Why do we need for more accurate predictive public transport planning?

EDIT SÜLE[1] – PETER CHIFIRIUC[2]

Abstract
The public transport mobility systems have been drastically affected by the changing transportation demands. In Budapest, comprehensive daily passenger number dataset is not available, the demand is not constantly followed. The mobility system needs to develop strategies that will help to shape the future, provide options to respond to different outcomes in case of unforeseen setbacks. The current digital passenger counting system provides limited data over a long period. Data collection should be improved to get real-time occupancy, implement predictive intervention, plan demand-based network; also for more efficient workflow and for exact cost/revenue allocation between operators. Another issue, the agglomeration of Budapest public transportation does not have unified coordinator, so the transport planning, datasets and the development are divided. The paper deals with these issues based on international best practices.

Keywords: public transportation, public transportation planning, passenger counting, MaaS

INTRODUCTION

At present, the level of transport services in Budapest agglomeration lags significantly behind that of European cities of similar size. This is compounded by design gaps that are unable to respond to short term changes in demand, traffic and capacity. A modelling program (EFM - Unified Traffic Model) is in use in Budapest. The essence of the model is that the number of passengers measured on vehicles is treated as a reference only. This is because the current methods of counting passengers on the lines are not suitable in themselves for determining the actual demand, they can only measure the attractiveness of the routes (more comfortable lines (e.g. frequently depart) attract passengers more than the lines with long waiting times). Thus, passenger census data are supplemented by household surveys (data about the transportation behaviour: e.g. from where to where they transport), KSH data, ticket sales data and road traffic data. Based on these data, the impact of a long term traffic change can be modelled during strategic planning. However, a huge disadvantage of this modelling procedure is that it is only suitable for medium- and long term macroscopic design. The data in the model (including passenger traffic) is updated annually.

While demand in a city varies every minute, such modelling techniques are becoming less effective, failing to meet current requirements, short-term microscopic prediction. Through digitization, large-scale or complete data collection is already available, i.e. we are able to determine micro level demands as well. With the contribution of predictive planning tools, we can find out when, from where and to where passengers travel. As its name implies, predictive planning is able to predict from historical data and what-if scenarios what will happen. Based on this, the optimal public transport capacity and network at any given time can be determined, and it can also be the basis for the development of an integrated mobility as a service system (MaaS). These issues will be observed in the next sessions in the region of Hungarian capital and other European cities.

[1] egyetemi docens, Széchenyi István Egyetem, Marketing és Menedzsment Tanszék, E-mail: sedit@sze.hu
[2] Senior közösségi közlekedés tervező, BKK Budapesti Közlekedési Központ, E-mail: PeterGabor.Chifiriuc@bkk.hu

1. DIGITAL PASSENGER COUNTING TECHNOLOGIES

1.1. ASSESSMENT OF CURRENT SITUATION

In Budapest the passenger number data comes from infrared and weight-based counters. Infrared sensors also used in Prague, Paris, Helsinki and Warsaw. Weight-based counters, due to its high sensitivity to weather and road conditions, are usually used on railways e.g. Sydney and Paris. In Oslo the most popular counting system is the people counting camera (BKK-EMTA survey, 2021). Due to the high cost of these systems just a smaller proportion of the fleet is equipped with digital counters, 20-30% on average. As a consequence, the lines cannot be measured comprehensively all the time, also the passenger counting requires planning.

With this method, detailed dataset cannot be collected, thus the constantly changing passenger demand cannot be determined. This system can be used only for annual traffic inspection and medium- or long-term macroscopic planning, but in the everyday usage short term microscopic prediction is needed.

During the pandemic, the demand for the rapid and qualitative passenger data is intensified, but in Budapest an integrated and extended digital passenger counting system is not available. In this period data was collected from only 10 lines, this way data collection was accessible on daily basis. The created average passenger number change was suitable at some level to determine demand and adjust the schedules, but each line has an individual characteristic and the schedule change caused unevenness on some lines. For instance, in the residential areas the passenger number decreased more than in the industrial areas. Compared to the regular school-term weekday average ridership level in 2019, the vehicle occupancy decreased by 70–80% due to the first government decrees in the spring of 2020. In the beginning of September 2020 and 2021 the ridership level was around 80%, but this value rather fluctuates between 65% and 85% according to the current restrictions.

