and rural categories based on their geographic scope. In urban areas, on-demand transportation is often implemented to optimize service utilization during both peak and off-peak hours. In rural and particularly peripheral areas, a common challenge is expanding transportation options to better serve local communities. While urban and rural systems exhibit distinct characteristics, suburban areas surrounding large urban centers often incorporate elements of both. In the Czech Republic, the authors examined flexible transportation systems, as illustrated in Figure 1.

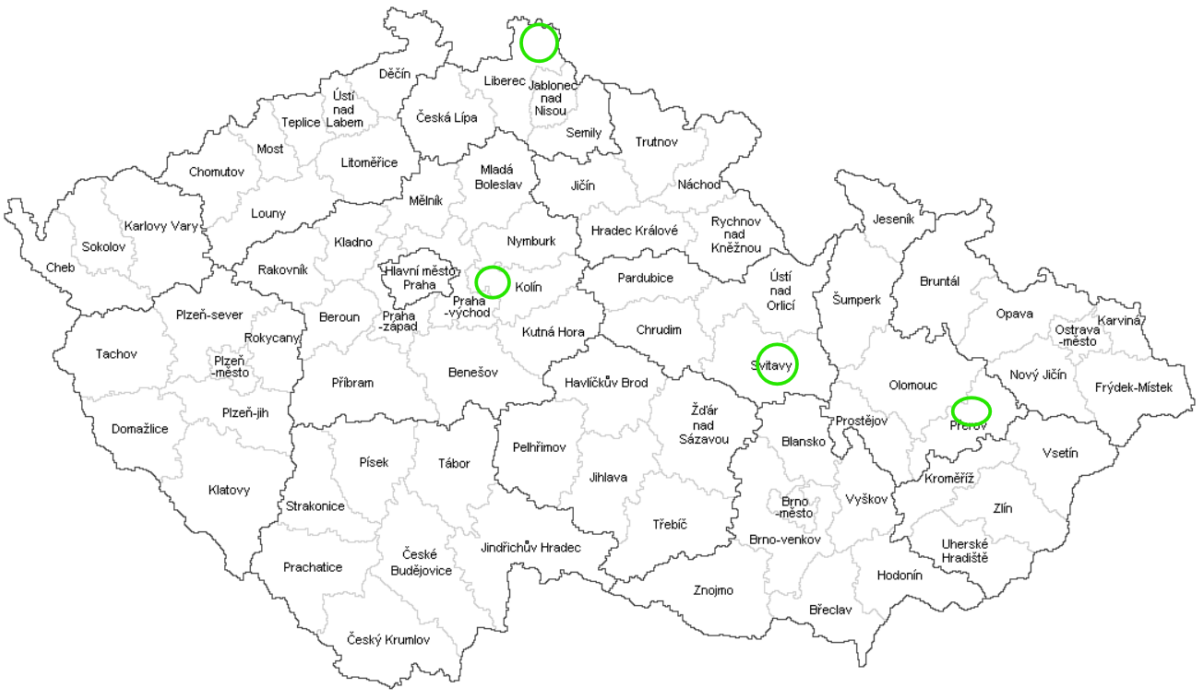

Fig. 1 Map of systems locations. Source: authors

Flexible transportation systems represent a specific solution that allows for greater adaptability to the demands of the traveling public. These systems are particularly effective in connecting remote peripheral areas, thereby improving the standard of living in these regions [8-10]. Transport services in peripheral areas are often limited to a few bus routes during peak hours, and small settlements (with 50 or fewer inhabitants) may not be served at all [11]. Transport services in these areas are crucial for addressing the transport needs of local residents, particularly for travel between their homes and places offering basic services. A specific example involves areas with a complex road network [12,13], where detours on bus routes result in a significant increase in travel time. Demand-responsive transport can substantially enhance the attractiveness of public transport compared to individual car transport.

Elements of flexible transportation systems can also be found in developed integrated transport systems, in the form of conditional services or parts of services. These services are operated within a fixed system, not as separate entities [14]. Services are typically provided by standard-sized buses that are diverted from regular routes. Service requests are often made via a hotline or web form, and fares are consistent with those of regular services. Operating hours depend on the scheduling capabilities of the unit managing the service.

Within the Czech Republic, several flexible transportation systems operate as part of Integrated Transport Systems (ITS). For example, in the Plzeň Region, many on-demand services are available. These services adhere to ITS fare structures and use standard vehicles that are employed on regular routes. To enhance the attractiveness of these systems within the ITS framework, extending operating hours can be beneficial. In the case of the aforementioned services in the IDPK system, booking is

required at least 30 minutes before departure from the starting stop, on weekdays from 6 AM to 6 PM, via a hotline, web form, or the ITS application. Passengers select the specific service and route they wish to take. Feedback is provided in the form of an automatically generated email summarizing the order, including a link for cancellation. Information about the booking is sent to the driver's on-board computer [15].

