

**UNIVERSITY OF PUBLIC SERVICE  
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**The author's resume of doctoral dissertation  
entitled**

**Some Innovative Techniques of the Preparation of Railway  
Infrastructure  
for Defence Purposes**

**by**

**Zsolt Lévai**

**Supervisor: Colonel Attila Horváth, CSc**

**University professor**

**Co-supervisor: Bence Tóth, PhD, Habil.**

**University associate professor**

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## THE IDENTIFICATION OF THE SCIENTIFIC PROBLEM

In order to find complex solutions in preparation for defence purposes the problems arising from the vulnerability of transport systems need to be examined from several aspects. Therefore, the scientific problem is approached from societal, transportation, and defence-security sides for a precise identification of the problem.

### Societal approach

Due to their extent, the disruption or damage to transport systems can cause disruptions in everyday life. This is especially true for intentional human actions. Terrorism is one of today's risk factors that is difficult to defend against, because it is not openly waged war since its targets are mostly civil facilities and civilians. Due to the large dimensions of the transport infrastructure, including the railway, it is considered a so-called "soft" target, i.e. it is easily accessible to terrorists. Due to the large extent, it is difficult to organize its protection, it cannot even be extended to the entire railway infrastructure, because in such a case the costs of the protection can be unrealistically high. Therefore, it is necessary to identify the elements whose protection must be fully organized in order to prevent the system from being rendered inoperable, and to be able to divert the passenger and freight traffic of the main lines following a possible attack. At the same time, the number of terrorist attacks against railways has recently developed a decreasing trend.

*Transport is basically an environmentally polluting activity.* The high level of emissions of harmful substances produced during the use of fuels is one of the pivotal points of the current climate emergency. The need to improve the liveability of our planet has already been recognised by political decision-makers, which is why promoting the use of environmentally friendly modes of transport has come to the fore. Railways (especially electric traction) can be labelled as significantly more environment friendly than road or air transport, consequently the significance of the sector can be expected to increase in the future.

The increasingly extreme weather and other emergency situations (e.g. pandemics) occurring as a result of *climate change* test the resilience of critical infrastructures, but at the same time, it is necessary for the transport systems to be able to perform their tasks even in such conditions in order to ensure that the life of a country is not paralyzed. The condition for this is the robustness of these networks.

*From traffic safety point of view*, railway is one of the safest types of transport. In the sub-sector, there are by magnitude fewer accidents than in road transport, but at the same time, due to the forces arising from the large mass and speed, the accidents that do occur can be more serious. Accidents, often fatal, reduce confidence in the subsector, similarly to terrorist attacks.

The above points lay the foundation for the *transport policy aspiration* to increase the share of railways in the European transport market. That is why the railway infrastructure will become much more significant in all respects in the future and it will play a greater role in the operation of supply chains. As a result, the protection of the infrastructure will also be of greater importance, since any damage to the system can significantly paralyze the life of a country or even a continent.

From a societal point of view, in order to reduce the risks of the mentioned problems, it is necessary to increase the safety of the railway sector since the loss of service due to the consequences of significant disruptions in the sub-sector results in negative societal and environmental processes.

#### Transport approach

Due to their large magnitude, transport networks can be considered the vital arteries of a country and even a continent. This statement is fully true for rail transport as well. The standard gauge (1,435 mm) used in most of the continent allows trains to travel from Great Britain to Greece or from the Mediterranean to the North Sea. Artificial obstacles (e.g. different track gauge, different traction voltage) can be easily overcome with current technical solutions (e.g. railway cars with variable gauge wheelsets, multi-system electric locomotives), so it is correct to say that rail transport, as a mode of passenger and goods transport, plays a decisive role in the economy of Europe.

If the system is damaged, the process of transportation is interrupted; therefore, no movement can be carried out as planned. All of this could lead to a disturbance in the transportation market. It is possible to replace rail transport by involving other sub-sectors but at the same time, this can lead to congestion of other modes of transport both in passenger transport and in goods transport. It is therefore necessary to protect the railway infrastructure so that transport and thus the entire economy can be sustained.

#### Defence-security approach

The legislative changes of 2021-2022 make it possible to modernize the defence and security system of Hungary, in order to allow for providing appropriate responses to the challenges that threaten security. They comprise primarily military responses.

