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The choice between road transport and rolling motorway: a case study

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Abstract

The paper reports on a research project aimed at estimating the potential demand for a rolling motorway service connecting Trieste (Italy) and Chop (Ukraine). More specifically, the study has explored which factors play a role in the choice between the current prevailing mode of transport, that is road transport by trucks, and a rolling motorway service. Based on the estimates derived from a discrete choice model obtained on the basis of stated choice data collected from truck drivers and from transport companies, it is found that the monetary cost, the travel time and the day of the week play an important role. The scenario analysis allows us to conclude that under the current prices and regulations a rolling motorway service operating on a weekday would have no potential demand, whereas some potential demand would have a service operating during the weekend. Substantial demand for a rolling motorway service appears only if the monetary road cost (fuel cost or highway toll) increases considerably. A heavy-vehicle road tax equivalent to the one used for crossing the Alps in Switzerland and Austria would alter the balance in favor of the rolling motorway.

Keywords: Rail transport, modal choice, road transport, rolling motorway.

1. Introduction

The paper reports on a research project aimed at estimating the potential demand for a rolling motorway service connecting the intermodal terminal of Trieste Fernetti and Chop, a city in the western Ukraine, close to the border with Slovakia and Hungary. Both cities are located along the Corridor V Barcelona-Kiev, identified by the EU as a major transport corridor between the southwestern European countries and the northeastern countries. Currently, along this corridor there is an considerable freight transport activity taking place almost exclusively by road.
The management of the Trieste Fernetti intermodal terminal conceived the rolling motorway project as means to promote both the role of the terminal in the competition

with other similar infrastructures and the shift of freight traffic from the increasingly congested road infrastructure to rail. Compared with the existing rolling motorway services, used mostly to cross the alpine countries of Switzerland and Austria, the one connecting Trieste Fernetti and Chop is of interest for its length (about 960KM), its multinational dimension and the fact that it involves former socialist countries with a long tradition of freight carried by rail.
The study of the potential demand for a rolling motorway service, carried out in collaboration with the management of the intermodal terminal, is crucial to assess the economic feasibility of the project and to calibrate it according to the needs of the potential users. As documented in an abundant literature (see Danielis and Marcucci (2007) as a starting point), the choice of the mode of transport depends on many factors including monetary costs, travel time, time of departure, frequency, punctuality, risk of loss and damage, flexibility, organizational and management costs and a series of regulatory, sociological and political factors. The choice between road transport, currently used, and the planned rolling motorway, is no exception. Consequently, it was thought essential for the study an interview with the truck drivers and the transport companies, who are the targeted clients of the service, in order to understand which factors play the most important role in their decision making process. Part of the interview consisted in a stated-choice exercise which allowed us to estimate a discrete choice multinomial logit model and to use it to predict the market shares of various service scenarios.
The paper consists of 7 sections. Section 2 introduces the technique of the rolling motorway. Section 3 presents the Trieste Fernetti (Italy) intermodal terminal and the characteristics of the rolling motorway project. Section 4 discusses the pros and cons of the rolling motorway relative to road transport with regards to the monetary and qualitative variables. Section 5 illustrates the interview and the choice experiments which were carried out. Section 6 discusses the econometric results and their simulative implications. And, finally, Section 7 draws the main conclusions and policy implications.

2. The rolling motorway

A ROlling MOtorway[1] (hereafter RoMo, also known ROLA from the German term “Rollende Landstrasse”, “rolling country road") is a combined transport system in which the trucks are transported by rail. Combined transport can be either unaccompanied or accompanied by the driver. In unaccompanied combined transport, the goods travel in swap bodies, standardized containers or semi-trailers. These are efficiently transferred at transshipment facilities, called terminals, which are conceived as links between these methods of transport.
In accompanied combined transport, the whole road vehicle is transported by rail, including the traction cabin and the drivers. The wagons consist in special close-coupled flatcars which provide a driveable track along the entire train. The wheels of the wagon are small, having a diameter of 380/360/335 mm. At both ends of the rail link there are purpose-built terminals which allow the train to be easily loaded and unloaded. The drivers of the road vehicles carry out the loading (called “horizontal loading”)

[1] An alternative term used in the literature is “rolling highway”. We prefer to use the term “motorway” since it better corresponds to the German term “Landstrasse”.

themselves and accompany the railway shipment in a couchette carriage in order to effect delivery by road at the final destination. Being a combined transport, only a part of the total journey of the road vehicle is carried out by rail. Before and after being loaded onto the wagon, the vehicle is driven on the road. Often, rail transport allows avoidance of a geographical obstacle or of a route section involving weight or access restrictions. The distance covered by rail depends on the length of the "obstacles" on the road and on the required statutory night rests. In this manner the driver can rest during a section of the route or during the crossing of the Alps. On arrival he can continue his trip completely rested.

2.1 Advantages and disadvantages

The RoMo has a series of advantages and disadvantages.

From the shipper point-of-view, an important advantage of the RoMo over other types of intermodal transport is organizational: a road vehicle can be transported by rail without any prior conditions, provided it is not oversize. Hence, the RoMo has a degree of flexibility almost similar to road transport. On the contrary, unaccompanied combined transport requires a specific organization (acquiring the loading unit, transporting the loading unit to the terminal, loading\unloading the unit, and transporting it to the destination). Having a good degree of flexibility the RoMo tends to be also used on a spot point-to-point basis, whereas the unaccompanied combined transport is more suited for frequent and consistent deliveries of goods. At the extreme side of the spectrum, there is the pure rail transport, either of singular wagons or block trains, which requires high organizational and infrastructural investments and it is therefore used for regular deliveries of large quantities of goods which, because of their size or volume, tend to be hauled by rail.

Since most freight is transported by road, the comparison between the RoMo and road transport is arguably crucial and it will be discussed in detail in Section 4. At this point we just point out that if a transport company uses the RoMo instead of the road it saves on fuel, highway tolls, time losses due to traffic jams and, in some instances, also on vehicle operating hours. In fact, the RoMo arrives and departs at specific times and in all atmospheric conditions and it never slows down because of the traffic. Moreover, when the rail transport is scheduled for the night, drivers travel in sleeping cars on the same train and are able to fulfill rest period regulations without interrupting the journey. Drivers can drive straight off without the need to take a break as they would otherwise be obliged by law to do. Additionally, in some cases, night driving or weekend driving prohibitions are not in effect for trucks coming from or going to end-points of RoMos. These properties of the RoMo increase the life of vehicles and allow a firm to optimize the rotation of vehicles and personnel.

