Integrated Telematics System for Passengers' Guide at Intermodal Traffic Centres

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Keywords: intelligent transport systems, mobility management, travel chain, influence of passengers, personal characteristics.

Abstract. This paper describes a new optimum search method regarding the passengers' transit process. Route-finder programs available nowadays via internet do not deal with users' personal characteristics (preferences), which are especially important at interchanges. Therefore *we have created a micro graph model, which is based on the parameters of intermodal traffic centres, passengers' behaviour, travel and environmental properties*. With the description of elementary specifications we could investigate passengers' movements which are modified as a result of the information perceived. Conclusions: *use of this new method in the users' applications allows them to gain real advantages* (i.e. reliable information, *reduction of access time*). This so called "micro approach" later can also be embedded in a macro model, which is an extension of this work. It provides opportunities for further, more detailed research regarding the entire transit process.

Introduction

The multimodal trip chains can be simple or complex according to the number of used transport modes. Every change of location without transfer belongs to the *simple travel chain* group. [1] In general the *complex travel chain*s consist of 2-3 travel sections and/or walking sections. The complex travel chains taking place in the urban, interurban and long distance travel space can be separated into three different phases such as

- travel,
- walking,
- waiting.

Fig.1. shows the interrelations of the three:

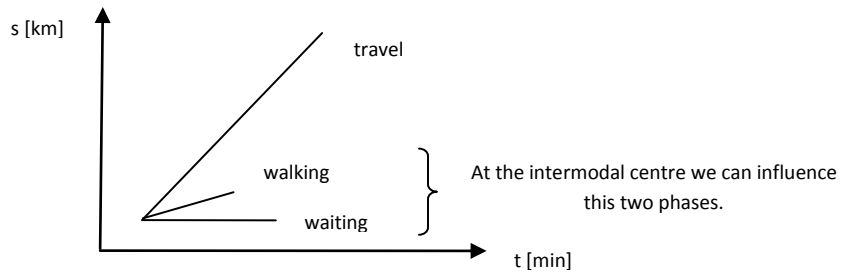

Fig.:1 Time and place features of the multimodal travel chain at intermodal centres

The *travel:* change of location using any transport device. This phase is the most sensitive to environmental and traffic disturbances. The more it is used in the travel chain the bigger uncertainty factor is caused. The degree of uncertainty at passengers is generally increased by sensibility to disturbances of travel environments. The travel disturbances may be originated from unexpected situations caused by the unpredictability of the travel environment (weather), passengers (accidents, delays) and vehicles (technical breakdown). As long as the most important task in the travel subsection is the control of the vehicle, in the phases of walking and waiting we are able to affect these processes by soft intervention procedures.

The *walking* is the simplest way of transit and on the other hand it is the connection element of the complex multimodal travel chain. Walking is the most predictable time element, due to its simplicity. It can also be modified (with consideration to certain limit), if the „user" is in possession of enough information. Fig.2. shows the sensitivity for disturbances during transit process.

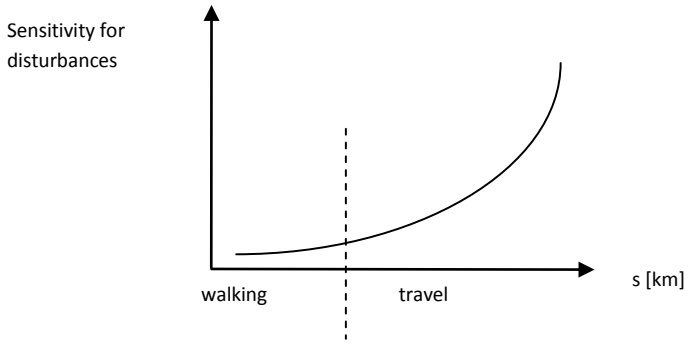

Fig.2. Sensitivity for disturbances plotted against distance

Most of the movements inside of a circle with radius of 1,5-2 kilometres are executed by walking. In case of disabled or elder people this area is smaller. For longer distances generally transport devices are used. Here, walking has only a connective function. These movements can be influenced by soft interventions, namely information-services.

