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**Status and development opportunities for Danube
freight shipping, evaluation of the results of the
Strategy for the Danube Region**

Theses of the PhD dissertation

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I. Introduction and objectives

The utilisation of the Danube as a waterway has always fallen short of its potential. This is mainly attributable to the geographical characteristics of the river. The Danube's water flow is uneven, with frequent low water levels in late summer and autumn. Another disadvantage is that it has few navigable tributaries, of which the Rivers Drava, Sava and the Tisza are of such size and flow that navigation is theoretically possible (Hardi 2012). The development of navigation on the Danube has always been hampered by the fact that it reaches the sea via a delta estuary, and the navigability of the individual branches could only be ensured by regular maintenance. And finally, it is a disadvantage that the river enters the Black Sea, which is a landlocked inland sea far from the main maritime transport routes.

The second impediment was of a political nature, with the river often meandering across cultures and empires, and development was often hampered by devastating wars. The 19th century saw the development of the countries along the Danube and parallelly an increase in the demand for transport, while at the same time the biggest competitor to shipping, the railways, was introduced. This delay in the development of Danube shipping meant that the canal construction, waterway, and inland waterway transport network development - that had been already completed in Western Europe - were not implemented in this region. Nevertheless, this period can be considered as one of the gilded ages of Danube navigation, as the “First Imperial and Royal Private Danube Steamship Company” (D.D.S.G.), founded in 1829 had become by the end of the century the world's largest inland waterway shipping company (Huszár 2021). In addition, the Austro-Hungarian Monarchy successfully completed the regulation of the Iron Gates, the construction of several lowland canals to promote the transport of agricultural goods.

The peace that ended World War I imposed harsh conditions on the defeated states but preserved the international status of the Danube. Surrounded by hostile states, Hungary was able to connect to international trade via the Danube. It therefore established a river-sea fleet, which became essential for the country's foreign trade and supply security.

After World War II, the Danube region came under the sphere of Soviet influence, and this allowed the signing of the Belgrade Convention in 1948, which after a long period of time gave the control of the Danube to the riparian countries. In the second half of the 20th century, shipping boomed once again, with the efficient development of waterways (Iron Gate swelling dam, Danube-Black Sea Canal), the main reason of which was the transportation needs of the heavy industries established along the Danube, which had been built up along the interests of the Soviet empire.

In the 1990s, Danube shipping essentially collapsed and has not been able to recover from this crisis since. The European Union supports the development of

inland waterway freight transport and its development in preference to rail and, even more so, road transport. The main reason for this is the constantly growing air and noise pollution, infrastructure needs and greenhouse gas emissions of road freight transport. The European Union Strategy for the Danube Region (hereafter referred to as the EUSDR) promotes the development of Danube waterway and port infrastructure and the modernisation of navigation and information systems. The aim of this dissertation is to examine the extent to which the European Union's policy in support of inland waterway shipping can contribute to overcoming the obstacles and improving the performance of the sector.

II. Objectives

It is appropriate to review the situation of freight shipping on the Danube, to assess the developments related to the EUSDR, and finally to identify the achievements of the past decade and the contribution of the strategy to the development of freight shipping. My analysis aims to answer the following questions:

1. What is the situation of freight transport on the Danube, what are the opportunities and constraints of its development?
2. In the context of the EUSDR, what investments are the countries undertaking to improve Danube navigation?
3. To what extent are Danube organisations active in international projects and what are the impacts of cooperation?
4. Whether it is possible to draw conclusions from the analysis of national and international projects on the commitment of the Danube countries to inland navigation?

III. Research methodology

The study area covers the countries along the Danube: Germany, Austria, Slovakia, Hungary, Croatia, Serbia, Romania, and Bulgaria. Where relevant, data from Moldova and Ukraine are also presented, as there has been some EUSDR-related developments implemented also in these two countries. The analysis focuses on the period between 2010 and 2020, but also considers the earlier shipping data. Data on inland waterway freight transport are extracted from the Eurostat database and compared with the Danube Committee's data, some missing data were extracted from the latter.

To ensure that the data for Germany refer exclusively to the freight traffic on the Danube, I have used indicators by the Bavarian Statistical Office (BSO), since the BSO's database for inland shipping, allows to access data separately for Danube freight traffic.