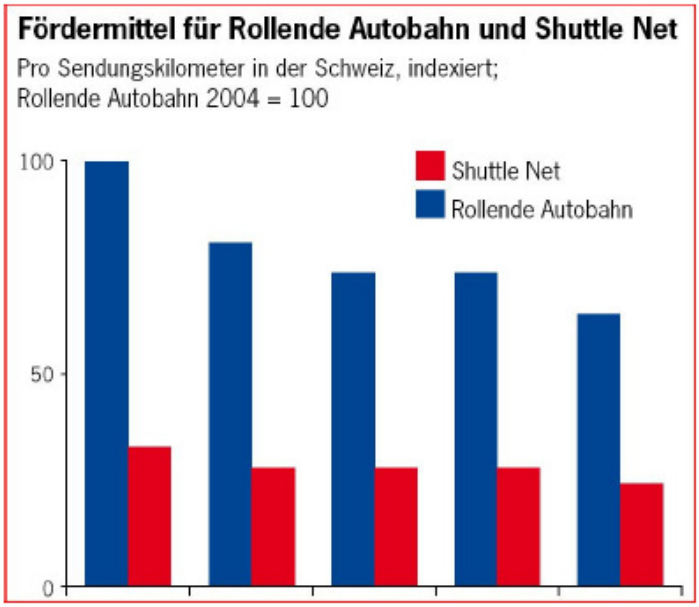
For trips coming from outside the EU, it is also claimed that the RoMo facilitates time savings in carrying out customs formalities.

From the societal point-of-view an important advantage is environmental. An interesting analysis on this subject has been performed in 2003 with the development of the Transport Emission Model (Tremod) by the IFEU at Heidelberg University. This model is used, among others, by the German Federal Environment Agency and the Ministry for the Environment, Nature Conservation and Nuclear Safety. Updated by the IFEU in 2005, the model demonstrates that transport by rail saves 53 grams of greenhouse gas per ton-kilometer compared with road transport. Shifting transport from road to rail delivers proven benefits because rail is the less polluting surface means of

transport; this also applies for the other relevant pollutants such as nitrogen oxides and hydrocarbons as well as primary energy consumption. According to Ökombi (2008), the RoMo has 80% less CO_2 emissions for each train-pair and it lowers NO_2 by 96%, SO_2 by 59%, particulate matter by 80%, and CO by 83%.
According to UIRR (2009), unaccompanied transport is more energy and CO_2 efficient than the RoMO. In fact, relative to road transport unaccompanied transport entails a 29% energy saving, while the RoMo saves up to 11%; moreover, unaccompanied transport reduces CO_2 emissions by 55%, whereas the RoMo enables a reduction of only 18%.
Turning to the disadvantages, an important, frequently-quoted drawback of the RoMo is the relevance of the deadweight because, besides the load, the whole truck must be carried by rail. This reduces the efficiency of the system considerably. According to Ökombi (2008) the weight carried is similar to that of the unaccompanied semi-trailer transport. Ökombi (2008) estimates that a RoMo wagon has an own weight of 17.5 tons. Carrying a 44 tons truck the total weight is equal to 61.5 tons. Since a 44 tons truck has an own weight of 12.5 tons, the net transported freight weight is equal to 31.5 tons. When an unaccompanied semitrailer is carried on train, his own weight is 7.5 tons and net load of 30.5 tons is possible[2]. Hence, their conclusion. However, it should also be noted that the total weight in the case of the unaccompanied combined transport is equal to 38 tons. This allows the use of longer trains compared with the RoMo. In fact, in Switzerland in 2005 it has been estimated that the average RoMo train carried 15 trucks, whereas the unaccompanied combined train can accommodate almost 3 times as much trucks. This has important implications when rail capacity is scarce.
Furthermore, the RoMo trains are deemed, compared to unaccompanied combined trains, to run on lower average distances (300 vs 800 km), to require twice as much investment costs per wagon, 4 times as much maintenance costs, and 3 times as much subsidies (source: Hupac Geschäftsbericht 2008, quoted by Metz (2009). Metz (2009) disputes such claims arguing that in Switzerland in 2008 the RoMo trains carried on average 16 road-equivalent deliveries, whereas the unaccompanied trains carried on average 20 road-equivalent deliveries: hence, the difference is not so large. The claim about the low distances is disputed by real-world examples of longer distances equaling a maximum of 900 km. It is instead recognized that the investment and maintenance costs are higher for the RoMo trains than for the unaccompanied trains, mainly because of the different nature of the wagons. With regard to the subsidies needed, Metz (2009) quotes the figure 1, which shows that in Switzerland the RoMo requires higher subsidies but that the difference between the two techniques is declining.

[2] For regular freight wagons their own weight is 20.5 tons with a loading capacity of 38.5 tons for a total of 59 tons.

Figure 1 - Subsides for the RoMo and for Shuttle trains in Switzerland (Index: 100= Rola subsidy in the year 2004)



Quelle: Geschäftsbericht 2008 der Hupac SA

Relative to road transport, the efficiency loss of the RoMo is balanced by the fact that a train has much lower rolling resistance than a truck.
Other economic and technical disadvantages of the RoMo are that, because of the limited tunnel profile in Europe, one must use for the transport of complete road trains and articulated vehicles special railroad cars with a very low loading floor and with extremely small wheels. This requires a significant design effort also for the wheels and the brakes. In addition, there are, at least partially, the staff costs for the truck drivers who are carried along on the train. Moreover, in certain countries of the European Union, particularly in southern Europe and Great Britain, the railway gauge is not sufficient to transport the 4m-high trucks on rolling road wagons. Freight forwarders also criticize, apart from the cost, the dependency on timetables and the time needed for loading and unloading.

