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External costs as competitive factor for affirmation of the Rijeka – Pivka railway route in the Baltic – Adriatic Corridor

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ABSTRACT

In accordance with the European Union transport policy, external costs have become a new and important factor in cargo flows formation. Shifting the freight from road to railway in order to decrease the external costs is one of the consequences of implementing such a policy. By incorporating the Port of Rijeka into the Adriatic Baltic Transport Corridor, the railway section of the Rijeka-Pivka corridor has gained first-rate significance. Considering external costs, shifting a part of cargo from the corridor section Koper-Divača onto the Rijeka-Pivka section, and modernization the railway of the latter one, has become the common interest of Slovenia and the Republic of Croatia. The increase of cargo flows intensity on this railway route, based on the principles of green logistics, would inevitably lead to the same effects at the Koper-Pivka railway route. Such development would not jeopardize the competitiveness of the Port of Koper, on the contrary, the cargo flows through Slovenia would increase in a short-term period. This approach means a practical realization of the interests for the EU members countries on the Baltic-Adriatic corridor and efforts of the European transport policy, which takes into account the external costs as an innovative approach to the creation of the "green corridors".

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1 Introduction

The Port of Rijeka (Croatia) is a candidate to become part of the Baltic-Adriatic corridor as the last port of the North Adriatic Ports Association (NAPA) members which have already been included there. Although the NAPA ports declare to be together on the market of the transport services, they are competitors at the same time. The port of Koper, the closest to the Port of Rijeka, is also its main competitor, as their interest market or gravitational area is overlapped. However, the European Union transport policy offers the possibility but also the duty of sustainable development in the transport sector, practically expressed in the decreasing of external costs of transport. This opens up the possibilities of cooperation and common interests of the previous competitors in common development towards green corridors. The cooperation in the field of external costs could lead to an increase of cargo flows on the corridor providing benefits to all stakeholders. Accordingly, including the Port of Rijeka into the corridor should be their common interest.

2 Geostrategic position of the Port of Rijeka considering the Baltic-Adriatic Corridor

The Baltic-Adriatic corridor is an 1800 km long road and railway connection between the Baltic ports of Gdansk, Gdynia, and Szczecin with the Adriatic ports of Koper, Trieste, Venice, and Ravenna (Figure 1).

The main axis of the Baltic-Adriatic corridor passes through six countries (Poland, the Czech Republic, Slovakia, Austria, Slovenia and Italy) which have already been included into the corridor, as well as through several countries positioned in the vicinity of the corridor like Germany, Russia, Hungary, and Croatia.

Considering the list of countries directly and indirectly connected to the corridor, the enormous potential of the corridor is demonstrated and emphasized in the fact that it has neither been interconnected in the whole length as yet nor has it reached the full capacity (Božičnik, 2014). The interest of the countries in the gravitational area of the corridor and the intention of taking part in the transport from powerful, industrial production regions in Northern Europe to

Figure 1 Baltic-Adriatic Corridor (EC, 2017)

Northern Adriatic ports situated as close as possible to the Mediterranean transport hubs is completely understandable. In 2016, the European Parliament approved the request of the Port of Rijeka (Croatia) to be included into the corridor, yet expecting the European Commission to confirm this decision in the near future (Presscut, 2016). Including the Port of Rijeka into the corridor principally means a new opportunity to increase the intensity of cargo flows and, consequently, the opportunity of creating valuable multiplicative effects on the Croatian transport and economic system. The Republic of Croatia has become the intersection of four corridors: Pan-European Corridors V and X, Mediterranean and Baltic-Adriatic Corridors, with the Port of Rijeka as a hub (Ministry of the Sea, 2017) (Figure 2).