Data on investments to improve inland waterway mobility were collected from the homepage presenting the results of the EUSDR Priority 1

(<https://navigation.danube-region.eu/>) in March 2019 and March 2020. Based on the status of the projects, the portal distinguishes between planned projects, projects under implementation and completed projects. In the detailed analysis, 100 projects under implementation and completed were examined for the period 2007-2020, covering two EU budgetary cycles.

An important part of the study is the cumulative assessment of the data from the three Danube sections, and to this purpose I have created groups of countries. The Upper Section is represented by Germany and Austria, the Middle Section by Slovakia, Hungary, Croatia and Serbia, and the Lower Section (including the Danube-Black Sea Canal) by Romania and Bulgaria.

The research underpinning the dissertation was accompanied by a series of interviews. The aim of the empirical research was to gain the opinions of experts and professionals who are familiar with Danube freight transport, the European Union Strategy for the Danube Region, climate change and the interaction of Danube shipping. So, the interview series was conducted with 10 shipping experts, researchers, and representatives of organisations active in Danube shipping.

IV. Summary of results

The research I conducted investigated the extent to which the European Union's policy to support inland waterway shipping can contribute to overcoming the obstacles and improving the performance of the sector. The barriers to Danube navigation have been studied by researchers before, but I feel that I have succeeded in using a novel approach to identify and concretise these. I was helped in this by getting to know the opinions of the relevant actors in the sector, I managed to carry out a comprehensive statistical analysis and to clarify some uncertainties (the importance of the Danube-Black Sea Canal and Constanța, the freight transport capacity of Serbia and Ukraine, the role of the Danube-Main-Rhine Canal, container transport). The synthesis of the results of EUSDR projects for the development of Danube shipping has not been performed before and I believe that the assessment of this was timely. I consider the answering of the research questions and the comparison of the two investigations to be the most important results of my work.

1. What is the situation of freight transport on the Danube, what are the opportunities and constraints of its development?

Danube freight shipping has not recovered from its decline during the 1990s until recently. Despite the removal of political obstacles and sustained economic development, it has not managed to strengthen its position within the transportation sector. Along with the growing transport demand, the share of road transport has been steadily increasing. Looking at inland freight transport performance in the Danube countries between 2010 and 2020, there is a clear decline of 14.2%.

I explain this decline by the availability of basic conditions for cargo shipping. The primary constraint, according to the consensus of experts, is the state of the waterway, with low water levels causing the emergence of reefs in critical sections (ex verbis Béla Szalma, ex verbis Botond Szalma, ex verbis Attila Bencsik, ex verbis Róbert Rafael, ex verbis Zoltán Fábíán, 2022). Although the waterway has several narrowing, ensuring the navigability of the most problematic sections could already bring significant progress (Róbert Rafael, 2022). So, a major step forward would be the damming of the middle section, the need for which is also the subject to professional consensus (ex verbis Béla Szalma, ex verbis Botond Szalma, ex verbis Attila Bencsik, ex verbis Róbert Rafael, ex verbis Zoltán Fábíán, 2022). A novel result of the research is the concrete presentation of the waterway problem, which, in addition to the expert interviews, was made possible by the results of the FAIRway project.

Another major problem is the supply of manpower in the sector, with a growing shortage of qualified staff, especially of skippers. This problem has been exacerbated in the freight sector by the draining effect of passenger transport, which has offered more favourable conditions for boatmen. The new finding of this thesis is that it clarifies the relationship between passenger and freight transport, that the advantage of hotel ships in terms of sluicing and administrative tasks does not cause a substantial competitive disadvantage for freight transport (ex verbis Béla Szalma 2022, ex verbis Attila Bencsik 2022).

Less of a problem is the availability of ports and fleet. The port infrastructure is well developed, with trimodal terminals operating at the Upper-Section at a high level of efficiency. The Middle- and Lower-Sections are characterised mainly by ports capable of handling bulk cargo, but only a few ports offer professional container handling. A novel result is the inventory of the container handling capacity of ports, the identification of professional container terminals (ex verbis Fábíán Zoltán 2022)..

The Danube fleet has managed to remain operational despite the ageing of its shipping stock. The problem will be the renewal of the ship fleet, as the modernisation of ships' machinery and the construction of new ships are both costly investments (ex verbis Attila Bencsik 2022)..