2.2 An overview of existing RoMo

Figures 2 and 3 illustrate the current use of the RoMo in Europe. The RoMo is mostly used for border crossing routes, e.g. through the Alps or from western to Eastern Europe.

Figure 2 – RoMo trains in Europe. Source: UIRR (2009)

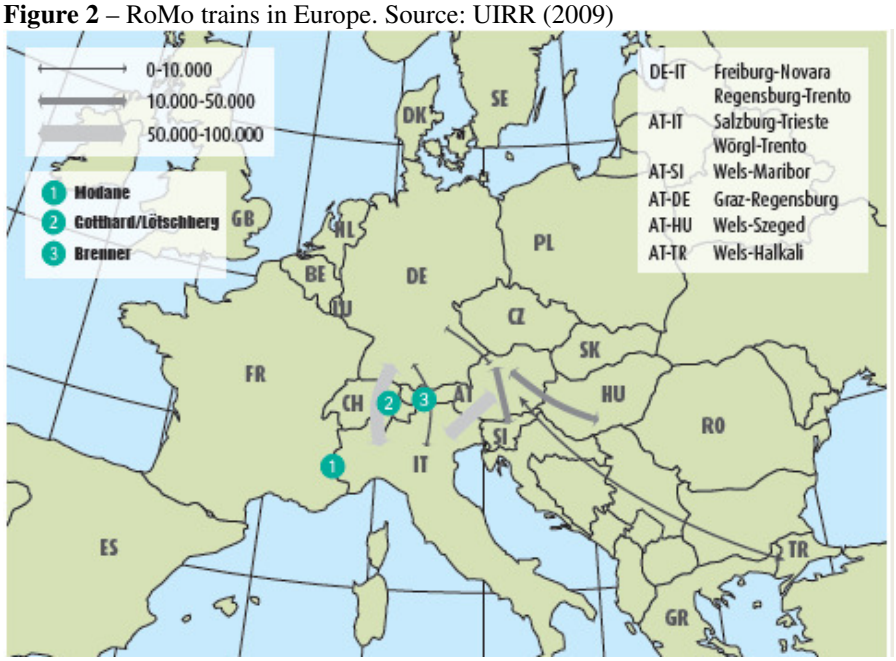
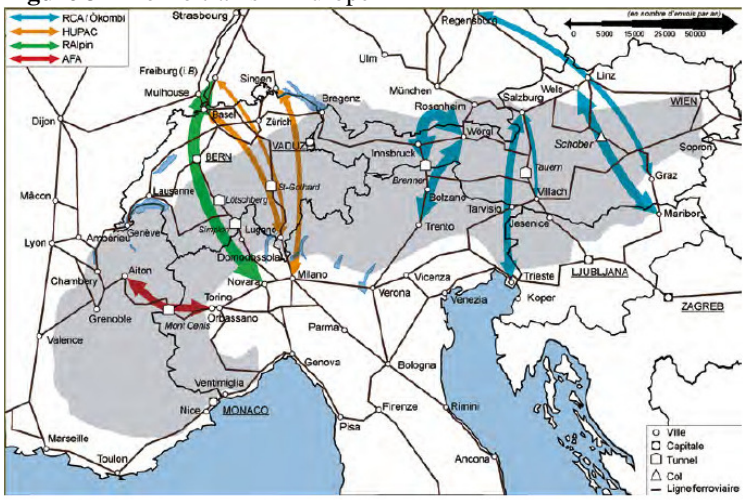


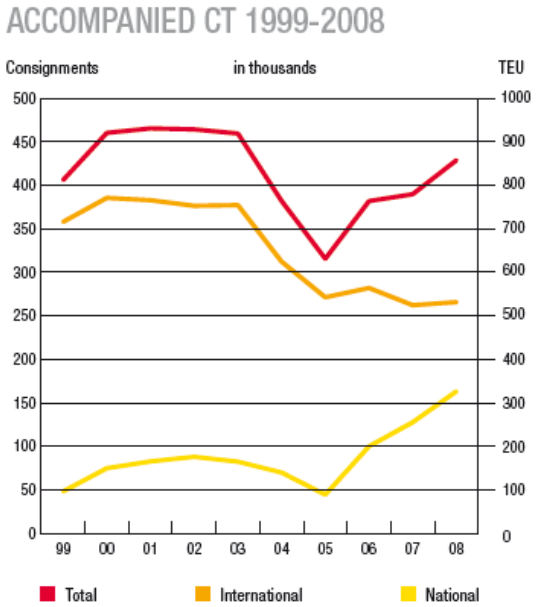
Figure 3 – RoMo trains in Europe



Übersicht der alpenquerenden Rollenden Landstrassen: Die Verbindungen Freiburg i. Brsg. - Lugano und Singen – Milano der Hupac werden zurzeit nicht bedient. (Quelle: MEDAD)

The most successful RoMo routes are located in countries where political support for rail is strong (e.g., in Austria and Switzerland) and where the railway gauge is high enough to allow for 4m heights (e.g., in the East-European countries like Hungary and Slovenia). According to UIRR (2009), the speed of an average RoMo train reached 45 km/hour in 2009 and had a punctuality rate (first truck to leave the ramp) of around 70%. Nearly 100 RoMo trains transport trucks on an average workday on border crossing and purely domestic relations in a single year throughout Europe. Considering the weight of a typical truck being 35/37 tons, and the average distance covered 210 km, each RoMo forwarded truck saves 10,000 tonne\km of road traffic.