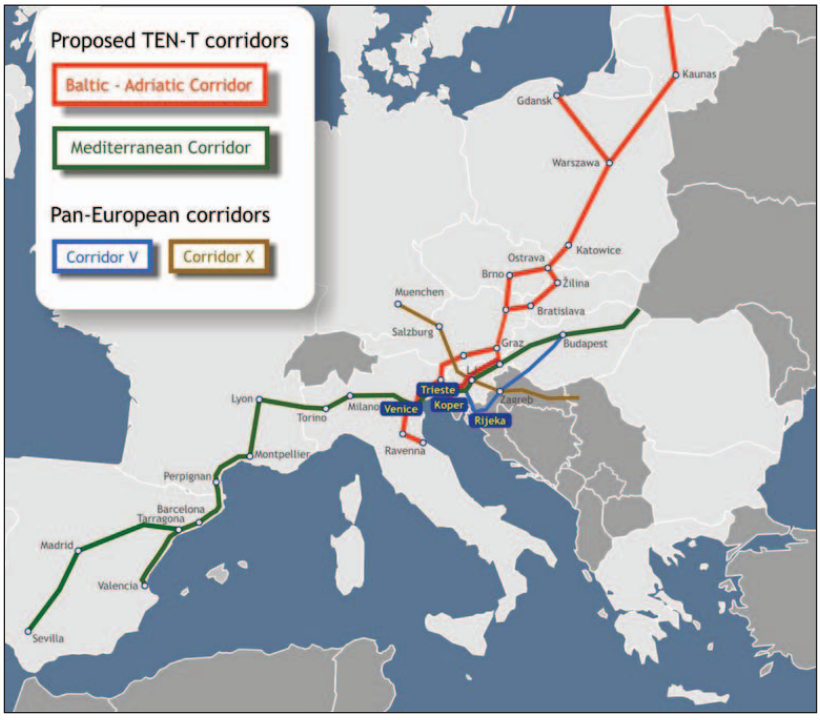


Figure 2 Geostrategic Position of the Port of Rijeka within the European Traffic Network and the Rijeka-Pivka Route-arrow (NAPA, 2017)

By implementing this decision, the existing connection of the Port of Rijeka to the Slovenian Railway Network needs a reconstruction to make it capable of accepting the increased freight transport. Practically, it is the Rijeka-Pivka railway route that represents this connection.

3 Regional freight flows, perspectives and European Transport Policy

The ports of Koper and Rijeka are the largest and the most important ports in their countries. Enabling the shortest connection between the Mediterranean and the middle and eastern European destinations, they are marked as ports with economic importance carrying international traffic. A total annual cargo turnover of the ports of Koper and Rijeka in the 2013-2016 period of time is shown in Table 1.

The data in Table 1 show an evident difference in the turnover of cargo, where the Port of Koper has a twice larger turnover as compared to the Port of Rijeka.

The sustainable development is a clear guideline policy of the European Union. The environmental impact of transport has become a leading point of view. Although, at the first sight, the Rijeka-Pivka railway route seems as a competitive route which could jeopardize the Port of Koper transportation business, from the ecological point of view it could be a common interest for both of the two countries. The European Transport Policy undoubtedly prescribes a duty for decreasing emissions in the transport sector in strictly defined deadlines. According to the existing forecasts, both ports are planning to increase the turnover in the future (Table 2), but it can be possible only by following the prescribed policy of sustainable development.

The ecological impact of transport is expressed through external costs, the costs of damage that the transport activities generate on the environment and human health, and in that form are not paid by transport users who have produced this damage. The European Commission has indicated the internalization of external costs as a main tool to conduct a policy of sustainable development. The internalization of the external costs indicates the intention to compensate the damage with different types of taxes, dues, and fees. All the activities have been performed in order to decrease the impact of the transport sector on the environment, and, respectively, to decrease the external costs as much as possible. The external costs of the different types of freight transport are shown in Table 3 and Table 4.

According to the presented data, the external costs of electric rail freight transport, calculated per tkm, are 13-18 times lower than the road freight transport by selected vehicles. Following the guidelines of the European Commission Transport Policy, the modal shift of inland freight transport from road to rail has become extremely important. The member states of the European Union are persistent in their efforts to fulfil the obligations in connection with decreasing emissions within the permitted levels. A review of the modal choice for freight transport in the EU is shown in Graph 1.

Table 1 Throughput in the Ports of Koper and Rijeka in the 2013-2016 Period of Time (in tons)

Year	Koper	Rijeka
2013	17,999,662	8,687,679
2014	18,965,351	9,022,776
2015	20,711,872	10,900,421
2016	22,010,652	11,159,161

Source: Port of Rijeka Authority, 2017; Port of Koper, 2017, modified by the authors

Table 2 Forecast of Transhipment Volumes through the Ports of Koper and Rijeka (net tons/year)

Year	Koper	Rijeka
2020	27,440,000	20,000,000
2025	30,526,667	37,000,000
2030	33,613,333	45,000,000
2035	36,700,000	49,000,000

Source: Port of Rijeka Authority, 2017; Port of Koper, 2017, modified by the authors