A novel result of the research is the definition of the degree and criteria of competitiveness. The cost of transporting bulk goods by ship is on average 30% cheaper than by rail (ex verbis Fábíán Zoltán, 2022). However, the origin and the destination of the goods are highly relevant in the case of river transport. In all cases, the transit costs of delivery to and onward transport have to be taken into account and so only a shipping route of sufficient distance can ensure a price advantage. The combined distance of delivery to and onward transport should be less than 150 km, while the fairway shall exceed 300 km (ex verbis Attila Bencsik, 2022). A limiting factor is the uncertain transport time and freight rates, which not all the clients tolerate, and this risk can be made critical by the problem of navigability due to low water levels.

A new result is the recognition of a trap that has not been identified in the literature so far, namely the "small water negative spiral", triggered by climate change et al. In essence, shipping with reduced cargo at low water levels (e.g., only 750 tonnes of cargo with 1500 tonne vessels) requires more vessels and crew (creating a shortage of vessels and crew), causes ports to operate less efficiently (slower and less efficient loading), and all this raises freight rates and reduces profitability and competitiveness.

Constanța and the Danube-Black Sea canal are among the promoters of the development of Danube freight shipping. Although previous academic works reported its limited utilisation, which was attributed to high user charges (Erdősi 2008, Hardi 2012), I will illustrate in this dissertation that its importance has now become paramount. Most of the experts agree that the vast majority of the goods transported on the Danube reach and arrive from the sea through the Danube-Black Sea Canal (ex verbis Botond Szalma, ex verbis Attila Bencsik, ex verbis László Erdélyi), as confirmed by the Danube Commission's data. And Constanța is the most important grain port in Europe (ex verbis László Erdélyi) and the fifth largest bulk port. In addition, I have shown that the Danube-Main-Rhine canal plays a minor role in cargo shipping, with no significant traffic mainly due to the quality of the waterway and the nature of the shipping.

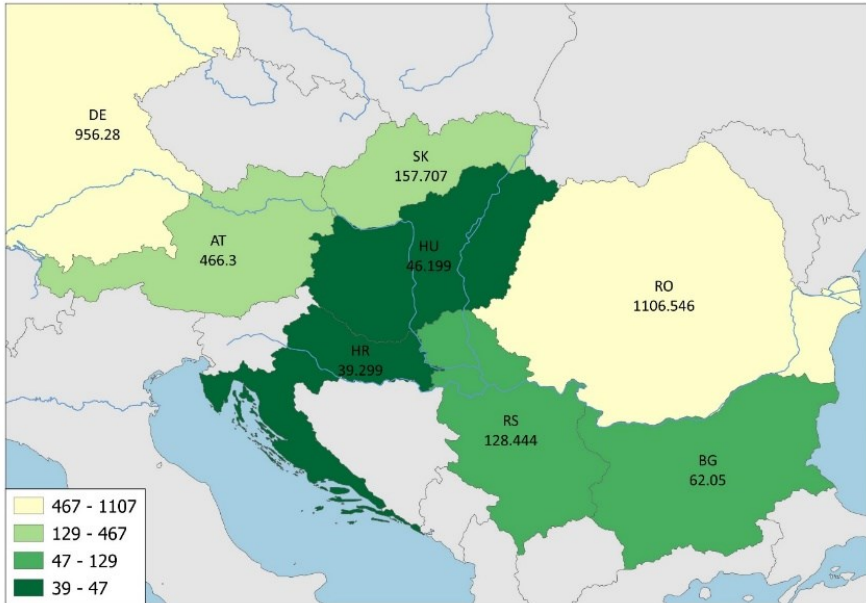
IWT has an important advantage, which has become apparent over the last 3 years, and that is its adaptability. The previously well-oiled transport chains have been put in crisis by the Covid-19 epidemic. After minor disruptions, river shipping has been able to adapt and has suffered a minimal decline. The Russian military intervention in February 2022 caused an even greater crisis. Danube shipping was able to give adequate respond to this situation too and make a major contribution to meeting transport needs.