1.2. PASSENGER DEMANDS

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 pre-planned. In this case, destinations are approached from those directions what is fundamentally more convenient, in other words services are more frequent and the trip chain is less disrupted by waiting. Similarly, the demand is also influenced by the walking distance; for example, a frequent service with a walking distance of 10 minutes will attracts the passengers more than a closer but less frequent service.

Based on these, classical on-board passenger counting methods are not suitable for determining the actual demand, but rather for determining the passenger attractiveness of the lines; they do not allow for an accurate determination of demand. To solve this problem, a modelling program (EFM - Unified Traffic Model) was developed Budapest based on PTV Visum. The essence of the model is that passenger numbers are only used as a reference value, supplemented by household records (e.g. from where to where), KSH data, ticket sales data and road traffic data. These can be used to model the impact of transport changes in the strategy planning.

1.3. IMPROVED DIGITALIZATION

A major drawback of the previous modelling approach is that it is suitable for medium- and long-term macroscopic planning only. The data in the model (including passenger traffic) is updated annually.

While the demand in the cities changes from minute to minute, such modelling procedures are increasingly inefficient and do not meet the current requirements of short-term microscopic prediction.

Digital technologies have made it possible to collect data completely and real-time, i.e. to determine demand also at the microscopic level. A good example of this are the 'tech giants', which are able to determine exact demand at individual level. In the case of public transport, the fortunate situation we only have to know about the traveling details (Origin, destination and the time).

Thanks to the digitalization, electronic ticketing is now being used in addition to the classic passenger counting devices. In Sydney, on the surface lines ticket validator counting is in usage instead of the classical digital passenger counters (*itnews.com.au* and *transportnsw.info*). The check-in check-out (or tap-on tap off) e-ticket system is suitable for counting by the tapping-in and tapping-of. On this basis, a flexible multi-dimensional origin-destination (OD) matrix can be generated. This means that for each day (even in real-time) a complete travel chains are available. This could fundamentally change transport network and capacity planning and facilitate the widespread deployment of flexible systems.

By the wide range of information, we have the opportunity to achieve the following information and services:

for transport organiser companies

- Real-time occupancy on every line,
- Collective daily travel characteristics,
- Daily database refresh (with Origin-destination matrix and maps),
- Predictive intervention/planning in short term,
- More efficient workflow for dispatchers and traffic control officers (live network status/occupancy tracking),
- New opportunities in network and capacity planning,
- Exact cost/revenue allocation between operators (also between state and municipality) for the passengers
- Real-time occupancy on every line,
- Real-time route planning - options between the fastest and lowest occupancy level routes,
- Precise predictive route planning - based on the previous day’s characteristics and route planner application searches,
- Personalized information and offers,
- Demand based network using the daily updated OD matrix,
- Higher service level due to faster intervention.
- Fair tariff system (‘pay as much as you travel’ instead of fixed-price tickets)

2. INTEGRATED TRANSPORT SYSTEM

2.1. BACKGROUND HISTORY

Flexibility also depends on the relationships, partnerships, regulations, and harmonisations between the companies.

In the beginning of Budapest transport (19^{th} century) only two transport companies were on the network. These two companies were merged to stop competition, and they also obtained monopoly on construction of omnibus lines. As the technology developed and the electricity became available, new companies appeared and perfect competition ruled the market. By the open market the network become unreasonable, and many parts of the city were not accessible by public transport. The competing companies were bought and merged into one company (BKV) by Municipality of Budapest.

In the 2000s, BKV (Budapest Transport Privately Held Corporation) had more and more problems. As a municipal monopoly, it had no interest in improving and developing the service, the age of the fleet became high and also the infrastructure was in poor condition.