2.1 PID Haló

The first demand-responsive transport project within the integrated transport system PID has been operational since July 2024. The service operates around the town of Český Brod during the evening peak hours. Regular PID fares are accepted on the buses, and the same contractual terms of carriage apply as on regular routes.

To order a service, the ITS mobile application is strongly recommended. In the app, passengers search for a connection, select a service, and, after being redirected to a chatbot, provide the necessary information to plan the journey (e.g., number of passengers). The order is processed by an autonomous algorithm, which recalculates previously created orders and determines whether there is available capacity. The result is communicated to the passenger, who can then confirm the ride [16]. Once the ride is confirmed, the order is saved, and the passenger receives a confirmation SMS. Prior to the vehicle´s arrival, the passenger will receive additional information about the service via SMS.

Alternatively, the service can be booked through a voicebot via the 24/7 hotline or through the project's website [16]. The service must be booked at least 30 minutes before departure. If necessary, the service can be cancelled via the app or hotline for planning purposes. The algorithm also plans journeys involving transfers.

2.2 TvůjBus IDOL

An innovative project by the Liberec Region has been operational since September 2024. The operating area of the system is the Frýdlant region, where it supplements bus and rail lines. In areas such as the local part of Dětřichovec, this system is currently the only public transport option available. The service operates on weekdays from 7:00 AM to 7:00 PM, with vehicles having a maximum capacity of 8 passengers. Strollers and children in car seats can also be accommodated. However, the system is not designed to transport immobile passengers [17].

Service ordering is preferably done through a mobile application, where passengers are first asked for initial information, after which they are informed about the planning result. Communication with the application includes the following steps:

- Location: determined by GPS or manual input.
- Destination: searched on a map or entered manually.

- Time: the app allows bookings up to 24 hours in advance.
- Feedback to the passenger: including the pick-up location and time.

While service ordering is also possible via the central dispatch hotline, the project's communication clearly favors app-based orders.

Service stops are defined within the operating area. Virtual stops are used throughout the area, and during the booking process, passengers are informed about the exact stop locations. Standard ITS fares apply to the service (during the first month, it was free of charge).

2.3 ZkusBus Svitavsko

The Svitavsko On-Demand Service, introduced by the Pardubice Region in May 2024, connects the city of Svitavy with surrounding municipalities. Operating on weekdays from 8 AM to 8 PM, the service utilizes an algorithm to calculate routes based on passenger requests. To enhance efficiency, journeys solely within the city of Svitavy are excluded. The primary focus is on transportation between nearby communities and the regional center. The preferred booking method is through a mobile app, and the service operates between virtual stops that cover the entire service area.

A seven-seater vehicle is employed for the service, accommodating both passengers and small luggage or strollers. The vehicle can be driven by individuals holding a standard B driving license. Payments are cashless and processed through the mobile app, with no on-board ticketing system. A flat fare is applied per journey.

2.4 FlexOK Lipník nad Bečvou

Launched in early September 2024 by the Olomouc Region, the FlexOK Lipník nad Bečvou service operates within the city of Lipník nad Bečvou and its surrounding areas. The region introduced this service to expand transportation options in outlying and peripheral parts of the region. Passengers book rides via a mobile app, with typical travel times within the service area being around 15 minutes or less.

The service operates between virtual stops strategically placed throughout the area, ensuring proximity to residential areas and key road intersections. Operating hours are from 7 AM to 7 PM on weekdays. A real-time route calculation algorithm is used, allowing for adjustments even during the journey. Service providers anticipate that one of the biggest challenges will be the complexity of the system, which could deter passengers. Similar to other mentioned services, marketing efforts emphasize user-friendliness.

2.5 Key Parameters of the Examined Systems - Summary

Several parameters were monitored in the examined flexible systems, serving as the basis for their analysis. These parameters are summarized in Table 1.

Table 1 Parameters of Transportation Systems. Source: authors

	Transportation Vehicle	System and Ordering Method	Feedback Form	Price vs. Regular Transport	Operating Hours	Restrictions for Passengers with Disabilities
Haló	8-seater vehicle	App, voicebot, web	In app, SMS	ITS fare	8:30 PM - 12:30 AM weekdays	None
TvůjBus	8-seater vehicle	App, hotline	In app, verbally	ITS fare	7 AM - 7 PM weekdays	None
ZkusBus	8-seater vehicle	App	In app	Individual fare	8 AM - 8 PM weekdays	None
FlexiOK	8-seater vehicle	App	In app	Individual fare	7 AM - 7 PM weekdays	None

3. Evaluation

Multi-criteria analysis methods address decision-making problems that require assessments from multiple perspectives [18]. These methods incorporate both objective and subjective inputs, contributing to a point-based evaluation of individual criteria. The Saaty method was selected for its suitability in comparing various on-demand transportation systems. Based on an analysis of domestic and international practices, the authors identified seven fundamental criteria. Due to the scope of this article, a comprehensive analysis, which was conducted as part of a future dissertation, cannot be fully included.