The main tasks of the functional areas of military logistical support include meeting the transport requirements of military organizations. Transport support is responsible for the execution of movements and transportations. In the framework of this activity, the transport sub-sectors are used, including, of course, the railway network. Since the armed forces do not have their own track network at national level (this is possible at local level with the help of the so-called own-use rail track network), therefore military movement and transport tasks are carried out by rail on civil tracks.

NATO also had to respond to the changed security environment due to the hybrid warfare method of the 21<sup>st</sup> century. The so-called "Prague Capabilities Commitment" adopted at the summit held in Prague in 2002 strengthened the rapid deployment of NATO forces and the maintenance of mobility in RSOM operations. After the annexation of the Crimean peninsula, and since 24<sup>th</sup> February 2022, NATO territories have become more valuable as a potential theatre of military operations. For this reason, the Alliance is currently paying special attention to the development and usability of the transport sub-sectors, of which the railway network is also a part. Due to the geographical location of Hungary, good railway accessibility and the existence of an infrastructure of loading/unloading were essential conditions for the selection of the locations designated for RSOM task.

Due to the above points, the railway transport sub-sector can therefore be considered as part of the military transport system, i.e. the protection of civil networks also means the protection of the military transport system, and the problems of civil systems can also be interpreted as military (defence) problems.

#### A research approach to the scientific problem

Ensuring the functionality of the transport sector, including that of the railway sub-sector, is therefore a social, transport, and defence-security interest, as defined above, which contains the strengthening of defence capability and preparation for emergency situations.

In general, it can be stated that the civil-military use of transport systems requires a level of defence preparation that is able to ensure the use of the systems both in regular conditions and in the case of introduction of special legal order, or to ensure the replacement of service when the functionality of the systems stalls. The availability of transport networks, as a means of meeting the requirements of logistical military processes, is indispensable from the point of view of the defence of a country or a crisis response.

Because of the above points, I consider the scientific analysis of the preparation of transport systems, including the railway sub-sector, for defence purposes to be relevant in Hungary as well, because our country is:

- a member state of the European Union (EU);
- a NATO member country;
- involved in international peacekeeping;
- located on one of the migrant routes leading to Western Europe;
- a transit country for goods and passenger transport corridors of international importance;

and as such, the proper protection and preparation, thereby stable operation of its vital systems are of specially importance.

### **RESEARCH HYPOTHESES**

As a result of elaborating on the research topic, I outlined the following hypotheses:

- H1: the safety level and current role of the rail transport sub-sector is of decisive importance in exploiting the potential inherent in the civil-military approach to infrastructure development, and through this in determining the tasks of preparation for defence purposes defined as part of the protection of vital system elements;
- H2: the preparation of the railway infrastructure for defence purposes can be considered effective if the sub-sector is able to respond to occurring extraordinary events or emergencies as a complex system, resulting in civil and military mobility on a safe railway transport system and at an appropriately high level of railway services;

- H3: the competitiveness of the rail transport sub-sector and thereby increasing its role in the transport chains can only be maintained if the necessary protection measures do not run counter to the infrastructure development plans and the two interests can be harmonized;
- H4: in addition to the solutions of physical protection, the latest cyber protection solutions are effective and therefore necessary to replace the role of human control with machines, thereby providing a higher level of preparation tasks for the protection of the railway infrastructure.

### **RESEARCH OBJECTIVES**

The fundamental objective of the research is to provide innovative solutions for the methods of preparing the railway infrastructure for defence and security related to transport development in a way that they promote the establishment of military and civilian mobility without any conflict with the interests of infrastructure development aimed at increasing railway competitiveness. My research therefore means developing the coherence of research linked to defence and security activities and research on transport development. The ultimate goal is to develop a safe and attractive transport system that appropriately serves both civilian and military interests. Consequently, my research focuses on two areas: on the one hand, they cover the preparation of railway infrastructure for defence purposes, and on the other hand, they examine the possibilities of creating harmony between development and defence interests through the civil-military approach to transport development.

Preparation for the purpose of protection is fundamentally aimed at maintaining the operability of rail transport against all activities and impacts that may result in damage and disturbance to the infrastructure and thus render rail transport impossible.