Figure 4 – Trend in RoMo use. Source: UIRR (2009)

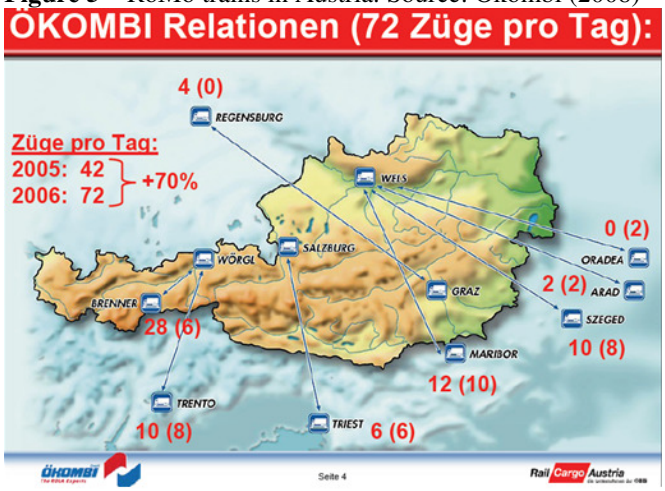


RoMo represents about 14% of the combined transport. Figure 4 shows that, although the share of international RoMO is higher than the domestic one, it is rapidly declining whereas the latter is increasing. This is basically due the following trends: in the Eastern European countries there has been a substitution of the RoMo with unaccompanied trains[3] and with road transport, and Austria provided a strong incentive\disincentive structure in favor of RoMo.

A picture of the RoMos in Austria is reported in Figure 5. Traditionally, Austria is a country crossed by transport flows and therefore the RoMo is of the utmost environmental importance. In 1999, the Austrian Federal Railways (ÖBB) carried 254,000 trucks, equivalent to 8.5 million tons of freight (158,989 trucks in 1993). The RoMo trains in Austria are operated by Ökombi GmbH, a subsidiary company of Rail Cargo Austria the cargo division of ÖBB.

[3] Unaccompanied transport consignments rose from 1,506,653 in the year 2000, of which 904,339 international, to 2,565,680 in the year 2008, of which 1,631,593 international (UIRR, 2009).

Figure 5 – RoMo trains in Austria. Source: Ökombi (2008)



Switzerland has also invested a lot of money and effort into transferring freight from road to rail. In comparison with its Alpine neighbors, it has been extremely successful: in 2007 64% of freight crossing the Swiss Alps did so by rail, an impressive result compared to France and Austria, where most freight continues to be transported by road. The RoMo is a continuation of this policy. It runs between Freiburg in southern Germany and Novara in northern Italy. Before the system could be introduced in 2001, the Lötschberg and Simplon tunnels had to be adapted, bridges had to be widened, and the flatcars on which the trucks are carried had to be lowered. The highway can be used by vehicles up to four meters high, 2.5 meters wide and 44 tons in weight. In some cases it is necessary to partially deflate the truck's tires, so tightly is the clearance in the tunnels calculated.

The agreement on setting up the RoMo was signed in 1992 by the governments of the three countries involved, by each of their national railways and by the Swiss private rail company, BLS, which owns part of the route, including the Lötschberg tunnel.

In Switzerland the capacity of the RoMos is continually being increased. In 2003, 105,000 trucks travelled with this technique. This number rose to 350,000 after the opening of the Lötschberg base tunnel in 2007. RoMos across the Alps exist for both the Gotthard and Lötschberg - Simplon route. They are operated by Hupac AG, headquartered in Chiasso, and in the case of the Novara - Freiburg im Breisgau route by RAlpin AG, headquartered in Olten.

In Italy, there is a direct RoMo between the harbor of Trieste, where the trucks arrive on ferries from Turkey, and Salzburg. In those cases, drivers arrive by plane via Ljubljana airport, to take over the truck.

Europe's longest RoMo route was launched on March 29, 2007 when the first train left the purpose-built terminal at Bettembourg, Luxembourg, bound for Bolou, near Perpignan in southern France. The 1050 km route is being operated by Lorry Rail a consortium including Luxembourg Railways and French National Railways.

Another example comes from the Republic of India. In 1999, the Konkan Railway Corporation introduced the RoMo service, a unique road-rail synergy system, on the section between Kolad in Maharashtra and Verna in Goa[4], which was extended up to Surathkal in Karnataka in 2004. The RoMo service, the first of its kind in India, allowed

[4] http://www.konkanrailway.com/website/tender/ro-ro.pdf

trucks to be transported on flatbed trailers. It was highly popular, carrying about 110,000 trucks.

2.3 Relevant literature

There is not much scientific literature on the RoMo. An important exception is Reffet et al. (2008) who tried to understand how and under which conditions a road carrier would be ready to use a motorway-of-the-sea or the rail, whether accompanied or unaccompanied, instead of the road. The study was made in order to help the French Government in his decision on how to implement sea motorway services on the Atlantic coast, and also to develop the existing rail and sea services. The authors raised the following questions: under which conditions a road carrier would use these services? What would be the consequences on its organization and operational and capital costs? Is the company size an important threshold impacting whether or not to use such a service? Which categories of road carriers would be able to adapt their structural organization to use an unaccompanied transport service (i.e. only the trailer is on the train/ship)?
They interviewed 22 road carriers, users of the alpine RoMo or the Motorway-of-the-sea between Toulon (France) and Civitavecchia (Italy). Their main conclusions are that the size of road carriers companies using both rail and sea services are quite different, while their purpose is the same: move regular and planned freight flows. Quantities and frequencies are variable and origins and destinations also. The choice between accompanied or unaccompanied transport depends on origins and destinations. Unaccompanied transport is mainly used with short pre- or post-transfers. Companies usually start operating accompanied transport, which is more flexible, testing the quality of service, while preparing their organization for a later use of the unaccompanied option. Unaccompanied transport is mostly a large-sized companies' choice, mainly because they carry high-volumes on a regular basis, own enough trailers, and are able to partner with foreign companies or even open subsidiaries in the other country. However, some small-sized businesses managed to optimize their organization to switch to unaccompanied transport too.
Either accompanied or not, carriers choose these alternative modes when they allow them to reduce their costs, improve driving time, and still deliver on time with the same quality of service. Environmental issues did not seem to be a criterion for carriers to choose these new modes.
Finally, they found that, although quite satisfied with current offers, carriers wish to see higher frequencies for the existing services.