2. In the context of the EUSDR, what investments are the countries undertaking to improve Danube navigation?

A new result of my research is a detailed analysis of the developments, especially investments, in Danube navigation. These findings confirm that Germany and Romania are making serious efforts to develop this waterway. Germany is mainly striving to ensure the navigability of the Danube-Main-Rhine waterway, while Romania's strategic objective is to increase the utilisation of the Danube-Black Sea Canal and to strengthen the role of the port of Constanta. The other Danube countries are striving to improve port infrastructure and maintain the waterway, but with a much smaller financial input. A particular problem is that Hungary and Bulgaria do not devote sufficient resources to waterway construction. Bulgaria is hampering dredging works on its territory, and thus hampers navigation too. The relevant intervention sites for navigability are the sections east of Vienna, Nyergesújfalu, Dunaföldvár (Solt), some sites of the Romanian-Bulgarian section, the Bechet-Corabia area (ex verbis Rafael Róbert, 2022), for which no concrete progress has been made during the examined decade. Slovakia has completed the

reconstruction of the closing dam, which was a major investment. Hungary has progressed in the field of port development.

Figure 1. Expenditure of national projects in individual Danube countries related to the EUSDR (in millions of Euro)



Source: own edition.

The analysis of the specific objectives of national projects showed that the share of investment projects within all development projects varies among the Danube states. A considerable number and very high cost of projects aimed at improving research, preparation and information systems can be observed. It is desirable to create some proportionality between investment and soft programmes in the financing of development (Nagy et al. 2019).

According to the experts I interviewed, the implementation of the EUSDR has had few tangible results and has not achieved the expected breakthrough in tackling the problems. The objectives of the EUSDR are sound, but they ought to be broken down to the level of operational programmes and actual activities, which has not been provided (ex verbis Zoltán Fábíán 2022, ex verbis Róbert Rafael). Some have an even more negative perception and believe that nothing of substance has been done in the framework of the strategy, that it was a "Danube Tragedy" and that claim that "it was lacking two things: the Danube and the strategy" (ex verbis Botond Szalma).

3. To what extent are Danube organisations active in international projects and what are the impacts of cooperation?

The detailed analysis of the international projects related to EUSDR Priority 1 is also a new achievement that has not been done before by any other researcher. I consider the grouping I have proposed important; in terms of the affiliation of participants, three types of international projects can be identified when evaluating international projects:

- projects in the Danube countries,
- EU projects (technological and maritime cooperation),
- projects with few actors or of a bilateral nature.

Typically, in the first half of the period under review (2007-2013), there was a higher number of projects with a broader EU scope, after which projects from the Danube countries became dominant. I found that the Danube countries' projects were more successful in terms of relevance and results. The number of projects with few participants was low.

Based on the activity of the Danube countries, three groups can be distinguished, the most active (A, RO), the active (DE, HU, BG) and the restrained (SK, HR, SRB).

The study found that Austria plays a key role in managing international projects and coordinating research and preparatory activities. The sectoral distribution shows that in the case of Germany and Austria, the market sector's participation exceeds 50%, while the other Danube countries are dominated by public actors. This can also be assessed as a lower level of market activity in the post-socialist countries (Nagy et al 2020).

Complex inland waterway projects and cooperation for waterway development have contributed greatly to identifying problems and the theoretical foundation of solutions. The infrastructure for monitoring the navigability of the Danube waterway has been significantly improved. Critical constrictions and fords have been identified and monitoring of the activities of individual countries to address them has been established. The harmonisation of port development planning according to a common set of criteria is also a successful area. Fleet development efforts have been given a prominent role in international projects. Possible technical solutions have been explored and presented in detail, but the question of financing has not been resolved (ex verbis Béla Szalma, ex verbis Attila Bencsik). One of the most successful areas is the development of river information systems and the harmonisation of administration, where concrete results have been achieved (ex verbis Róbert Rafael, ex verbis Edita Stojić Karanović 2022).

There has been a high activity in the field of environment and climate change, but the main achievements have been the theoretical grounding and the involvement of actors in a common communication platform. The latter statement is true for all international projects, with valuable studies, plans, collaborations,

development of substantive innovations and preparations for their market introduction. However, it has yielded few practical results, giving rather political and cooperative impetus, creating an intellectual basis, bringing together the players and establishing regular working contacts (ex verbis Rafael Róbert).

4. Is it possible to draw conclusions from the analysis of national and international projects on the commitment of the Danube countries to inland navigation?

The presentation of the commitment of individual countries to the development of Danube navigation I consider a new achievement. All countries have been indisputably involved in the implementation of the strategy and have actively contributed to the efforts. However, it can be concluded that there are significant differences in the activity of the individual Danube countries in the case of projects related to EUSDR Priority Area 1. The table below classifies the countries into four categories according to the criteria I consider most important, and the figures per river-km also consider the different geographical conditions and the size of the tasks that each country has to perform. By evaluating the four aspects jointly, we have attempted to draw conclusions on the different motivations of each country.