The *waiting* belongs to the process of interchanges; it is a prerequisite for boarding and transfer. Although the waiting is the shortest phase (in case of a planned transit) in a well-operating system, it is the most unpleasant part of the chain, as besides waiting itself, there are only a few other activity options available to a passenger.

Therefore information in an understandable format for passengers and solutions making the waiting time more comfortable, i.e. internet via smart phone, notebook or tablet PC are all necessary. Depending on agreements between an operator of the intermodal centre and transport companies fees for accessing these services can be included in the fares.

Problem exploration. The most important features for the passenger of a complex travel chain are the reliability of the service and – in this context – the time of travel. The latter so called „time-management" problem can be solved in two ways:

- reduction of waiting time, or
- making possible to spend it in efficient and/or pleasant way.

For achievement of these aims the development of information management is also necessary. [3] Namely during multimodal travel chains the travellers do not have enough information related to their transit process. In addition, they are often unable to process it properly. Because of these reasons they often choose "inefficient" modes and/or routes (travel chains). Decision-making in case of sudden traffic incidents is particularly difficult.

During the journey travellers usually have only limited access to the information concerning their current situation (location). Therefore the perceived quality of the transport is lower and the travellers feel uncertainty in decision-making situations. [2]

In this article we will present a procedure for soft control that allows passengers involved in a complex travel chain to save their time. This elaborated procedure, will form the basis of the multimodal mobility manager application. [6] The most important features of it:

- This system provides *personalized recommendation*s for the users based on pre-set (personal) parameters and as a result of 'self-learning'. These parameters may be originated from personal features, disabilities, social affiliation, etc. The system can recommend the fastest, the cheapest, the most obstacle-free, and the less traffic-jammed, less congested etc. route. [4]
- It can store the input data and results of the queries, as well as show the so called *"subjective map"*. It means that every user has a list in his/her mind about the locations where the services are available and the habitual paths to there.
- The software (including database-management application) can provide a detailed recommendation, that informs the users about the additional services of a certain line (for instance: WIFI is available or not on board). [7]
- In case of an unknown environment the application helps users in orientation with photos and layouts.
- Operation of the application is based on dynamic data (information about the current situation).
- It is able to provide value-added information (e.g. predicted traffic situations).
- It gives recommendations about the environmental load data and the energy consumption of a certain transport device.
- In a wider approach it can handle the daily (routine) activities and their spatial features.
- It is available via internet with fixed or portable end-devices (terminals).
- The basic functions are available for anyone free of charge, but the additional (premium) functions are subject to payment.
- It is able to manage also the operator functions (reservation, pricing aspects).

Handling of two time elements of the travel chain (travel and waiting time) belong to the tasks of the traffic organizing. Therefore these parameters are considered as preconditions and depend on the environmental effects, actual traffic situations on the transport network as well as traffic and vehicle control. Thus acting, time saving during the transit process can only be achieved by using information services at interchanges. Therefore we focus on the preparation of the changing process (on board information about the connections) and the aid of the walking (at intermodal centre).

Working out in details of the elements and functions of the outlined complex system constitutes the referent of our continuous research activity.

Modelling – Delineations. The information management procedures concerning pedestrian traffic belong to type of soft interventions. Therefore we have examined how the transparency, barrier-free feature and pedestrian flows all change at intermodal centres as a consequence of these measures.

To manage this problem we have determined two kinds of model space:

1) In connection with the entire transit process we have worked out the micro- and macroscopic model in order to search both personal and public optimum solutions. The Venn diagram in Fig.3 summarizes the expected results.

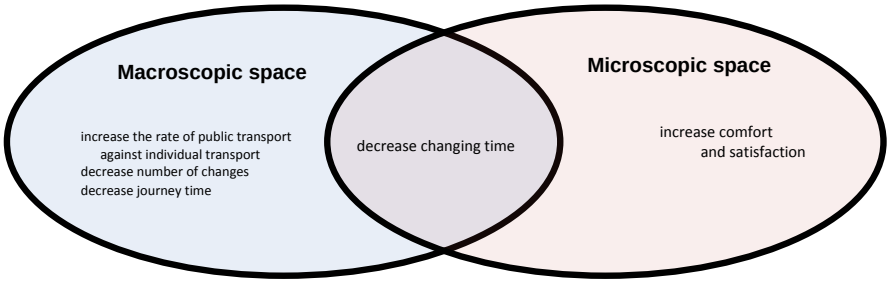

Fig.3. The expected results in these areas

During the travel phase the subsequent pedestrian movements can only be prepared. The travellers, after boarding a vehicle, form a group. The on-board collective information, which gives recommendations and orientation concerning changing, should be managed in the same way as the information at intermodal centres.

