New Technological Solutions to Improve Rail Passenger Services Based on the Example of the In2Stempo and ExtenSive Projects of Shift2Rail

Grzegorz STENCEL[1]

Summary

There is a reason why it is said that stations are the business card of railroads. In the IN2STEMPO and ExtenSive projects, research work is looking at solutions to improve the passenger experience at stations. This article presents the scope of research carried out within the projects, including the development of more effective tools for crowd management at high-capacity stations, but also on new methods of designing stations and their elements taking into account the latest architectural trends. An important issue is also a problem still troubling the staff of many railroads, that is, improving accessibility from the platform to the train. Rail services, by their universality, should take account of the extensive opportunities offered by information technology. This applies to the complete process of passenger service, from purchase of a ticket to arrival at commercial outlets and the journey itself. The article also outlines the principles of the ExtenSive project, which is a continuation of previous work aimed at developing both passenger applications and software for transport operators, which at the end of the day will enable the provision of transport services of the highest standard. This paper presents the results of the analysis so far on the eve of the projects' completion, and identifies possible applications of the results of the work carried out.

Keywords: rail passenger services, Shift2Rail, Horizon 2020

1. Introduction

In the discussion on zero-emission transport, railway is always identified as the greenest transport. The aspiration to reduce environmentally destructive greenhouse gas emissions must therefore take into account the extensive development of railway transport. In recent decades, the overall European rail picture has seen the development of high-speed rail infrastructure, while infrastructure for regional railway has been reduced. It seems that it will not be easy to reverse the decreasing trends, due to the sometimes very high costs of restoring traffic. Railway lines located within agglomerations are an exception, as rail wins decisively in competition with other modes of transport due to the widespread phenomenon of urban sprawl.

In order for the railways to be a popular choice for passengers, in addition to modern infrastructure and vehicles, adequate service at stations and wide access to information in the virtual world are essential.

When planning such services, the need to ensure unrestricted accessibility for all passengers, regardless of ability, should not be overlooked. It should be noted that the absence of unnecessary obstacles to passenger movement and clear passenger information are useful not only for passengers with impairments, but also for other passengers. The benefits of a properly planned station space are also on the part of the station manager and operators, as passengers are happy to stay in such places and use the services.

The services provided by railway transport should be assessed through the prism of the European Union network, particularly from the point of view of the ambitious goal of railway interoperability. It is reasonable for Member States to cooperate in this area not only by creating common rules but also by carrying out research and development work together. Research cooperation is not only an excellent opportunity for valuable exchanges of experience from individual countries, but also allows the best innovative solutions to be developed.

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[1] M.Sc.Eng.; Railway Research Institute, Railway Track and Operation Department; e-mail: gstencel@ikolej.pl.

2. Shift2Rail

Shift2Rail is a research programme dedicated to railway transport within the framework of Horizon 2020, with projects scheduled to run from 2014 to 2024. It is a public-private venture to coordinate research and development in the field of railway. Nearly 30 companies are participating, together with associated companies [7].

The main objectives of the programme are to support the common European rail market, to increase the competitiveness and attractiveness of railway transport, and to strengthen the leading position of European manufacturers and rail service providers in the global market. The total budget for the programme is more than €900 million, including European Commission funding from Horizon 2020 sources of €450 million. The budget is currently more than 80% completed.

Shift2Rail comprises more than 100 completed projects, which are divided into five main thematic areas:
1) vehicles (18 projects),
2) rail traffic (19 projects),
3) infrastructure (16 projects),
4) IT solutions (14 projects),
5) freight transport (16 projects).

The remaining projects were dedicated to interdisciplinary issues and those that do not fall into the above categories [9]. An interactive map of possible solutions is shown in Figure 1.

Each project envisaged the creation of a technological demonstrator, i.e. a solution or technology resulting from the work envisaged in the project. Solutions delivered under the Shift2Rail programme are typically at a technological level in the TRL5-TRL7 range. They are typically solutions that have been tested in laboratory conditions or on existing trains and are ready for market deployment.

3. In2Stempo

In the In2Stempo project, the work concerned breakthrough improvements in energy and station technologies. The topics were divided into a total of 8 work packages, where WP2-WP5 dealt with energy and WP6-WP9 dealt with stations (Fig. 2).