3.1 Saaty's Multi-Criteria Selection Method

The evaluation criteria are derived from Table 1. Given the numerous similarities among the systems introduced since 2023, the criteria are based on their differences. The selected seven criteria subsequently applied in the Saaty method [19] are as follows:

- Criterion 1: Ability to order outside the app (voicebot, web, or hotline)
- Criterion 2: Form of feedback outside the app (SMS, verbal)
- Criterion 3: Validity of the ITS fare
- Criterion 4: Financially advantageous "introductory" fare
- Criterion 5: Operating hours throughout the workday
- Criterion 6: Operating hours in the evening and night (outside regular line operating hours)
- Criterion 7: Vehicle capacity exceeding eight passengers

For the sake of brevity, the criteria are denoted by their ordinal numbers listed in the criteria list. The following Saaty matrix [19] is presented, from which criterion weights are calculated using geometric means and presented in Table 2 below.

Table 2 Assigned Preference Values for Criteria. Source: authors

	1	**2**	**3**	**4**	**5**	**6**	**7**
1	1	3	1/9	5	1/7	1/5	1/5
2	1/3	1	1/9	4	1/8	1/6	1/6
3	9	9	1	9	3	5	6
4	1/5	1/4	1/9	1	1/7	1/6	1/6
5	7	8	1/3	7	1	3	4
6	5	6	1/5	6	1/3	1	2
7	5	6	1/6	6	1/4	1/2	1

The results of the Saaty method highlight the dominance of the criterion related to the utilization of the integrated transport system (ITS) fare. Additionally, criteria tied to the system's operating hours are identified as priorities.

Table 3 Calculated Weights of Criteria. Source: authors

Non-app booking options	0.044
Non-app feedback channels	0.029
Validity of the ITS fare	0.421
Introductory discounted fare	0.019
Full workday operation	0.247
Evening and night-time operation	0.136
Vehicle capacity exceeding eight passengers	0.104

Table 2 highlights a significant disparity between the weight of Criterion 3 (validity of the ITS fare) and Criterion 4 (introductory discounted fare). This contrast underscores the difference in value between a one-time discount and long-term integration into the fare system. The values in Table 3 can be categorized into the following groups:

- Integration with ITS
- Scope of operation
- App substitution options
- One-time benefits

The consistency of the criteria evaluation is reflected in the similarity of the weights assigned to criteria within individual groups. The importance of the criterion groups corresponds to the order in which they are listed.

3.2 Options for Making Flexible Transport Systems More Attractive

Through a comparative analysis of the criteria, the authors concluded that the most crucial factor in making flexible systems more attractive is whether the given system is fully integrated into the existing ITS fare system. Another significant factor is the scope of operation. Users, regardless of age or region, prefer all-day operation. Given that these systems are utilized by older individuals, the ease of use of the booking system and the overall processing time for requests can also be considered important evaluation criteria. In the event that the decision-maker opts to create or integrate a new flexible system, a comprehensive SWOT analysis should be conducted to identify its strengths and weaknesses.

4. Discussion

The functioning of a flexible transport system must always be evaluated within the context of the area in which it is operated. The demands on public transport are shaped by the social and demographic characteristics of the area [13]. Flexible transport systems in peripheral areas are designed to complement the existing fixed transport system that operates in the given region.

The results of the Saaty method not only identify individual criteria but also group them into categories. Within individual groups, other criteria may exist that are not included here. The key contribution lies I in the identification of groups where improvements can be made.

In the case of peripheral areas, it is necessary to ensure rapid connections to the center, particularly along the commuting routes of the population [20]. Alternatively, a fast connection to inter-regional public transport services should be provided. When operating in suburban areas during off-peak hours (for example, a system providing service during evening off-peak hours in the Central Bohemian Region), a longer travel time can be accepted within a variable route, as these journeys are not related to commuting to work or school, but to other travel purposes.

The findings of this article can be applied, for example, when introducing new flexible transport systems or reviewing the proper functioning of existing ones. In practice, this could include systems for border regions of the Karlovy Vary Region, or border regions or areas with a higher number of small settlements in the Ústí nad Labem Region. Connections in these areas can be linked, among other things, to the Ústí nad Labem - Karlovy Vary - Cheb route.

5. Conclusion

This article addresses the issue of flexible transport systems in the Czech Republic, focusing on their application in peripheral areas, and particularly the forms of service booking and user communication with the transport system. The characteristics and parameters of transport systems were analyzed, and based on these, criteria were established and assigned preference weights. The result is a ranking of

the importance of criteria and, in particular, the creation of groups of criteria with similar weights (criteria with similar characteristics).

The findings of this article can be used for planning future transport services and setting up flexible transport systems appropriately. A SWOT analysis of the relevant operating area should be conducted for both planned and existing flexible transport systems, followed by an evaluation of the groups of criteria presented in this article.

The findings are applicable to flexible transport systems in peripheral areas, as well as to complementary systems in suburban areas (for example, systems assessed include one system from the vicinity of Prague). The appropriate design of the system is crucial for the level of use among passengers, and subsequently for the effective functioning of the system, investments in the vehicle fleet, and the overall image of the transport service.

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