3. The intermodal terminal of Trieste Fernetti (Italy) and the RoMo project

The Intermodal Terminal of Trieste Fernetti, constructed almost 20 years ago, is located at the Italian-Slovenian border as a node of the intermodal corridor connecting Barcelona to Kiev (Figure 6). The Terminal comprises 24,000m² of warehouses, 130,000m² of parking/clearance/storage yards and is directly connected with the railway station of Villa Opicina, with the motorway to Venice (Italy - Switzerland - France - Spain), Tarvisio (Austria - Germany) and Ljubljana (Slovenia - Central Southern

Europe). It lies 18 km away from the Port of Trieste and 30 km from the Airport of Ronchi dei Legionari. H24-custom services for transport in transit and for clearances are provided.
The Intermodal Terminal of Trieste Fernetti offers a wide range of logistic services, including warehousing and cargo handling. It hosts custom offices, revenue guard corps, a road tax office, a phytopathology office, a sanitary control office for animal, vegetable and foodstuff products, 60 forwarding agencies, and transport and assistance services to international traffic.

Figure 6 – The Barcelona-Kiev Corridor

The management of the terminal is considering organizing a RoMo service connecting: Trieste Fernetti with Chop in the Ukraine. The RoMo would run at least once a week in both directions. The details of the project (prices, management, regulations) are still under discussion. The research documented in this paper is aimed at evaluation of the market potential for such RoMo service.
Based on the data collected by the Trieste Fernetti Terminal in 2009, it is estimated that in a year about 50,000 trucks stop in Trieste Fernetti, of which it can be estimated that 26,303 take the Chop-Trieste Fernetti route. This represents a potential demand of about 114 trucks a day (about 4 RoMo trains a day).

4. Elements of comparison between RoMo and road transport

In order to have a better understanding of the factors which play in favor or against the RoMo relative to road transport, in this section we focus on some cost and quality factors such as monetary costs, travel time, punctuality, frequency, flexibility, departure time, risk of loss and damage, organizational and management costs, regulatory, sociological and political issues. Most information is derived from the literature or obtained though costing modeling.

Monetary costs
The components of the RoMo monetary costs include track-use cost, train personnel cost, rolling stock cost and the cost of loading\unloading the trucks on the train. We were not able to find in the literature estimates of the actual industrial cost of providing a RoMo service. There is, on the contrary, public information on how much the companies offering the RoMo ask for their service.

Table 1 provides such information for some RoMo connections in Austria (column: RoMo Price 2008). On average they charge about 0.30 to 1.50€ per vehicle-km, but they generally differentiate according to whether a night or day service is considered. The night service is more costly. In the table, the variable road costs are also estimated, including highway tolls in Austria, Germany and Italy, the diesel fuel costs and the maintenance and repair costs. Comparing the total road monetary cost with the RoMo price, it results that the latter are generally set just below the road costs in order to make the RoMo attractive. It is worth noting that tolls make up to between 37 and 82% of the road monetary (variable) costs.

Table 1 - Cost comparison Road-RoMo in Austria

RoMo-Relation		km	Toll A (€)	Toll D (€)	Toll I (€)	Total road toll (€)	Fuel cons. per 100 /km	Diesel cost (€)	Maint. Cost (€)	*Tot. road mon. cost (€)*	*RoMo Price 2008 (€)*	Sav. RoMo p.trip (€)	Time RoMo (h.)
Graz – Regensburg		408	129.9	17.5		147.4	32	150	29	*326*	*370*	-44	10
Graz - Regensburg	A	408	129.9	17.5		147.4	32	150	29	*326*	*300*	26	10
Salzburg - Villach		206	96.6			96.6	33	78	14	*189*	*170*	19	5
Wörgl-Brenner, up to 42 To	D	92	80			80	60	63	6	*150*	*94*	56	2.5
Wörgl - Brenner, up to 42 To.	N	92	138.2			138.2	60	63	6	*208*	*120*	88	2.5
Wörgl - Brenner, up to 44 To	D	92	80			80	60	63	6	*150*	*104*	46	2.5
Wörgl - Brenner, up to 44 To.	N	92	138.2			138.2	60	63	6	*208*	*131*	77	2.5
Brenner - Wörgl, up to 42 To.	D	92	80			80	23	24	6	*111*	*94*	17	2.5
Brenner - Wörgl, up to 42 To.	N	92	138.2			138.2	23	24	6	*169*	*120*	49	2.5
Brenner - Wörgl, up to 44 To.	D	92	80			80	23	24	6	*111*	*104*	7	2.5
Brenner - Wörgl, up to 44 To.	N	92	138.2			138.2	23	24	6	*169*	*131*	38	2.5
Wörgl - Trento	D	229	80		20.7	100.7	40	105	16	*222*	*258*	-36	6
Wörgl – Trento	N	229	138.2		20.7	158.9	40	105	16	*280*	*278*	2	6
Wörgl - Trento	A	229	80		20.7	100.7	40	105	16	*222*	*188*	34	6
Trento - Regensburg	D	467	90.3	28	20.7	139	38	204	33	*376*	*403*	-27	11
Trento - Regensburg	N	467	150.8	28	20.7	199.5	38	204	33	*436*	*403*	33	11

A: AKTION up to 31.12.2008: Net price only with written agreement with regular users. D: day, N: night
Diesel fuel cost, Price per Liter: € 1.15 per Liter. Maintenance, service, tires, oil: € 0.070 per Kilometer
RoMo-Price 2008 excl. € 5 Konto-Bonus. Time needed: from loading at the sending terminal up to downloading at the receiving terminal
Source: Ökombi GmbH (2008)

Table 2 - Derivation of the RoMo price in Switzerland (prices in Swiss francs)

	Rates	Current road base case (Market price)	Current road base case Plus ATB	RoMo Gottard	RoMo Lötschemberg
a) Distance (km)	300				
b) Lenght (h)		4.5	4.5	5.60	4.85
		(CHF)	(CHF)	(CHF)	(CHF)
c) Performance-related Heavy Vehicle Fee (HVF) (from 2007) in CHF / km	1.024	307	307		
d) Driver cost in CHF/h	60.0	270	270	252	218
e) Diesel consumption in CHF/100km	51.0	153	153		
f) Variable costs: tyre use in CHF/km	0.1	30	30		
g) Variable cost: maintenance, oil, etc. in CHF/km	0.1	30	30		
h) Fixed costs *)					
i) Custom formalities in CHF	20.0	20	20		
j) Additional costs in Domo II relative to Chiasso in CHF					86
k) Price increase ATB			200		
l) Maximal RoMo-Price without ATB (incl. MWST)				558	506
Total		**810**	**1010**	**810**	**810**
RoMo price in % of road costs				93%	93%
m) Estimated RoMo-Price without ATB (incl. MWST)				500	450
Total		**810**	**1010**	**752**	**754**