Table 3 External Cost Value Units of Road Freight Transport by Rigid HGV >7.5 t, class EURO V

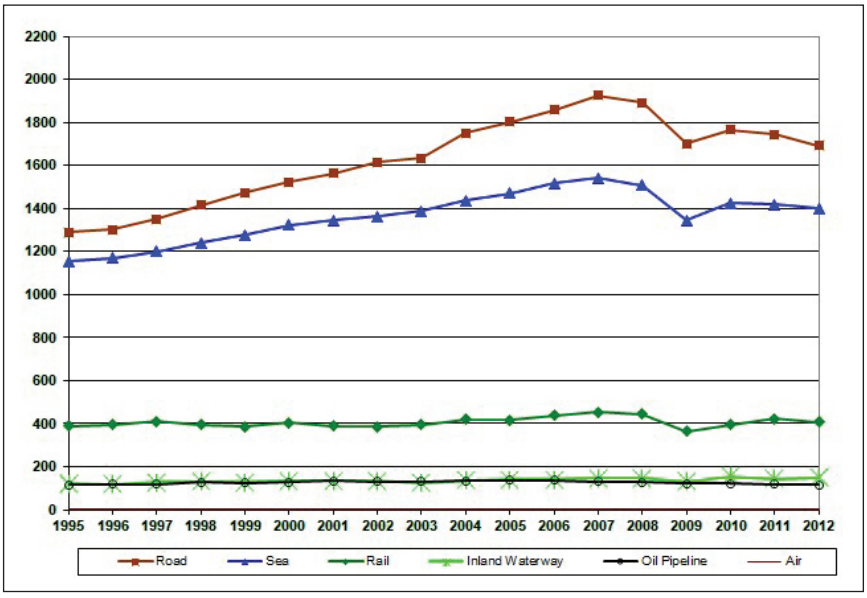
External cost value unit (€ct/tkm)	Emission	Accident HR/SI	Congestion	Climatic change	Infrastructure
Motorway	0.106	0.12/0.066	3.38	0.493	0.08
Rural	0.16	0.08/0.093	4.64	0.52	0.13

Source: Korzhenevych et al., 2014; modified by the authors

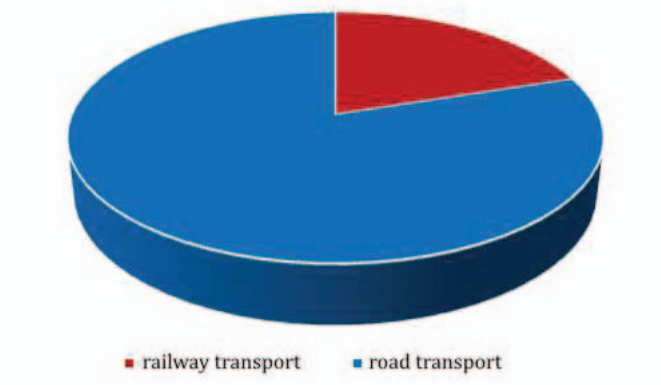
Table 4 External Cost Value Units of Electric Rail Freight Transport, LF 500

External cost value unit (€ct/tkm)	Emission	Climatic change	Infrastructure
Rail electric (rural)	0.08	0.208*	0.02-0.07

* 22% less than diesel train (Givoni et al., 2009)
Source: Korzhenevych et al., 2014; modified by the authors



Graph 1 Structure of Freight Transport by Transport Mode in the European Union for the 1995-2012 period of time (in billion tkm) (EU, 2014)