Transport development investments are aimed at increasing the level of service, primarily at reducing travel time, and their main goal is to increase railway competitiveness by making service faster. Therefore, an area to be researched is the methods of harmonising the conflicting interests arising in some areas: to create the security of military mobility through the preparation for defence purposes and increase the competitiveness of the railways. This means using protection methods that do not disproportionately increase travel time compared to the appeal of increased security.

In order to achieve the above points, the following research sub-goals were set:

- to explore the connections between the transport and defence safety of the railway sub-sector;
- identify the current position of railway transport in civil transport and military transport support systems;
- to determine the requirements and tasks of preparation for defence purposes, as well as the objectives to achieve;
- to determine the safety-related expectations of users of the railway sub-sector;
- determine the cooperation opportunities between industry players and the authorities in order to achieve a higher level of security;

- to elaborate a procedure ensuring the synchronisation of development and defence interests through a civil-military approach to the planned railway (critical) infrastructure investments;
- on the basis of the above points, to determine innovative defence solutions and methods that ensure the consistency of defence preparation and transport development;
- to determine the achievable effectiveness of IT protection tools in preparation for protection purposes.

## **RESEARCH METHODOLOGY**

In order to examine the defence preparation of the sector, I established a set of requirements through modelling, with which I examine the sustainability, substitutability and vulnerability of the functionality of infrastructure. Examining the courses of development of the railway infrastructure, as well as assessing the security needs of individual users, I developed a system of criteria based on a civil-military approach that can be used for the defence planning of railway infrastructure investments, and cooperation opportunities between the railway industry players and the bodies providing defence and security measures. With the use of an analytical method, I determined the current situation of the subsector and its connection to the military transport support system. In detail, I used the following research methods:

- literature processing: for exploring the relevant literature;
- preliminary modelling: for the creation of a requirement model for defence preparation in the railway transport sub-sector;
- empirical research: a questionnaire-based survey of railway customers' safety expectations; interviews with defence, military, and transport experts to determine possible defence needs and cooperation opportunities, as well as to develop a system of criteria to be set up in order to create adequate defence for planned (critical) infrastructure developments; producing and analysing drone footage to prove the role it can play in the defence-related preparation of the railway infrastructure;
- analysis: for researching the protection opportunities of the elements of the railway infrastructure against destructions and disruptions, for determining the current situation of the railway sector and its connection to the military transport support system, for mathematical mapping the relationship between transport and defence security, and for examining the vulnerability of the railway transport sub-sector.

## **BRIEF DESCRIPTION OF EXAMINATIONS PER CHAPTER**

### **Chapter I**

I analysed the traffic safety and critical infrastructure protection security of the rail transport sub-sector, examined their interconnections, and examined the current role of the sector in civil and military transport systems. Based on these, I analysed the vital system elements, their impact on the tasks of defence preparation interpreted as part of their protection through the civil-military

approach to infrastructure development, which is also formulated as one of the goals of creating military mobility.

## **Chapter II**

I developed the theoretical foundations of the complex defence preparation of the railway transport infrastructure. Based on the research findings described in Chapter I, I defined the concept of comprehensive defence preparation, defined its tasks as well as the connections between the safe railway transport system, military and civil mobility, and the level of rail service that determines its effectiveness. Based on the theoretical analyses, I developed the requirements model for the defence preparation of the railway infrastructure, and defined its operating environment and scope.

## **Chapter III**

I examined the civil and military necessity of railway infrastructure development, I determined the relationships between the development interests that ensure the increase of the service level on safe infrastructure and the creation of military mobility. Based on my findings, I developed the criteria for the civil-military approach to the planning of railway infrastructure investments, which I summarized in a flowchart.

## **Chapter IV**

Based on the research findings in chapters II and III, I defined the innovative protection solutions that can be linked to transport development investments. Within defence preparations, I examined the effects of the latest cyber defence solutions and methods, aimed, inter alia, at reducing the human role in defence and security solutions.

## **SUMMARISED CONCLUSIONS**

In the third decade of the 21<sup>st</sup> century, European transport policy prioritized the railway sub-sector by assigning it a greater role in the transport market as an environmentally friendly mode of transport. As a result of the expected growth, the exploitation of the railway tracks will increase, however, the condition of the infrastructure does not allow for an increase in traffic in many places. It is possible to solve bottlenecks with infrastructure development investments.