Energy issues were considered in terms of the power supply itself, as well as in the context of smart metering. The work on power supply was concerned with the possibility of creating an energy resource network, allowing the integration of smart metering data collection systems, innovative equipment, energy
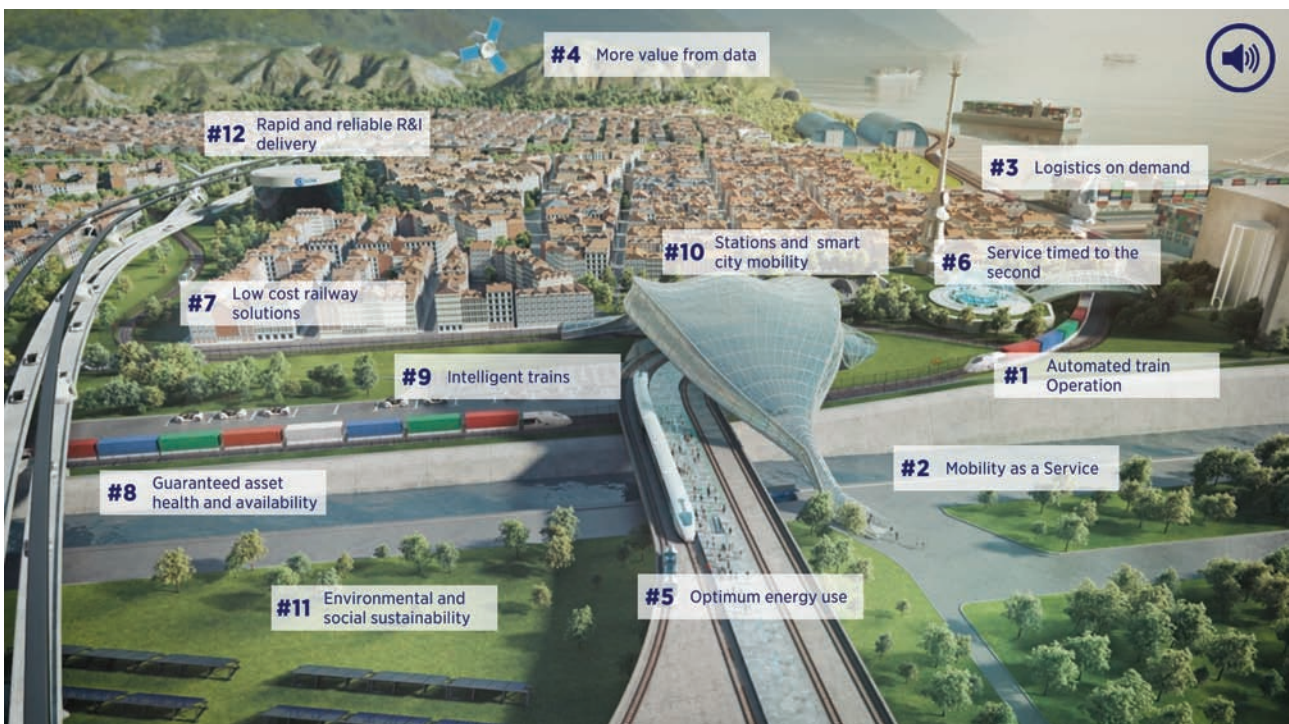