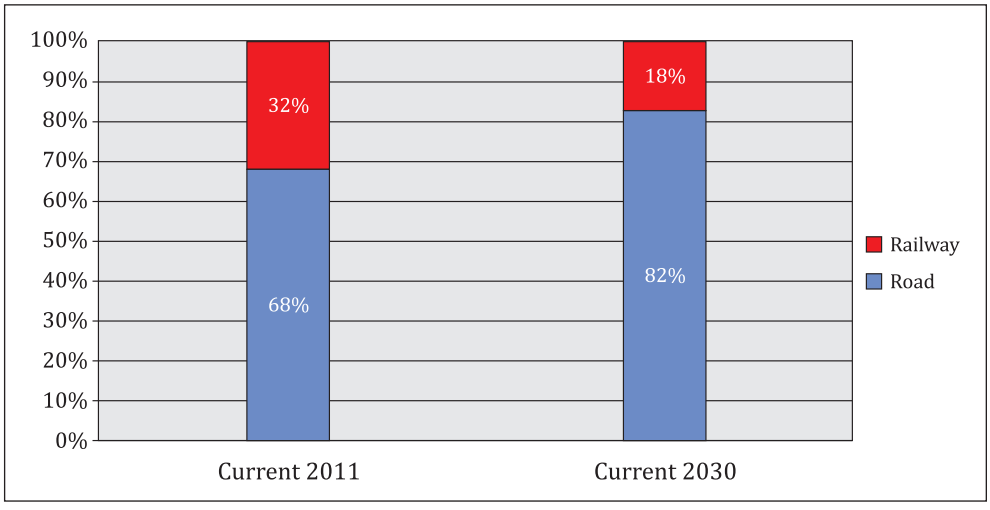


Graph 2 Structure of the Inland Transport from/to Port of Rijeka to/ from Its Hinterland (rail/road) in 2013 (Ministry of the Sea, Transport and Infrastructure, 2017)

Source: online:http://www.mppi.hr/UserDocsImages/TR-DEVLP%20STRAT-M-DOC3010-14%20FINAL%2025-12_15pdf (2017)

The annual railway freight transport share in the EU is only 400 of the totally 3500 billion t/km per year. The road freight transport predominates with the turnover of 1600 billion tkm per year.

The White Paper (Pastori, 2015) has determinated the modal shift of freight transport from road to rail by 30% up to 2030, and 50% up to 2050. The current state of the modal choice for freight transport in Slovenia and Croatia has also shown the ratio in favour of road transport by 3-4 times. The perspective could be even worse (Graph 2 and Graph 3).



Graph 3 Structure of the Inland Freight Transport (Rail/Road) in the Republic of Slovenia

Source: Ministry of Infrastructure of the Republic of Slovenia, 2015, http://www.intesi2017.at/intesi_db/document.php?id=174&&dl (2017)

According to the Croatian Transport Development Strategy (2017), the development and modernization of the Port of Rijeka are not accompanied by the convenient development of the railway infrastructure in the hinterland. Despite the growth of the annual port turnover, the share of railway freight transport in/from the port remains the same. The rail freight capacity at the Rijeka port is limited to 6.5 million tons per year, mainly due to an inadequate infrastructure on the route towards Zagreb, and not towards the Slovenian border (Ministry of the Sea, Transport and Infrastructure 2017). The predominance of road freight transport is evident in both countries and the same trend is unfortunately true even in the European Union. The exception represents the container transport moving in/from the port of Koper with 60% share in favour of the rail transport which makes the port of Koper one of the best port in Europe in that context. It is important to note that this result does not change the prevailing road modal choice on the traffic routes in/from Koper, because the container transport share was 32.50% of the total freight in the port of Koper in 2013 (Port of Koper, 2017). So, the shifting of freight from road to rail becomes necessary and urgent more than ever before. The Transport Policy Resolution of the Republic of Slovenia (2006) clearly, states that "the majority of freight transport should be carried out by rail" and the policy of doing nothing means the development in the opposite direction. The SWOT analysis in the Slovenian Transport Development Strategy (2015) aims to improve the Slovenian traffic network resolving the bottlenecks indispensable to the proper development. Items related to the port of Koper have indicated the possibility of a "shift of the vessel freight to other North Adriatic ports that will provide and adjust their capacities quicker (improve their offer which will be more competitive)" as a threat, and the need for a "cooperation of the Port of Koper with other North Adriatic ports (Venice, Trieste and Rijeka) to attract the freight from North European ports as an opportunity." Although the intentions in the two items seem as if they exclude each other, they open up new horizons spreading the possibilities of cooperation in the field of sustainability and external costs.

4 Geo-transport characteristics of the routes which connect the Port of Rijeka with the Baltic-Adriatic Corridor

The Rijeka-Pivka railway route represents the connection of the Port of Rijeka to the Baltic-Adriatic corridor (Figure 3).

The Rijeka-Pivka railway route is divided into two parts: Rijeka-Šapjane (Croatian part) and Jelšane-Pivka (Slovenian part). The Koper-Divača-Pivka railway route is also divided into two parts: Koper-Divača and Divača-Pivka (a part of the Ljubljana-Sežana-Trieste route) (Table 5).