Considering the whole transport network, it should not be handled as a „full graph" because not all the transfers among the services are relevant in general. That is why the graph on Fig.4. has been introduced. The used ways for depicting the graph are the followings:

- On the *macro graph* (for movements among junctions)
  - A. the nodes represent intermodal centres,
  - B. the links represent paths between neighbouring intermodal centres.
- On the *micro graph* (for movements inside of the intermodal centres)
  - a) the nodes represent the place where passengers access/egress the vehicles (place of boarding/alighting),
  - b) the links represent possibilities of movements either on foot or by special mechanisms for disabled/elderly passengers.

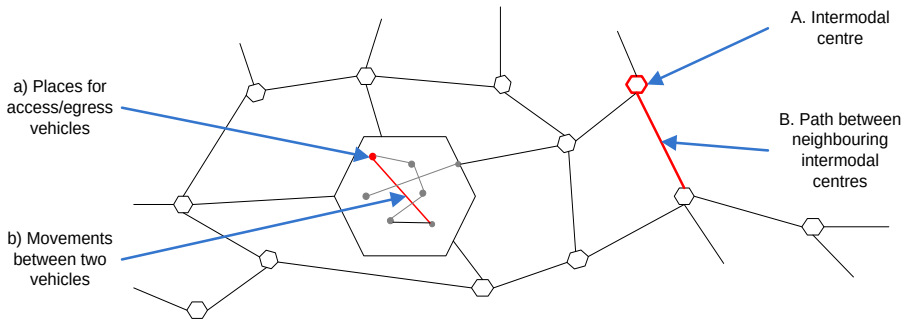

Fig.4. Relation between macro and micro graph

2) For analysis of orientation processes and movements at the intermodal centre a simplified model has been used. Fig.5 shows the basic movements and the information handling processes at the same time.

Fig.5a represents an intermodal centre schematically from an above viewpoint. It shows how passengers reach and leave the intermodal centre. As an outcome four possible movements (signed by thick arrows) can be distinguished:

- arrival to the intermodal centre with vehicle, interchange, and leaving it with vehicle,
- arrival to the intermodal centre with vehicle, alighting, leaving it by walking,
- arrival to the intermodal centre by walking, boarding, leaving it with vehicle,
- arrival to and leaving the intermodal centre by walking.