However, railway tracks are used not only by civil trains. One of the possible means of carrying out military movement and transport tasks is also the railway transport sub-sector. However, the normal period and special legal order military transport needs can only be met on an infrastructure that has been properly prepared for military use.

The research on military mobility by the European Parliament Research Service established that the creation of military mobility covering the performance of military movement and transport tasks can be facilitated by a civil-military approach to the development of transport infrastructures. The elaboration of military requirements for transport infrastructure is the starting point for an effective and coordinated approach to military mobility all over the EU. Therefore, it is necessary to conduct scientific research that explores civil and military transport development interests, as well as proposals for defence requirements, innovative methods, and solutions that promote the

same orientation of transport development and defence interests in order to achieve the above goals.

In order to achieve this, in my doctoral research I dealt with the preparation of railway infrastructure for defence purposes, as it is a system of military and critical infrastructure protection requirements that can determine transport development investments. I researched the defence and security solutions and methodology that could be appropriate against the harmful effects on the system within the framework of defence preparation of the sector. My objective was to produce a dissertation that, with a thorough scientific approach, defines the tasks of preparing the railway transport sub-sector for defence purposes, while paying attention to the competitiveness of the sector in the transport market.

In my opinion, as a result of the analysis of defence and transport development interests, my dissertation showed that the development of the sector is ensured only by coherent thinking through developments aimed at increasing both efficiency and safety. These goals can be achieved with transport development investments, but it is necessary to ensure that the system remains operational, because it is the only way to realise the benefits of the developments. On the other hand, the high cost and value of the investments, and their economic and social usefulness require the establishment of an adequate level of protection. These security needs necessitate the protection of transport systems, which can be achieved by preparing the existing elements for protection purposes, and by asserting protection interests when designing new elements.

The preparation for defence purposes and the enforcement of defence interests can be fostered through the development of innovative procedures and methods that can be used to increase the security of the system. In order to achieve this, I developed innovative protection methods that can significantly contribute to making the railway subsector safer, thereby increasing its role both in civil and military transport systems.

Overall, I consider that the preparation of the railway infrastructure for complex defence purposes can be effective both in the performance of defence tasks and in the competitiveness of the sector in keeping them. By applying the developed methods as well as innovative cooperation and protection solutions, it is possible to increase the safety level, raise the level of railway services, and create military mobility realized through the transport support subsystem of civil and military logistics. Thus I achieved my objective: by using my research findings, the rail transport sub-sector can become a functional, safe, customer-friendly, and environment-friendly transport sub-sector that can meet both civil and military transport needs, and thus the criteria of national resilience.

## **NEW SCIENTIFIC RESULTS**

1. I elaborated the Railway Defence Safety Indicator (VBMv), which determines the level of preparedness of the railway sector for defence purposes. The indicator determines how much protection capacity reserves the given railway line has in proportion to the defence safety requirements from a traffic and civil-military point of view, so it is suitable for underpinning the need for infrastructure investments for railway defence and measures to improve traffic safety.



2. I defined the concept and requirements of the defence preparation of the railway infrastructure for complex purposes, which I transformed into a requirements model based on cause-and-effect relationships. I identified the impact areas and elements of the model, which I verified based on literature studies. For a more precise definition of substitutability, I further developed the edge weighting method of the algorithm of the shortest paths in the applied graph theory model by incorporating the railway protection safety index into the edge weights, as well as the method of determining and interpreting the competition index by its integration into the substitution threshold value of the VBMv.

3. I elaborated a system of criteria based on the civil-military approach to railway infrastructure investments, promoting their planning for defence purposes, the elements of which have been summarized in a flowchart. The criteria take into account safety expectations and cooperation opportunities between the authorities and railway companies. With their application, during the planning period of railway infrastructure investments, the protective measures and solutions necessary to achieve the outputs of the requirements model can be determined, with which the protection and competitiveness of the subsector can be synchronised.

4. I defined the roles that the latest IT defence solutions can play in the defence of the railway sector:

- a. I determined the civil and military impacts of the use of drones for defence purposes, and I verified the direct effects with drone experiments;
- b. I determined the impact mechanism of blockchain-based smart contracts on preparation for defence purposes, which I verified by mapping the information-connection diagram of rail freight transport.