It is evident that the Jelšane-Pivka railway route does not meet the requirements of the international freight transport (category D4) and needs a reconstruction (Ministry of the Sea, Transport and Infrastructure 2008). According to the Transport Development Strategy in the Republic of Slovenia (2015), this route is evaluated as an 'important for freight traffic' but although indispensable, the reconstruction does not indicate a short-term priority. The possibility of constructing a new railway line to connect Rijeka and Trieste directly was also expressed in the academic and entrepreneurial circles (Amanović and Kralj, 2016).

Figure 3 Rijeka-Pivka Railway Route (red) – a Connection to the Baltic-Adriatic Corridor; Koper-Divača Railway Route (black) – already in the Corridor (Slovenske železnice, 2017)

Table 5 Characteristics of the Railway Route **Rijeka**-Šapjane-Jelšane-**Pivka**-Divača-Koper

Railway route	Koper-Divača	Divača-Pivka	Rijeka-Šapjane (HR-SI border)	Jelšane-Pivka
Length (km)	49	24	31	24
Track (No.)	1	2	1	1
Load per axle (kN/ax)	225	225	225	200
Load per length (kN/m)	72	80/72	80	64
Category	D3	D4/D3	D4	C2
Electric supply system (kV)*	3 DC	3 DC	25 AC	3 DC

* AC-alternating current, DC-direct current

Source: HŽ Cargo, 2004; Slovenske železnice, 2016; modified by the author

Table 6 Characteristics of the Road Route Rijeka-Rupa-Postojna-Divača-Koper

Road Route	Koper-Divača	Divača-Postojna	Rijeka-Rupa (HR-SI border)	Rupa-Postojna
Length (km)	28	23	19.7	37
Track (№)	4	4	4	2
Category	Motorway	Motorway	Motorway	Rural

Source: Google Maps, 2017; modified by the authors

According to the same authors, this is a long-term plan that also requires the reconstruction of the Rijeka-Pivka route as a temporary solution during the construction of new one.

The road connection of the Port of Rijeka to the Baltic-Adriatic corridor is the Rijeka-Postojna route. The competitive Slovenian route is Koper-Postojna (Figure 4).

Figure 4 Rijeka-Postojna Road Route-Connection to the Baltic-Adriatic Corridor (thin); Koper-Postojna Road Route (thick), already on the B-A Corridor (Slovenske železnice 2017)

According to the characteristics of the two mentioned road routes and the need for this research, both road routes are divided into two parts (Table 6).

The freight transport on the Koper-Divača road route is an indicator of the Port of Koper volume transhipment. The Divača-Postojna road route is a part of the Ljubljana-Sežana-Trieste motorway. The Rijeka-Rupa is the Croatian part and Rupa-Postojna the Slovenian part of the same road route.

5 External costs calculation

The total annual freight turnover on the target routes, related to each specific port, is difficult to calculate. After the Divača intersection, it is impossible to calculate the share of freight going from or to the port of Koper. It is the reason why the turnover of the Koper-Divača route has been taken as the starting point for the estimation of the minimal and maximal amounts of freight on the route Divača-Pivka/Postojna. In the road freight transport, the number of trucks is an indicator of the amount of the freight turnover. Considering the truck loading level as an unknown value, the maximal loading and half loading level, as the minimal one, has to be assessed, as if every other truck is empty. The calculation of the overall freight turnover on the routes has been done by using the described methods. Due to the unknown loading level of trucks, the load factor (LF) has been set by using the data from the Slovenian Infrastructure Agency (2017) regarding the type of trucks that passed at the 2101KozinaAC metering point on the Koper-Divača-Postojna road route in the year 2013 (Table 7). The average load factor was 8.6 t, and the lowest load factor was presumed as if half of the trucks were empty (LF 4.3 t). The road route distances are measured by using the Google Maps software.

Table 7 Truck Types According to the Load Capacity Passed at the 2101KozinaAC Metering Point on the Koper-Divača Road Route in 2013

Truck types (truck load capacity in tons)	№	Total load (t)
<3.5*	1908	6678
3.5 – **7**	187	1309
7 – **10** – 14	108	1080
14 – 20	1068	14952
>20	360	7200
Total	3631	31219

* bold values are taken in calculation

Source: Traffic loads, 2013; modified by the authors

By incorporating known unit values of external costs for road traffic, the annual external cost of freight transport has been calculated on the selected routes. The Rijeka (Diračje)-Rupa- Postojna road route is divided into the Rijeka-Rupa A7 highway segment in Croatia and Rupa-Postojna road segment in Slovenia. The load factor (LF) is the same as on the Koper-Divača-Postojna route (Table 8).