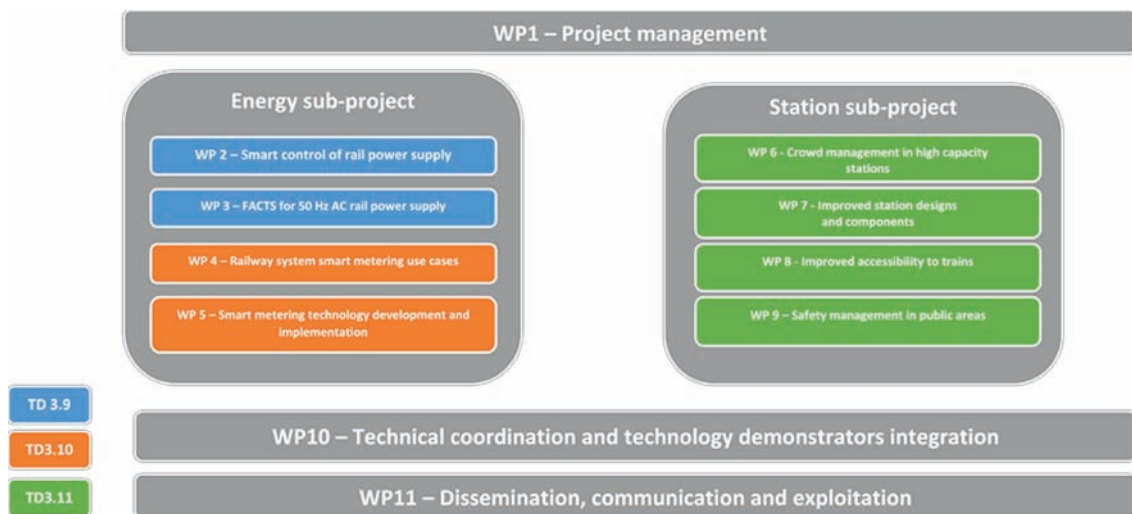Fig. 1. View of the interactive capability map available on the Shift2Rail website [9]

Fig. 2. Work packages in the IN2STEMPO project [8]

management and storage systems. Such a solution allows for improved operation, reduced electricity consumption costs and increased security of energy supply for railway consumers.

The development of metering systems for data collection and analysis, taking into account the creation of a sensor network, aims to improve the energy analysis and decision-making process regarding energy consumption. Such a system makes it possible to create preventive maintenance plans, improve the asset management process and enhance life-cycle cost management. The work in the In2Stempo project related to the station theme was divided into four parts: crowd management in large stations, design of small stations, improving accessibility to trains and safety management [6].

In the crowd management part, a number of simulation studies were carried out using specialised software. The software allowed the use of advanced machine learning algorithms that take into account the spatial and temporal distribution of the data to calibrate the crowd simulation. A use case for simplified conditions was demonstrated in the paper [1], where only crowd density and concentration in a small area were considered. The test scenario will be enhanced with additional features such as passenger speeds, macro-behaviours (e.g. train departures and arrivals) and the inclusion of a larger station area, including tunnels and platforms.

The implementation of such a system makes it possible to use a station monitoring centre in day-to-day operations to manage passenger flow more efficiently. Based on the data that is collected and analysed on an ongoing basis, key performance indicators for crowd management can be applied, allowing potential crowd congestion to be detected before it occurs. Depending on the situation, this creates the opportunity to take early action to prevent dangerous situations.

In the analyses related to the design of small stations, particular attention was paid to the use of modern materials and technologies in station construction. Many of these solutions have been applied in innovative system stations, whose construction programme is currently being implemented on a large scale by PKP S.A. [2]. Distinctive features of this type of building, in addition to contemporary architecture incorporating universal design, using sustainable materials, include the following technologies:
- energy-efficient LED lighting,
- power supply via local energy sources in the form of solar panels and heat pumps,
- a building management system that collects data on, among other things, the efficiency of installed appliances,
- systems enabling the use of rainwater.

Experience with the innovative stations currently in operation is very promising. The undoubted advantages of creating a passenger-friendly space, as well as the use of modern technologies and ecological solutions, such as low-energy systems, lead to the conclusion that this type of station will be a great showcase for railway transport.

An equally important issue related to passenger service at stations is the problem of the interface between platform and train [2]. Analyses carried out during the project highlighted the problem in all European countries. Undoubtedly, the main aim should be to unify the height of the platform to a level of 760 mm above the running surface of the rail heads (Fig. 3). However, in many regions platforms with heights ranging from 300 to even 1000 mm are still in

use. This poses a major challenge for the purchase of new rolling stock and also for the management of vehicles on existing lines. It is difficult to design a vehicle to accommodate any platform height that will allow safe and comfortable passenger service. Fortunately, the rail infrastructure modernisation programme means that there are fewer and fewer platforms with abnormal heights.