Table 1. Assessment of the motivation of countries to implement the EUDRS project

Countries	Total cost of national projects	Total cost national projects per river km	Number of participants in international projects	Number of participants in international projects per river km
Germany	XXXX	XXXX	XXXX	XX
Austria	XXX	XXXX	XXXX	XXXX
Slovakia	XX	XX	XX	XXXX
Hungary	X	X	XXX	XXX
Croatia	X	XX	X	XXX
Serbia	XX	XX	X	X
Romania	XXXX	XXX	XXX	X
Bulgaria	XX	X	XX	XX

Source: own edition.

Although the aspects examined were objective, the conclusion on motivation cannot be considered as such, so I do not consider it justified to establish a sort of order. The countries surveyed can be divided into two groups according to their activity. The more active group is made up of Germany, Austria, Slovakia, and

Romania, with the addition that Slovakia has taken on a greater role in relation to its shorter section, but Romania's outstanding involvement is diminished by the greater duties naturally deriving from its geographical location. This result is confirmed by the assessment of the experts I interviewed, who all acknowledge the commitment of Romania and Austria. In the case of Germany, the commitment to shipping is nuanced by the emphasis placed on environmental aspects, while Slovakia is doing its job regarding the waterway, but its ports are being degraded (ex verbis Béla Szalma, ex verbis Botond Szalma, ex verbis Róbert Rafael, ex verbis Zoltán Fábán, 2022).

Countries in the moderate activity group are Hungary, Croatia, Serbia, and Bulgaria. In the case of Serbia, the level of involvement is clearly affected by the fact that the country is a non-EU member (less involvement in international projects) and Croatia has only joined in 2013. Hungary and Bulgaria have shown passivity in national projects, with no major investments, apart from the Hungarian port developments. Experts confirm the low motivation of Croatia and Hungary. Hungary's port development master plan and its port investments are acknowledged, but strong criticisms are voiced regarding waterways, fleet and training (ex verbis Béla Szalma, ex verbis Botond Szalma, ex verbis Attila Bencsik, 2022). In the case of Bulgaria, low motivation for development is also confirmed, which is explained by lack of funds and political reasons.

In the case of Serbia, the assessment of motivation should be treated with reservations, based on the opinion of the experts and other circumstances (non-EU country, economic disadvantages) (ex verbis Edita Stojić Karanović, 2022). Some experts consider Serbia to be explicitly committed (ex verbis Zoltán Fábán, 2022) and acknowledge its development policy and achievements (ex verbis Zoltán Rafael, 2022).

In my view, the success of the development of Danube freight shipping in the coming decade will to a large extent depend on the success in convincing less active countries to make greater efforts in this respect. A good example could be the successful involvement of Serbia in the development of shipping. A key factor here may be whether it is possible to set strategic goals for these countries that they can identify with and providing political support to achieve them. The other key challenge is to reconcile environmental protection and the development of shipping to successfully implement appropriate compromise solutions.

V. Further directions of research, possibilities for the exploitation of results

The results of the research justify a number of further studies and provide a natural incentive for continuing to monitor and evaluate developments in the next EU planning period 2021-27, possibly introducing new considerations. These aspects could include climate protection, the spread of digitalisation and automation in inland navigation, safety, and economic sustainability issues.

An assessment of the cost effectively transportable commodity base for inland waterway transport, considering the criteria outlined in this paper, would contribute to understanding the competitiveness of the sector. A detailed survey of ports and industrial towns along the river, mapping of the various national and international transport links could also provide valuable additional information. The role of ports in urban development should also be examined in detail.

The greatest challenge Danube shipping will face soon is adapting to the problems caused by climate change. The possible changes in climatic conditions and their impact on the Danube have been widely researched, but unfortunately the studies carried out so far show a gloomy outlook. Moreover, the assessment of the impacts specifically on navigation and the possible responses to these impacts are still poorly researched. The issue of the Danube and environmental sustainability goes beyond navigation, but the transport sector is used as an indicator and so it can warn of even more serious consequences.