The road freight transport on the Koper-Postojna route joins to the traffic of the Ljubljana-Sežana (Trieste) route at the intersection of Divača. Thus, the relevant value of freight volume coming from the port of Koper is taken from the Divača metering point (2101KozinaAC). This value has been used to calculate the external costs on the Koper-Postojna route although the traffic between Divača and Postojna is double higher (Transport Development Strategy, 2014). It is the maximum freight volume that can burden this route by the freight from Koper, but in fact, it decreases at the Divača crossroad. This has been done to compare the external costs with the ones on the Rijeka-Postojna road route. The results are shown in Table 9.

Table 8 Road Freight Traffic Volume and External Costs Calculation on the Rijeka (Diračje)-Rupa-Postojna Road Route in 2013

Destination	km	Trucks (№/y)	Freight min-max (t)	Transport** min-max (tkm)	Total external costs value unit (€ct/tkm)	External costs min-max (€)
Rupa (HR) (motorway)	19.7	137,397*	590,807.10 - 1,181,614.20	11,638,899 - 23,277,799	4.179	486,389.63 - 972,779.26
Postojna (SI) (rural)	37	137,397*	590,807.10 - 1,181,614.20	21,859,862 - 43,719,725	5.543	1,211,692.00 - 2,423,384.60
Total	56.7	-	-	33,498,761 - 66,997,524	-	1,698,081.60 - 3,396,163.80

* Božić et al., 2013

** LF 4.3-8.6 t (min-max)

Table 9 Road Freight Traffic Volume Transport and External Costs Calculation on the Koper-Divača-Postojna Road Route in 2013

Destination	km	Trucks (№/y)	Freight min-max (t)	Transport** min-max (tkm)	Total external costs value unit (€ct/tkm)	External costs min-max (€)
Divača (SI) (motorway)	28	1,307,160*	5,620,788 - 11,241,576	157,382,060 - 314,764,120	4.125	6,492,009.90 - 12,984,019.00
Postojna (SI) (motorway)	51	1,307,160*	5,620,788 - 11,241,576	286,660,018 - 573,320,370	4.125	11,824,725.00 - 23,649,465.00

* Slovenian Infrastructure Agency, 2017

** LF 4.3 – 8.6 t (min-max)

Table 10 Rail Freight Traffic Volume Transport and External Costs Calculation on the Koper-Divača-Pivka Railway Route in 2013

Destination	km	Freight (tons)	Transport min-max (tkm)	Total external costs value unit (€ct/tkm)	External costs (€)
Divača (SI)	49	10,400,000*	509,600,000	0.308	1,569,568.00
Pivka (SI)	73	10,400,000*	759,200,000	0.308	2,338,336.00

*Slovenian Infrastructure Agency, 2015

Table 11 Rail Freight Traffic Volume Transport and External Costs Calculation on the Rijeka-Pivka Rail Route in 2013

Destination	Km	Freight (tons)	Transport (tkm)	Total external costs value unit (€ct/tkm)	External costs (€)
Pivka (SI)	55	411,817*	22,649,935	0.308	69,761.80

*Ministry of the Sea, Transport and Infrastructure 2014

The rail freight transport volume value on the Koper-Divača route is taken as a relevant value for the Koper-Pivka route as it is impossible to determine the moving of freight after the Divača intersection. This is also the maximum value that can burden the target route in the external cost calculation. This procedure makes the routes to be comparable. The results are shown in Table 10.

There is not a large intersection on the rail route Rijeka-Pivka. The complete cargo practically arrives at the destination and there is no need for estimation. The results are shown in Table 11.

6 Valorisation of the routes due to external costs

According to the cargo flows in 2013 and the established research conditions for the purpose of this paper, the external costs on the Koper-Postojna road route are 3.8 – 7 times higher than the ones on the Rijeka-Postojna road route. The external costs on the Koper-Pivka railway route are 22.5 – 33.5 times higher than the ones on the Rijeka-Pivka rail route. Theoretically, the minimum ratio is real if no truck/train continues driving towards Postojna/Pivka after the Divača intersection (half load

trucks, LF 4.3), and the maximum ratio is worth if all vehicles continue towards Postojna/Pivka (full load trucks, LF 8.6).