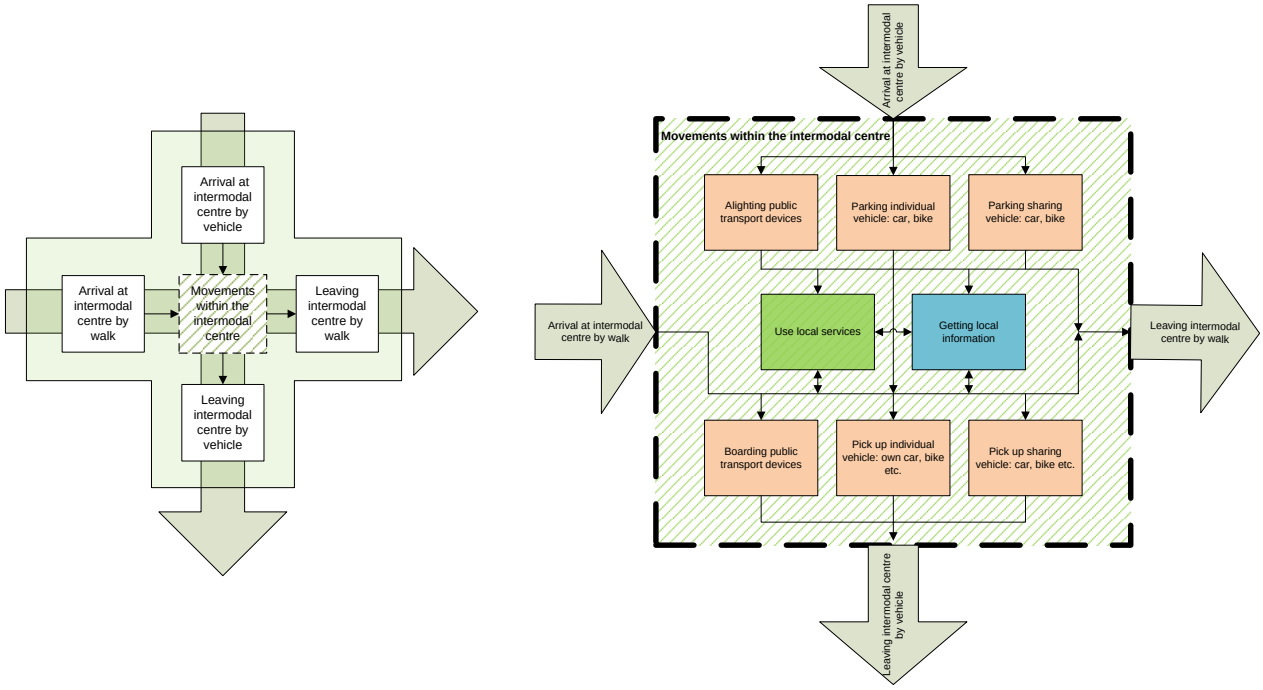

Fig.5a **Fig.5b**

Fig.5. Pedestrian movements and information processes within the intermodal centre

The destination can also be inside of the intermodal centre, but this case has not been examined. On the Fig.5b the magnified micro environment is illustrated, which is originated from the middle part on left.

- conventional (only local information is available, according to the current practise: number of line/service, timetable),
- online and information available on spot (this is the blue box on the picture).

The arrows show the movements. The blue box represents the solution, when the passengers modify their transit chain on spot as a consequence of use of dynamic information.

The micro graph model will be based on the following parameters:

- the geometry (local conditions e.g.: centre was built on hillside, or riverside),
- the layout (planned elements e.g.: blocks as design-elements and barriers),
- the number of available services.
- connection points of the transport services,
- spatial features of the connection points,
- obstacles (hindrances) between connection points (stairs, pedestrian crossings, ramps, etc.)
- volume and nature of the pedestrian traffic at the intermodal centre (partly shapeable).

The most important devices available for information services (in correlation with the functions of the intermodal centre) are:

- platform signs,
- VMS (Variable Message Signs) installed on the platform, [8]
- location-based information services (with use of GPS application; based on the actual location and situation).

For the easier handling of the model the maximum number of connection points should be limited. In case of an intermodal centre with *n* connection points (*n* is around 20 in general) the calculation of the *n*n* matrix may be rather complex. The time-values derived from distance parameters between services form the elements of the matrix. [5] Generally the matrix is not symmetric because the distances are not the same in both directions. To calculate the personal (and the global) optimum solutions large amounts of (dynamic) data, highly qualified processes and high transfer capacity is needed. To solve this problem the most modern computer networks with the highest capacity are already available.

Summary

The article addressed one problem among the range of challenges in the whole transit process and mobility management, namely, the reducing the time value of interchanges using intelligent transport systems. After defining the parts of the transit process and the relationships among the elements (travel, walking, waiting) we described our micro graph searching approach.

The micro graphs can be connected in the later phases of the research and the further investigations on a macro graph may be executed. The expanded search methods and the macro-graph model make it possible to find the personal (and global) optimum time of location change. While the result of the micro graph search is mainly useful for individual travellers, the macro search optimum provides benefits for transportation companies. The communal optimum solution is defined by the size and nature of a community, such as a city district, a city or even a country.

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This work is connected to the scientific program of the " Development of quality-oriented and harmonized R+D+I strategy and functional model at BME" project. This project is supported by the New Széchenyi Plan (Project ID: T MOP-4.2.1/B-09/1/KMR-2010-0002).