According to directives of European Union (also White Paper) new goals were set, for instance market opening in passenger transport, creating framework for transport information, management and payment system, competitive and sustainable system in passenger and freight transportation.

BKK (Centre for Budapest Transport) was founded by the decision of the General Assembly of the Municipality of Budapest in 2010. This made BKK the new mobility manager and organiser, responsible for the ordering services and developing Budapest public transport. BKK was prepared for being an integrated transport organizer in the whole Budapest metropolitan area. Despite the goals, BKK has been disintegrated in 2015.

Current transport system in Budapest:

Municipality of Budapest side

- BKK: transport organiser and developer
- BKV: internal operator
- ArrivaBus: private operator, mainly owned by Deutsche Bahn

State side

- ITM (Ministry of Innovation and Technology): ordering and approving service
- KTI (Institute for Transport Sciences): coordinator
- BFK (Centre for Budapest development): developer
- NIF (National infrastructure developer): developer
- MÁV - VOLÁN - Group

  MÁV-START: railway operator

  MÁV-HÉV: operator - “green” suburban railways, previously owned by BKV

  “blue” VOLÁNBUSZ: operator in the suburban area - BKK design, technology and fares - previously the routes were operated by BKV.

  “white/yellow” VOLÁNBUSZ: operator - suburban and long-distance buses

2.2. INTEGRATION

The number of mobility service is growing rapidly (incl. sharing services), for the user it is challenging being confronted by all these options when choosing the best way to travel. „*A topological approach to Mobility as a Service*” document determines zero to four level of MaaS (Mobility as a Service): 4. integration of societal goals, 3. Integration of the service offer, 2. Integration of booking and payment, 1. Integration of information, 0. No integration: separate services. Currently, Budapest transport is between level 1 and 2, a few integrations has been started, but the whole agglomeration of Budapest transport is on lower integration level.

Examples for different type of integrations:

- Wiener Linien - WienMobil (Vienna): It is between level 1 and level 2 integration (including the whole agglomeration). It also contains information from private service providers, and it allows in-app-payment for some service, but not for all.
- Google Maps – worldwide route planner. It contains the main services from GTFS (General Transit Feed Specification) database almost worldwide, but we cannot purchase any ticket from it.
- FlixBus (FlixMobility Gmbh): A private transport organizer company mainly for intercity bus transport (subcontractor-type business model). In 2018 Flixbus reached

90% market share of intercity bus service in Germany, which is criticised for being close to monopoly.

The following ones are required for a successful integration: regulations, legal frameworks, coordination between the companies, accessible infrastructure, finance and funding, technology and digitalization and data sharing.

3. CONCLUSIONS

Public transport companies must actively use available digital tools and technics in an integrated way to know the passenger demands in order to provide adaptive services. The key is to enable real-time optimization of mobility flows and assets at city or national or international level. For instance, companies should utilize not only their current digital passenger counters, but further tap-on tap-off (check-in check out) e-ticket systems through the validators, journey planner applications and external sources (e.g. weather forecast) to determine the exact passenger demands.

To achieve EU goals (integrated, demand responsible and competitive transport service) and to manage easier the European Mobility as a Service connection, a transparent and effective integration is needed.

REFERENCES

BKK Centre for Budapest Transport and European Metropolitan Transport Authorities (EMTA) (2020) *Automated Passenger Counting and (digital) Onboard Services Questionnaire.*

Sochor, J.–Arby, H.–Karlsson, M.–Sarasini, S. (2018) *A topological approach to Mobility as a Service: A proposed tool for understanding requirements and effects, and for aiding the integration of societal goals.* Elsevier.

Internet sources:

„NSW brings personalised real-time occupancy alerts to Opal Travel app" - *Software - iTnews*. https://www.itnews.com.au/news/nsw-brings-personalised-real-time-occupancy-alerts-to-opal-travel-app-555691

Transport for NSW, „Opal Travel", *transportnsw.info* http://transportnsw.info/apps/opal travel