The value of external costs of 11,824,725 €/year on the Koper-Divača-Postojna road route, representing the freight of 5,620,788 t/year, is probably the closest to reality. It verbatim means the costs as if all half load trucks continue towards Postojna after the Divača crossroad presuming that half of the total freight goes in the Sežana (Trieste) direction. Making efforts to shift this freight from road to rail, according to the EU transport policy, there is a limiting factor of the Koper-Divača railway line throughput capacity. In reality, the traffic amounts to 72 trains/day and the throughput would increase to 82-85 trains/day in the first stage of the modernization procedure (Slovenian Infrastructure Agency, 2015). Theoretically, it means that the capabilities are related to a maximum transport of 15 mil tons per year and, despite the efforts, makes shifting the freight from road to rail impossible. However, shifting about 5.5 mil tons of freight transport from the Koper-Divača-Pivka rail route to the Rijeka-Pivka rail route enables shifting the total freight off the road Koper-Postojna to the Koper-Pivka railway. External costs of the rail freight transport on the Koper-Pivka route would be left the same, while the costs on the Rijeka-Pivka rail route would increase to half of that value. Initially, the amount of rail freight transport in Slovenia would be the same, but including the Rijeka-Pivka rail route into the Baltic-Adriatic corridor, the new markets would be reachable, potentially increasing the amount of transport. This detailed project saves about 12 million € per year (Table 9). The Port of Rijeka and the national transport policy would also get an opportunity to shift the freight from road to rail on this route. It would enable the saving of another 1 million €/year. By the modernization of the Rijeka-Pivka rail route through the interests of stakeholders on the Baltic-Adriatic corridor and with the implementation of the European Union policy measures, the Republic of Slovenia and Croatia would create two "green transport corridors" with international importance making them more competitive than they used to be. Unburdening the Port of Koper would increase the importance and position of the Port of Rijeka on the market of transport services. The port of Koper would acquire a new development possibility with the final result of cost-effective and ecologically more acceptable freight transport. The advantages/disadvantages of the project are shown in Table 12.

The reconstruction of this railway line is an alternative to the construction of the second track of the Koper-Divača route, but it does not exclude it. Moreover, it shows numerous advantages for the Republic of Slovenia that can be realized in a short period of time. The reconstruction of the existing rail track is usually less expensive and lasts shorter than the construction of a new track. The decrease of external costs by operating on the Rijeka-Pivka rail route has already been shown. Alternatively, by the construction of the Koper-Divača second track, the external costs would remain the same. The potential decrease of them would be compensated by the external costs of the increased turnover in the port of Koper being expected during the long period of construction. The turnover in the port of Koper would increase in any case; once, according to the regular development plan; another time due to extending the gravitational area. In the first case, it would be neither the period of a temporary unburdening nor the development towards the «green port». On the contrary, the period of congestion can be expected according to the shown forecast of volume transhipment in the future.

"The temporary unburdening" can be also explained as a disadvantage but welcomed at this time. According to the current results, the perspectives of the port of Koper are favourable in both variants, but the variant of shifting a share of cargo to the Port of Rijeka offers the development according to the European Union transport policy and benefits of it in a short-term period including the expansion of the market by incorporating into the Croatian traffic system the eastern Adriatic coast. Finally, such a development of events would strengthen the position of both the countries within the North Adriatic Ports Association.

Table 12 Modernization of the Rijeka-Pivka Route Versus Second Track Construction of the Koper-Divača Route – Advantages/disadvantages for the Republic of Slovenia

Advantages/Disadvantages	Koper-Divača Second track construction	Rijeka-Pivka Reconstruction
Cost	higher	lower
Time	long	short
External costs	same	lower
Freight flow gravitation area	same	larger
Total freight transport	same	same
Port of Koper	congestion	temporary unburdening
Perspectives	good	better
Cooperation within NAPA	same	better

7 Conclusion

The competitiveness between two neighbouring ports of which one of them expects to be included and the second one has already been included in the Baltic-Adriatic corridor can result in some degree of restraint of the second one in preserving a competitive advantage and economic benefits acquired from the position on the corridor. According to the European Union transport policy, the external costs have been introduced as a factor that has to be counted on in the future development of the transport sector. The results have shown that a common interest to a decrease of external costs can lead to the rise of competitiveness of both the ports with a potential increase of the cargo flows on the Baltic-Adriatic corridor in a short period of time. In the worst case scenario, the cargo flows on the corridor would not be changed but other benefits would remain.

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