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Use of the locomotives with ETCS system on the Bratislava – Žilina railway line

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INTRODUCTION

Backround information & Market Context

Currently, there is a growing push to introduce interoperability in the rail sector in order to make rail transport more competitive with other modes of transport. In Slovakia, as in other EU member states, the European Rail Traffic Management System (ERTMS) also known as ETCS, has been in use for several years. The aim is to harmonize signalling systems across all countries and thus achieve interoperability on the railways. This would greatly simplify the transit of trains through the countries of the European Union, eliminating the need for most border crossings and ensuring the most efficient use of train crews. ETCS is currently in full operation on the Slovak railway line no. 120 (Bratislava – Žilina) and in test mode on the Slovak railway line no. 127 (Žilina – Čadca). From 15 December 2024, rolling stock equipped with equipment fully capable of communicating with this signalling system will be able to operate exclusively on railway lines equipped with ETCS.

MATERIALS, METHODS & IMPLEMENTATION

Description of research methods and materials

There are several important publications and studies about the mentioned topic, which are also the inspiration for the proposed research presented in this paper. Important scientific and research outputs are presented mainly in the manuscripts. Based on the mentioned facts, it is necessary to solve the mentioned problem systematically and conceptually. The following scientific methods are used to propose the steps of this procedure:

- The heuristic method – the method offers and discovers new ways of solving problems and inventing certain new contexts; it is a scientific activity based on a “discovery” procedure, which usually starts with a general proposal or some rough estimate, which is gradually refined; this method represents an intersection between empirical and exact methods.
- Panel expert method - it is a forecasting method that, based on the input data, provides a vision or recommendations for future options and needs related to the analyzed transport topic; the method involves about 10 - 20 experts who work on a specific problem for a certain period of time (6 - 18 months), the basis is the elaboration of final outputs on the basis of joint compromises and joint scientific and professional research.
- Method of the predictions – method based on the inductive and deductive reasoning from the specific hypothesis or theory which tries to suggest universal pragmatic solutions to a certain issue.

RESULTS

Academic Findings & Innovation

Due to the insufficient number of locomotives equipped with the mobile part of ETCS, they are primarily deployed on long-distance trains on the Bratislava - Trenčín - Žilina - Košice route and on one pair of InterCity trains on the Vienna - Košice transport route. The comparison of locomotives circulations focuses on trains of categories InterCity trains (IC), Express train (Ex), fast train (R), regional fast train (RR), and Regional Express train (REX) in March, for the timetable periods 2023/2024, 2022/2023 and 2021/2022. In timetable period 2023/2024, in March, a total of 2,175 trains were dispatched between Bratislava, Trenčín, and Žilina, of which 1,421 had locomotives with the active mobile part of ETCS at departure from the station, representing 65.33% of the total. The total number of trains increased by 52 compared to the last timetable period. A significant part of the increase in the number of trains with ETCS is due to the deployment of new 561.1 series units into service on most REX trains to Trenčín.

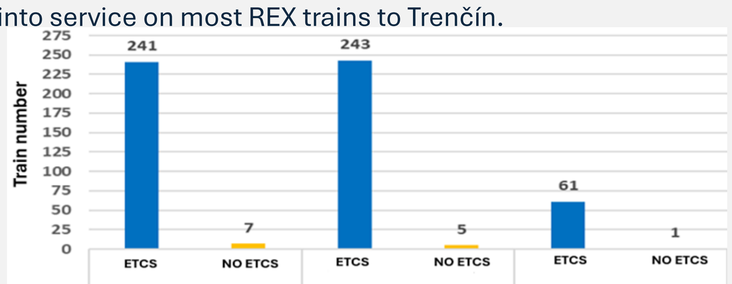

Fig. 1. Comparison of InterCity trains in individual years.

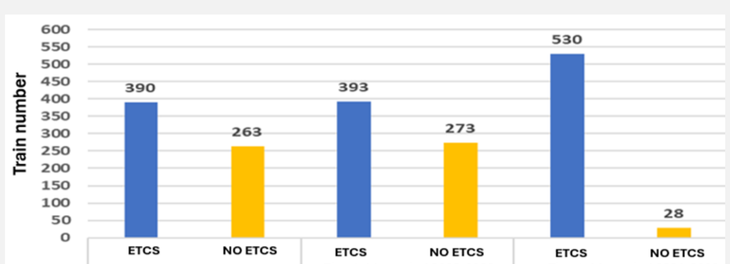

Fig. 2. Comparison of express trains “Tatran” in individual years

Table 1. Occurrence of the locomotives with ETCS on express trains in March 2024

The most trains				Fewer trains			
Train number	With ETCS	Number of trains per month	Percentages	Train number	With ETCS	Number of trains per month	Percentages
600	31	31	100,00%	**621**	0	24	0,00%
607	31	31	100,00%	**623**	0	20	0,00%
606	30	31	96,77%	**626**	0	20	0,00%
611	26	31	83,87%	**602**	2	31	6,45%
614	26	31	83,87%	**609**	2	31	6,45%