During the study, I was able to get to know the Danube from the perspective of various actors, and I was often confronted with the argument that navigation is no relevant factor for the river, and therefore its specific needs do not need to be taken into account. I have also experienced that there is not only one, but many visions for the future of the river, its conservation, and its utilisation. I have not, however, found any synthesis work that has attempted to propose a role for the Danube in the 21st century, its use and protection. Although this task requires way more than the work of a single researcher, or even a single discipline, it is a major challenge to be tackled in the long term. I am convinced that if a well-thought-out strategy is ever developed, which also considers environmental, social, and economic aspects, shipping will also have a place in it.

The better understanding of Danube cargo shipping can contribute to the elimination of obstacles hindering it and to increasing its competitiveness. The results of this research can help to plan projects for the development of Danube shipping in the current EU planning period 2021-27. It is my understanding that the results can contribute to the scientific basis for addressing major cross-cutting issues, in particular the sustainable use and protection of the Danube and the climate protection objectives of the transport sector.

List of publications

Scientific publications related to the topic of the theses:

1. Nagy, D. (2022) Challenges of sustainable transport in danube navigation, In: Stojić Karanović, Edita; Ristić, Kristijan (szerk.): Sustainable development and security - global and regional aspects, Scientific Thematic Compendium, Belgrade, Szerbia, ISBN-978-86-82825-23-4, p. 16.
2. Miskolczi, M., Jászberényi, M., Munkácsy, A., & Nagy, D. (2020) Accessibility of major Central and Eastern European cities in Danube cruise tourism. DETUROPE: CENTRAL EUROPEAN JOURNAL OF TOURISM AND REGIONAL DEVELOPMENT (Q3), 12(3), 133–150.
3. Hervai, A., Nagy, D., & Konkoly, S. (2020) Landscape transformations on Mohács Island following river regulations. PODRAVINA: CASOPIS ZA MULTIDISCIPLINARNA ISTRAZIVANJA (Q4), 19(37), 47–59.
4. Nagy, D., Munkácsy, A., & Jászberényi, M. (2020) Organisational and Sectorial Commitment in the Development of Inland Waterways Freight Transport. In Socioeconomic and Environmental Aspects of Sustainable Development During the Fourth Industrial Revolution (pp. 220–236).
5. Nagy, D., Munkácsy, A., & Jászberényi, M. (2019) Impacts of the Eu Strategy for the Danube Region (Eusdr) in Light of Transport Volumes on the Danube River. DETUROPE: CENTRAL EUROPEAN JOURNAL OF TOURISM AND REGIONAL DEVELOPMENT (Q3), 11(3), 59–79.
6. Nagy, D. (2018) Turizmusfejlesztés a Duna-Sió Desztinációban, in: Turisztikai és Vidékfejlesztési Tanulmányok 2018. 3.évf. I. szám, pp. 34–47.
7. Nagy, D. (2016) A turizmus vidékfejlesztési hatásai a magyarországi Alsó-Duna völgyben, in: Turisztikai és Vidékfejlesztési Tanulmányok 2016. 1.évf. III. szám, pp. 43–59.

Conference papers and abstracts closely related to the research topic:

1. Nagy, D. (2020) A Duna szerepe a teherszállításban: a Duna Régió Stratégia eredményeinek vizsgálata. In Utazás a tudományban 2020 (pp. 43–47).
2. Miskolczi, M., Munkácsy, A., Jászberényi, M., & Nagy, D. (2020) Attrakciók elérhetősége a szállodahajózásban. In Utazás a tudományban 2020 (pp. 40–42).
3. Nagy, D. (2019) Milyen hatással lehet Tolna megye turizmusára a Dunai Limes magyarországi szakaszának világörökségi helyszínné nyilvánítása? In “Military landscape Baranyában” (pp. 60–60).
4. Nagy, D. (2018) Turizmus és területfejlesztés a Duna-Sió desztinációban In: Generációk a turizmusban absztraktkötet, I. Nemzetközi Turizmusmarketing Konferencia, Pécs, 2018.03.23. pp. 20–21.
5. Nagy, D. (2018) Turizmus és területfejlesztés a Duna - Sió desztinációban. In Generációk a turizmusban. I. Nemzetközi Turizmusmarketing Konferencia: Tanulmánykötet (pp. 88–96).
6. Nagy, D. (2017) Tourism and regional development in the Danube-Sió Destination, In: Abstract volume of an international scientific conference, II. EAST-WEST COHESION INTERNATIONAL SCIENTIFIC CONFERENCE, Dunaújváros, 2017.11.16-17. pp. 27–28.