ATB (Alpentransitbörse) is the term use for the proposal to introduce in all Alpine countries a transit rights allocation mechanism or Alpine Transit Exchange[5]. Source: Ecoplan (2007, p.36)

Similar information can be derived from a Swiss study evaluating the strengths and weaknesses of three types of RoMo services in Switzerland aimed at a border-to-border service for the truck crossing the country (Ecoplan 2007, p.36). The table calculates the RoMo prices needed to provide a competitive alternative the road transport (set at 93% of the estimated road costs). The results obviously depend on the fiscal disincentives to road crossing. The RoMo prices vary between CHF 450-500 for a 300km stretch of road. Note that the current road costs are composed of a performance-related heavy vehicle fee of CHF 307 which is higher than the road costs which, excluding drivers' cost (that would be incurred also with the RoMo), amount to CHF 233.
Using the cost model developed by Buzzulini (2010), we have estimated the current road transport costs on the relation Chop-Trieste Fernetti (Table 3) in order to assess what would be a competitive price for the RoMo in this case.

[5] This proposal for an Alpine Transit Exchange involves a fixed number of transit lorry trips to be distributed according to concrete criteria and allocated equally to the various transit passages and weekdays. These trips will then be sold in the form of tradable transit permits through an advance auction via an internet-supported exchange system.

Table 3 - Estimated the road transport costs for Chop-Trieste Fernetti for a single delivery

	Type of costs	*€*	*%*
1	Highway tolls	100	9.48%
2	Fuel cost	290	27.54%
3	Depreciation	233	22.07%
4	Maintenance	58	5.50%
5	Una tantum taxes	2	0.20%
6	Insurance	76	7.24%
7	Ownership tax	7	0.62%
8	Tyres	106	10.10%
9	Labour costs	182	17.26%
10	TOTAL	1055	100.00%
11	Cost savings by adopting RoMo (include cost components 1,2,4,8)	555	52.62%
12	Remaining costs even when adoption RoMo	500	47.38%

Main assumptions: 900 km, of which 800 of tolled highway. Fuel cost: 0.89 €/l, Truck cost: €20391, trailer cost: €33048, average lifetime: 6, una tantum tax: €1399, maintenance and repair cost for the entire lifetime: €38249, annual total insurance cost: €8391, annual labor cost: €20000, annual tires cost: €11700, annual ownership cost: €717. Most assumptions are drawn from CSST (2005). Further details are available from the authors.

The estimated total road transport cost is equal to € 1055. By adopting the RoMo, it is estimated that companies would currently save a maximum of € 555[6]. Hence, this is the maximum price that a RoMo operator could charge in order to be competitive with the current road costs in terms of the out-of-pocket monetary cost. Although monetary costs play presumably an important role in the decision making process, there are other potential costs and benefits which need to be taken into consideration such as the ones listed below to which we will turn our attention in the following paragraphs.

Travel time

The RoMo travel time is easily predictable and known to the user. It depends on engineering features such as the speed of the trains given their load, type of tracks, slope, type of locomotives, etc.. But it depends also on factors such as the chosen departure time and the congestion on the network.

According to UIRR (2009) the speed of an average RoMo train reached 45 km per hour in 2009 and had a punctuality rate (first truck to leave the ramp) of around 70%[7]. Trucks' travel time is more uncertain since it depends on road congestion and on the chosen route. Relevant factors are also speed limits, driving time regulations and their enforcement, as well as accidents. For the Trieste Fernetti-Chop relation it is estimated that the RoMo would take 22 hours including loading and unloading, while, according to truck drivers, it takes on average 26 hours by road.

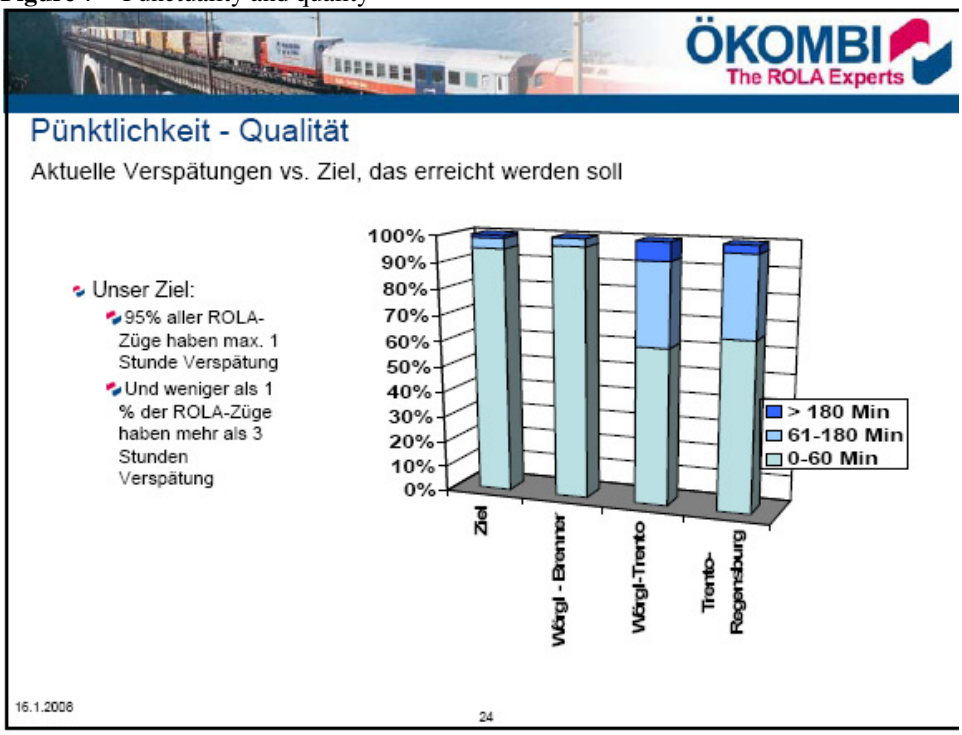
Punctuality

[6] Since some assumptions on costs are drawn from Italian sources, it is likely that the cost for an Ukrainian transport company could be lower.