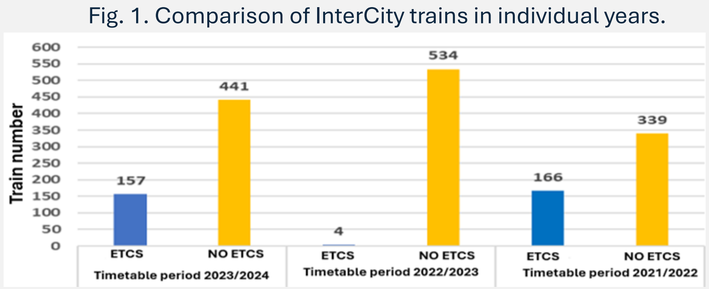

Fig. 3. Comparison of fast trains “Považan” in individual years.

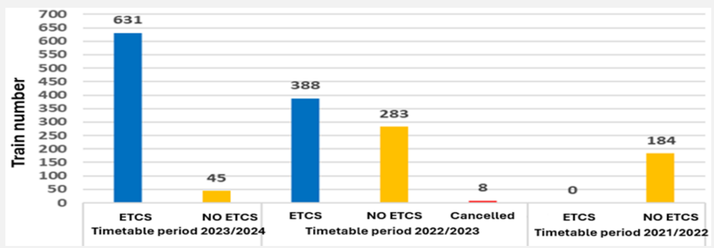

Fig. 4 Comparison of regional expresses in individual years.

Table 2. The occurrence of the locomotives with ETCS on the fast trains in March 2024

The most trains				Fewer trains			
Train number	With ETCS	Number of trains per month	Percentages	Train number	With ETCS	Number of trains per month	Percentages
702	12	31	38,71%	**730**	0	31	0,00%
701	10	26	38,46%	**731**	0	31	0,00%
704	11	31	35,48%	**716**	3	25	12,00%
707	11	31	35,48%	**700**	4	25	16,00%
709	11	31	35,48%	**713**	5	31	16,13%

Table 3. Comparison of the number of trains in each timetable period

Timetable period 2023/2024		
Total number of trains	**with ETCS**	**without ETCS**
2175	1421	756
Percentage ratio	**65,33%**	
Timetable period 2022/2023		
Total number of trains	**with ETCS**	**without ETCS**
2123	1028	1095
Percentage ratio	**48,24%**	
Timetable period 2021/2022		
Total number of trains	**with ETCS**	**without ETCS**
1309	757	552
Percentage ratio	**57,83%**	

Locomotives circulations on the particular train types in 2022-2024

The number of trains in 2023 increased significantly compared to the previous timetable period 2021/2022, with the total number of trains rising by more than 60%. There was a notable increase in the number of regional express and Považan express trains, which, along with REX trains, began operating regularly on weekends. It was also the first year that Tatran express trains were replaced by the express category. The number of stops between Bratislava and Žilina was reduced, shortening the journey time by 21 minutes, bringing it to 2 hours and 2 minutes. New pairs of morning and afternoon Tatran express trains from Bratislava to Vrútky and Poprad were introduced, along with three additional pairs of InterCity trains.

CONCLUSION & IMPLEMENTATION PATH

Possibilities to improve the use of the locomotives with ETCS system

This section presents five proposals to enhance the use of ETCS-equipped locomotives and improve rail transport on line 120, focusing on locomotive deployment, infrastructure upgrades, and streamlining services between Bratislava and Žilina.

- *Commissioning of 381 Series Locomotives*
- *Leasing Additional 383 Series Locomotives*
- *Complete Trainsets for Bratislava-Žilina Routes*
- *Supplementing ETCS Infrastructure*
- *Connecting to High-Speed Lines*

Summary of research conclusions, impact and potential areas of further research in this field

The paper analyses the use of ETCS-equipped rolling stock on the Bratislava - Žilina railway line and the challenges of implementing the ERTMS system on Slovakia’s rail network. The study compared data from March in the last three timetable period (2021/2022, 2022/2023, 2023/2024). The positive outcome was a nearly 50% increase in train services, enhancing mobility for work, education, and tourism. However, the growth highlighted a shortage of ETCS-equipped trains, particularly for fast and express services, though regional express trains saw a sharp increase in ETCS-equipped units, with 93% of trains in March 2024 having ETCS, a 36% increase from the previous year. InterCity trains maintained a stable share of ETCS-equipped trains. The paper proposes five measures to improve the efficiency of this system. Future research will expand on these analyses, comparing them with the upcoming 2024/2025 timetable, which will see a doubling of express trains and the cancellation of InterCity trains between Bratislava, Žilina, and Košice. This research will contribute to optimizing transport operations and improving the efficiency of the railway line.

ACKNOWLEDGEMENTS

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