Based on the above, I concluded that IT protection tools are effective in preparing the railway sector for defence purposes, but at the same time, in addition to the necessary physical protection, it is necessary to strengthen drone technology and cyber defence, with special regard to promoting the applicability of blockchain-based smart contracts.

## **RECOMMENDATIONS**

The objective of my writing this thesis is to determine innovative methods and solutions for the defence preparation of the railway transport sub-sector, which do not hinder competitiveness, and also to promote joint thinking in transport planning and defence, therefore I recommend my dissertation:

- to defence administration professionals working on the establishment of national cooperation and resilience;
- to transport and defence policy decision-making experts;
- to specialists responsible primarily for the selection and preparation of vital transport system elements;
- to experts in the defence sector, particularly cyber defence experts, dealing with countering terrorism;

- to professionals who plan and make decisions on investments in transport infrastructure and service development, as well as their financing;
- to specialists working on strengthening railway traffic safety;
- to the preparation of emergency plans for specialists working in the prevention of traffic accidents;
- to specialists involved in the planning and implementation of military transport support;
- to specialists dealing with the education of national defence and military operational logistics, as an educational aid;
- to researchers dealing with the topic, as inspiration for further research topics.

### **CIVIL AND MILITARY PRACTICAL USABILITY OF THE RESULTS OF THE DISSERTATION**

Due to the dual purpose of writing the dissertation, its usability is also twofold: on the one hand, it can be used for the purpose of traffic development, and on the other hand, it can be used for defence and security purposes.

The findings presented in my dissertation provide assistance in the planning phases of transport development investments to take into account protection objectives and solutions, and as such, they can be used for any investment that aims to improve the competitiveness of transport systems. The research findings can also be used by the railway company for the development of infrastructure protection systems that are necessary for new technologies to be introduced (for example, alternative and hybrid vehicles and the infrastructures connectable to them). Individual protection solutions can facilitate the realization of traffic safety goals by providing greater security for (railway) transport operators.

In the field of transport and vehicle sciences, responding to substitutability issues can provide useful information for handling network problems of transport systems.

It can also provide assistance in solving capacity bottlenecks caused by planned construction, maintenance activities, or natural impacts.

In the field of defence and security, the results can be used for the preparation of operator security plans for each critical infrastructure sector, for the establishment of a reliable transport system for the operation of the armed forces, and for the implementation of battlefield reconnaissance.

It can also provide useful information for planning the implementation of military movement and transport tasks, which can facilitate the full and high-level execution of our tasks within the Alliance.

In the field of military technical sciences, this dissertation can serve as a basis for further defence research and encourage specialists to develop methods for preparing the railway sub-sector and related transport sub-sectors for specific defence purposes, through the applicability of the latest methods of cyber defence in particular.

The (transportation) protection created by smart contracts based on blockchain technology can promote the increase of the capacity of the railway network, thereby making the necessary national defence transport capacities available.

### **AUTHOR'S PUBLICATIONS ON THE TOPIC OF THE DISSERTATION AND RELATED AREAS**

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5. Lévai Zsolt – Albert Gábor: Vasútfejlesztés és kritikus infrastruktúra védelem; In: Hamarné Szabó Mária (szerk.): Közlekedésfejlesztés Magyarországon 2021, Budapesti és Pest Megyei Mérnöki Kamara, Budapest, 2021, pp. 85-94.
6. Lévai Zsolt: A Budapesti Agglomerációs Vasúti Stratégia által javasolt új budapesti vasúthálózat helyettesíthetőségének vizsgálata; In: Horváth Gábor – Horváth Balázs (szerk.): XX. European Transport Congress / XII. International Conference on Transport Sciences, Győr: After pandemic – before autonomous transport; Közlekedéstudományi Egyesület (KTE), Győr, 2022, pp. 342-354.
7. Horváth, Attila – Lévai, Zsolt: Protecting the railway infrastructure from the hazards of freight trains carrying dangerous goods; In: Lesenciuc, Adrian (Editor-in-chief): Redefining Community in Intercultural Context, Vol. 11., No. 1., ‘Henri Coanda’ Air Force Academy Publishing House, Brasov, Romania, 2023, pp. 144-152.