[7] For the unaccompanied combined transport the average speed reaches almost 50 km per hour whereas the punctuality rates (punctuality meaning that the first loading unit needs to be ready to be picked up by the customer with a tolerance time of 30 minutes) are at about a still unsatisfactory 70%.

It seems fair to assume that the RoMo is more punctual than road transport since it is less exposed to erratic congestion and accidents. Moreover, meteorological factors such as snow or ice are likely to affect more severely road transport than RoMo. Data from Ökombi show that on Worgl-Brennero axis (Figure 7) most trains have a delay of maximum 60 minutes; on the Trento-Regensburg axis 60% of the trains arrive with a maximum delay of 60 minutes, whereas an about 5% arrive with more than 3 hours delay. There are no data on road trucks punctuality rates.

Figure 7 – Punctuality and quality



Source: Ökombi (2008)

Frequency, flexibility and departure time

The greatest advantage of road transport is arguably its high frequency, flexibility and freedom in choosing departure time. On the contrary, the RoMo has a time-plan with fixed departure and arrival times. In the case of the better established RoMo services, as in some corridors in Switzerland and Austria, there is an hourly frequency during the day. In some cases the RoMo runs when the trucks are obliged to stop such as on festivities, night hours or summer days.

Risk of loss and damage

It seems also appropriate to assume that the RoMo suffers lower risks of loss and damage that road transport since it is takes place in a more protected environment.

Regulatory issues

Restrictions play a crucial role in determining the relative advantages\disadvantages. The RoMo has a clear advantage when it can run when the road cannot: on festivities,

on Saturdays and during the night. Restrictions vary depending on country and on type of road[8].
Furthermore, the railway journey of the trucks can be legally recognized as resting time for their drivers which means they may resume their road journey immediately after the arrival of the train. An additional regulatory advantage consists of the possibility of having the positioning road legs to/from a terminal exempted from applicable driving bans. Custom formalities are also often avoided.

Organizational and management costs
There might be differences in organizational and management costs between RoMo and road transport but it is difficult to state *a-priori* whether they are in favor of the former or of the latter.
An important point of discussion is also a difference between accompanied and unaccompanied combined transport. The former certainly require less programming and is more appropriate for small quantity of deliveries, whereas the latter require a medium term choice of setting up the logistics of the shipping firm accordingly. Hence, the supporters of the RoMo argue that it represents a valuable addition to the existing transport possibilities which is especially valuable for time-sensitive deliveries and delicate and valuable goods that require continuous surveillance. The existing RoMos carry various commodities including chemical products, high-tech components, parts components, perishable goods and air-freight goods.
A further claimed advantage of the RoMo is that it allows optimal planning of the trucks and the average life of a truck increases since it runs lower distances.

Social issues
The RoMo often implies that drivers share a cabin in the train and are for long hours restricted to a stay in the train with no access to restoration services and with forced interaction with other drivers. This could be potentially both and advantage or a disadvantage.

Political issues
One cannot forget to mention that several political and economic factors could play in favor either of the RoMo or of the road. For instance: variations in transport costs and oil prices, the introduction of a European road pricing, the mandatory use of the electronic tachograph also outside Europe, the already mentioned EU-wide driving time regulations and the changing environmental concerns.

In order to appreciate which role these monetary and qualitative factors play in the decision making process of choosing between RoMo and road transport in the case of the proposed Trieste Fernetti-Chop service, we carried out a series of interviews with the main actors of the choice: the truck drivers and the transport companies.

5. The interview and the stated choice experiment

[8] In Switzerland neither the trucks nor the RoMo travel during the night. In Austria trucks are not allowed between 10 p.m. and 5 a.m.

The interview consisted in two parts. The first part aimed at understanding the degree of knowledge and experience of the respondent with the RoMo technique, his role in the organization of the trip and his preference regarding travel times, dates and destination (see the questionnaire reported in the Appendix). Furthermore it aimed at getting information on the actual cost that he incurs traveling by road (fuel, highway tolls, taxes) and on the current travel times needed and on the route followed. The second part consisted in carrying out a stated-preference choice exercise. To characterize the alternative choices it was decided to include the following attributes and levels:

- travel time: 14, 16, 18 and 20 hours
- departure time: 7 p.m., 9 a.m.
- RoMo cost: € 350, 400, 450, 500, 550, 600, 650
- day of the week of departure: Friday, Saturday or Sunday, rest of the week
- number of sleeping places per compartment: 1, 2, 3
- highway tolls: 0%, +10%, +20%, +30% increase of current level

An example of the choice-scenarios presented to the respondents is illustrated in Table 4.

Table 4 - An example of the choice-scenario

What would be your choice among these three alternatives?		
Alternative 1: *RoMo service from Chop to Trieste Fernetti*	*Alternative 2:* *RoMo service from Chop to Trieste Fernetti*	*Alternative 3:* *Current truck transport*
Travel time: 16	1 pm - 5 am	Travel time: current
RoMo cost: €800	RoMo cost: €650	
Day of the week of departure: Friday	Day of the week of departure: Saturday	Day of the week of departure: current
N° of sleeping places per compartment: 2	N° of sleeping places per compartment: 3	
		+20% of current highway toll

Attributes such as punctuality, frequency, flexibility and organizational and regulatory factors were not included in order not to impose a too heavy burden on the respondent.
The choice tasks have been extracted using Ngene software (http://www.choice-metrics.com/), with the aim of maximizing the efficiency level of the design accordingly to the principles described by Rose and Bliemer (2005). The choice experiment has been tested colleting 30 interviews with the truck drivers and the estimated parameters of a multinomial logit have been used as priors to update the subsequent versions of the questionnaire. Each interview consisted in 10 choice scenarios.
The interview allowed us to interact with the respondents at the personal level and to have a frank, open and informal discussion of the current difficulties of driving a truck in the enlarged Europe. Many interesting remarks were made by the truck drivers who, although not part of the formal analysis, helped us to gain a better understanding of the social and human implications of the transport business. Some of these comments will be reported in the next paragraphs. The interviews with the truck drivers were carried out by one of the authors in Russian.