Fig. 3. The no longer existing platform at one of the stations in Mazovia with the edge of the platform clearly away from the train [photo by G. Stencel]

Until the platform infrastructure is fully standardised in this respect, the following can be used to improve passenger service:
- solutions that modify the platform structure,
- devices to facilitate access from platforms to trains installed on the vehicle,
- ICT technologies.

These solutions were identified by the partners participating in the In2Stempo project on the basis of analyses and surveys addressed to organisations representing people with impairments [3, 5, 10].

As part of the In2Stempo project, a number of solutions have been developed and tested for use on railway infrastructure that can significantly improve passenger comfort. Methods to prevent crowd congestion at stations, the design of safe space for travellers located at stations, and solutions to improve boarding and alighting at platforms of different heights, are at the same time additional tools for railway operators to improve the quality of services.

4. ExtenSive project

ExtenSive is a project that is a kind of continuation of the work on IT solutions created by the already completed projects, carried out as part of the Shift-2Rail initiative, namely ATTRACkTIVE, Co Active

and IT2Rail. In addition, collaboration with the ongoing two projects Ride2rail and IP4MaaS is envisaged. The project involves the creation of new IT application functionalities to improve the services provided by rail operators in areas such as shopping, journey tracking, ticket booking and purchase, and mobility.

One of the issues being worked on is the development of an application for traffic dispatchers to analyse the data collected on incidents occurring on the network and to support decision-making, for example to redirect travellers to another mode of transport. The software would analyse the occupancy of individual means of transport (in real time) in the immediate vicinity of an incident causing traffic obstruction and, on this basis, suggest decisions to be taken.

Another IT solution aimed directly at travellers is the Travel Companion application (Fig. 4). In its current form, the application makes it possible to plan a multi-modal journey through any European country. In the ExtenSive project, this application will be developed with new functionalities such as payment systems, navigation through the station and the immediate surroundings, including shopping and points of interest directly related to the journey. The navigation will take into account the specific needs of people with different dysfunctions.
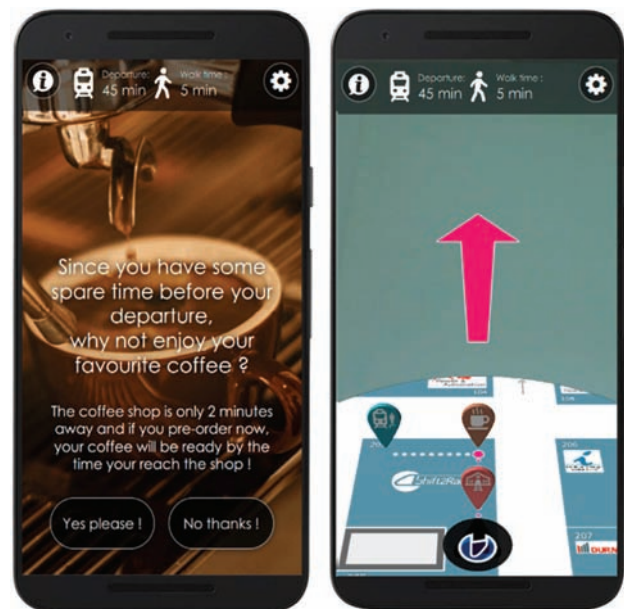

Fig. 4. View of selected pages of the Travel Companion application [9]

The first solutions developed as part of the ExtenSive project have already been tested and presented at the INNOTRANS International Trade Fair in Berlin in September 2022. Other functionalities are still being developed and will be tested by spring 2023.

5. Conclusion

The solutions that are the subject of research and development in the In2Stempo and ExtenSive projects offer the possibility to improve passenger service not only for railway, but also for public transport in the broadest sense. The tools developed as part of the projects can be used by public transport operators to increase the attractiveness of the services provided and to improve their quality.

Rail is usually the fastest and most efficient transport both on an agglomeration and regional scale, so it is up to rail operators to create models for technological and organisational solutions to improve travel, especially for people with reduced mobility. Passenger-friendly solutions can encourage more widespread use of public transport, thus tackling major transport problems, especially in the agglomeration area. The results of the In2Stempo and ExtenSive projects primarily represent implementation-ready solutions, but can also inspire the initiation of measures to improve other issues related to passenger services in public transport.

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