#### University course book

1. Lévai Zsolt: Közlekedésbiztonság; Dialóg Campus Kiadó, Budapest, 2019, 207 p., ISBN 978-963-531-012-8 (elektronikus)

#### Conference contributions (unpublished)

1. Lévai Zsolt – Béres Barna: A vasúti forgalom lebonyolításával kapcsolatos informatikai adatok védelme; Közlekedéstechnikai napok konferenciasorozat IV. rész: Vasúti informatika a kezdetektől napjainkig, Közlekedéstudományi Egyesület, Budapest, 2019. 11. 07.
2. Lévai Zsolt: Kritikus közlekedési infrastruktúrák fejlesztésének matematikai modellezése; A matematika és a fizika időszerű kérdései konferencia, Nemzeti Közszolgálati Egyetem Természettudományi Tanszék, Budapest, 2020. 09. 01.
3. Albert Ágota – Üveges András József – Lévai Zsolt: Személyszállítási utastájékoztatói rendszerek kiberfenyegetettség; Robothadviselés 2021 konferencia, Nemzeti

Közszolgálati Egyetem Elektronikai Hadviselés Tanszék – Magyar Hadtudományi Társaság, Budapest, 2021. 11. 24.

4. Lévai, Zsolt: A new complex model for the critical infrastructure protection in transportation; New Challenges in Military Logistics in the 21<sup>th</sup> Century Conference, Nemzeti Közszolgálati Egyetem Műveleti Logisztikai Tanszék, Budapest, 2022. 09. 14.
5. Albert Ágota – Lévai Zsolt: A vasúti közlekedés adat- és kibervédelmi kockázatai, különös tekintettel az új innovatív technológiákra; Közlekedéstechnikai napok konferenciasorozat VII. rész: Vasúti informatika a kezdetektől napjainkig, Közlekedéstudományi Egyesület, Budapest, 2022. 11. 16.
6. Lévai Zsolt: A vasúti infrastruktúra komplex védelmi célú felkészítése a helyettesítési lehetőségek vizsgálatával; A Közlekedéstudományi Egyesület és a MH Tartalékképző és Támogató Parancsnokság, Logisztikai Támogató Igazgatóság, Közlekedési Osztály közösen szervezett konferenciája, Budapest, 2022. 12. 07.

#### Publications published on railway competitiveness

##### Peer-reviewed journal articles and specialist studies

1. Molnár Balázs – Lévai Zsolt: A kör négyszögesítése: Budapest lehetőségei a kelet-közép-európai vasúti városlátogató turizmus esetében; Turisztikai és Vidékfejlesztési Tanulmányok, 6:3, 2021, pp. 27-43., DOI: 10.15170/TVT.2021.06.03.02
2. Schwáb Zoltán – Lévai Zsolt: A vasúti árufuvarozás versenyképességének javítása az árufuvarozási folyosók fejlesztésével; In: Duleba Szabolcs (főszerk.): Logisztikai évkönyv 2022, Magyar Logisztikai Egyesület, 2021, pp. 172-183., DOI: 10.23717/LOGEVK.2022.16
3. Lévai Zsolt – Munkácsy András – Schwáb Zoltán: Határ menti együttműködési lehetőségek a közforgalmú közlekedésben; Külügyi Műhely, 3:2, 2021, pp. 6-27., DOI: 10.36817/km.2021.2.1
4. Oszter Vilmos – Berényi János – Lévai Zsolt: A környezetbarát logisztikai megoldások kutatása a CORCAP projekt példáján keresztül; Közlekedéstudományi Szemle, 72:3, 2022, pp. 4-16., DOI: 10.24228/KTSZ.2022.3.1

5. Molnár Balázs – Lévai Zsolt: Dolce Vita – Olaszország biztonságos vasúti elérésének kérdései; Turisztikai és Vidékfejlesztési Tanulmányok; 7:4, 2022, pp. 74-93., DOI: 10.15170/TVT.2022.07.04.06

#### Conference contributions in Hungarian and foreign languages

1. Lévai Zsolt – Molnár Balázs: Vasút és turizmus: lehetséges válaszok a globális klímaváltozás kihívásaira; In: Albert Tóth Attila – Happ Éva – Printz-Markó Erzsébet – Kupi Marcell – Török Nikolett (szerk.): Multidiszciplinaritás a turizmusban: X. Nemzetközi Turizmus Konferencia (Tanulmánykötet), Széchenyi István Egyetem, Győr, 2020, pp. 81-98.
2. Berényi János – Lévai Zsolt: CORCAP – a környezetbarát áruszállítási folyosók kialakítása útján; In: Horváth Balázs – Horváth Gábor (szerk.): X. Nemzetközi Közlekedéstudományi Konferencia Győr 2020 – X. International Conference on Transport Sciences Győr 2020; Széchenyi István Egyetem Közlekedési Tanszék – Közlekedéstudományi Egyesület, Győr, 2020, paper: 38, 12 p.
3. Lévai Zsolt – Molnár Balázs: Greta Thunberg EuroNight: a vasút és a repülés változó versenyhelyzete; In: Horváth Balázs – Horváth Gábor (szerk.): X. Nemzetközi Közlekedéstudományi Konferencia Győr 2020 – X. International Conference on Transport Sciences Győr 2020, Széchenyi István Egyetem Közlekedési Tanszék – Közlekedéstudományi Egyesület, Győr, 2020, paper: 45, 20 p.
4. Lévai Zsolt – Molnár Balázs – Munkácsy András: A turisztikai célú vasúti utazások piaci változásának turizmusbiztonságra gyakorolt hatásai; In: Horváth Balázs – Horváth Gábor (szerk.): XI. Nemzetközi Közlekedéstudományi Konferencia: „Közlekedés a járvány után: folytatás vagy újrakezdés”, Széchenyi István Egyetem, Győr, 2021, pp. 222-233.
5. Lévai Zsolt – Molnár Balázs: Vasútfejlesztés és versenyképesség a Budapest – Záhgráb viszonylaton; In: Horváth Gábor – Horváth Balázs (szerk.): XX. European Transport Congress / XII. International Conference on Transport Sciences, Győr: After pandemic – before autonomous transport; Közlekedéstudományi Egyesület (KTE), Győr, 2022, pp. 712-723.
6. Szander, Norina – Jenei, Tamás – Lévai, Zsolt – Munkácsy, András: Investigation of the modal shift of road freight transport to rail and waterways; In: Zanne, Marina – Bajec,



Patricija – Tvrđy, Elen (editors): ICTS 2022 20th International Conference on Transport Science: Maritime, Transport and Logistics Science, Conference proceedings; University of Ljubljana, Faculty of Maritime Studies and Transport, Portoroz, Slovenia, 2022, pp. 351-359., ISBN 978-961-7041-11-8 (PDF)

## **CURRICULUM VITAE**

Name: Zsolt Lévai

Place and date of birth: Budapest, 24<sup>th</sup> July 1975

### **EDUCATION**

2019 – 2023 National University of Public Service Military Technical Doctoral School – final year

2000 – 2004 Budapest University of Technology Doctoral Program in Transportation Science – final

1996 – 2000 Budapest University of Technology – certified transport engineer

1993 – 1996 Széchenyi István College – transport engineer (railway specialization)

### **WORK EXPERIENCE**

2019 – KTI – Hungarian Institute of Transport Science and Logistics Nonprofit Kft. – senior researcher

2007 – 2018 MÁV-START Zrt. – international rail-service planner

1996 – 2007 MÁV Zrt. – various positions in the traffic department

### **EDUCATIONAL ACTIVITIES**

2019 – Széchenyi István University, Department of Transportation – master lecturer

2017 – National University of Public Service, Department of Military, Finance and Military Transport – guest lecturer

2003 – 2018 MÁV Zrt. Baross Gábort Officer Training Institute – instructor

### **LANGUAGE SKILLS**

English: B2 level complex language examination with railway professional material

German: B2 level complex language examination

### **SCIENTIFIC ACTIVITIES**

Defence Economics and Logistics Department, Hungarian Military Science Society

Honours, prizes and scholarships

2021 – Shared publication level award, National University of Public Service (conference announcement category)

2020 – 2023 Cooperative Doctoral Program Student Scholarship

2020 – Certificate of recognition from the Minister (Ministry of Innovation and Technology)