6. Sample and results

Two separate populations were interviewed: the truck drivers and the representative of the transport companies.
About 60 truck drivers were interviewed at the Trieste Fernetti intermodal terminal during their stops either to perform the custom formalities or to rest. Reflecting the above mentioned data on the population of the drivers stopping in Trieste Fernetti, 80% of the respondents were of Russian, Ukrainian or Byelorussian nationality.
A crucial aspect that was investigated at the beginning of the interview was whether they owned the truck and what was their role in deciding the route. In almost all cases they did not own the truck and they had a contractual relationship with the truck-owning transport company. The route decision, on the contrary, was to some degree left to them. Although it was clear after the first interviews that the truck drivers, in most cases, are not the main decision makers, we decided to proceed with the interviews because we deemed interesting to get to know as much as possible their preferences as well.
In general, they manifested a medium-low knowledge and experience with the RoMo concept. Some of them said to have had a previous positive experience in Austria, others reported negative experiences (i.e., accidental damages to the truck), others simply did not know about it. Although their experience with the road transport service can be characterized as being quite good, some drivers reported issue concerning time delays or bribes in the process of carrying out custom formalities in some locations. As far as these difficulties could be avoided using the RoMo, they would welcome such development. Some drivers complained about the excess of fines for alleged regulation infringements to traffic or truck maintenance regulation, particularly frequent in some eastern European countries.
A further element that emerged is that some drivers have special contractual arrangements with the transport companies linked to the number of kilometers driven, a factor which can alter substantially their acceptance of the RoMo. But the main interest manifested by the drivers is on how the time spent on the train would be considered and organized in relation with the current mandatory rest regulation. If the train time does not count or, even better, if the access time to the RoMo terminal does not count, their acceptance of the service would be substantially enhanced.
Since most of the truck drivers are employed by transport companies, it appeared crucial to have information on the transport companies' point of view. A difficult issue to solve is that the potential number of companies who could be interested in using a RoMo service on the Chop- Trieste Fernetti relation is large and difficult to get in contact with. For convenience, it can be divided into those transport companies (or freight forwarders) located within the Trieste Fernetti intermodal center and those located outside the Trieste Fernetti intermodal center, either in Italy or in the Ukraine or Russia. Obviously the first category is much easier to identify and to come in contact with. Consequently, they were the first companies we interviewed (7 interviews). About 15 Russian companies were contacted by phone, but so far only 2 completed the interview. Although the sample size is admittedly limited, and should be expanded in the near future, the interviewed companies are highly representative since they are those specializing in freight deliveries on the Trieste Fernetti-Chop corridor.
To summarize, we are able to report in Table 5 the results from the interviews to 33 truck drivers (the initial 27 interviews which allowed us to improve the design efficiency are not included) and 9 transport operators. Since each respondent was given 10 choices scenarios the data consist in 330 and 90 stated choices, respectively.

Table 5 – MNL estimates for the truck drivers and the transport companies

	Truck drivers		Transport companies	
	Coeff.	t-ratio	Coeff.	t-ratio
Monetary cost	-0.007	-6.66	-0.010	-4.05
Highway toll	-0.016	-2.36	0.015	0.64
Travel time	-0.153	-4.71	-0.247	-2.74
Departure time at 19 p.m.	0.315	1.71	0.290	1.11
Departure on Saturday or Sunday	-0.306	-1.32	1.855	3.35
Departure on Friday	-0.449	-2.24	0.905	1.56
1 sleeping place per compartment	0.062	0.30	-0.701	-1.40
2 sleeping places per compartment	0.004	0.02	-0.195	-0.38
ASC road transport	3.787	4.31	2.077	0.71
Adjusted rho2	0.11		0.24	
Number of obs.	330		90	

The out-of-pocket, monetary costs to pay for the RoMo or for fuel are highly significant variables both for the truck drivers and the transport companies. Interestingly, the highway toll variable is significant for the truck drivers but not for the transport companies. This result might depend on the contractual agreements between the truck drivers and their employers. Travel time is in both cases highly significant with an absolute value higher for the transport companies. This makes sense since a higher travel time implies lower utilization ratios of both the fleet and the drivers, and hence higher costs, for the transport companies to bear. The truck drivers are also sensitive to travel time because, in some cases, their incomes are linked to the number of deliveries.
The dummy-coded variable "Departure time at 19 p.m." as opposed to "Departure time at 9 a.m." is significant at the 10% level only for the truck drivers, meaning that the night ride is preferred to the day ride.
With regard to the day of departure, not surprisingly, truck drivers prefer to travel during the week while the transport companies are in favor of the weekend days for obvious reasons.
No definite preference can be found for the number of drivers accommodated in a compartment. Some drivers manifest a preference for solitary trips while others enjoy the colleagues' company, probably depending on social and cultural attitudes.
With regard to the alternative specific constant for road transport, which represents the status quo, the coefficient is positive and significant for the truck drivers, while it is not significant for the transport companies. This result might be due to the low level of knowledge and experience with the RoMo of the truck drives, to the attachment to their daily work routines, and to the feeling of independence[9] that it guarantees.
On the basis of the estimates reported in Table 5, it is possible to simulate the choice between RoMo and road.

[9] Some drivers reported that they would miss the opportunity to choose their working time, restaurants and places to visit, the solitude, and so on.

Table 6 – The choice between RoMo and road under 4 scenarios

	Base1 scenario		Base2 scenario		Tax Increase scenario		Switzerland or Austria scenario	
	RoMo (weekday)	Road	RoMo (Sat-Sun)	Road	RoMo (weekday)	Road	RoMo (weekday)	Road
Monetary cost for RoMo or fuel (€)	1700	1055	1700	1055	1700	1355	1700	1721
Travel time (hours)	22	26	22	26	22	26	22	26
Departure time	19 p.m.	0	19 p.m.	0	19 p.m.	0	19 p.m.	0
Departure day of the week	Week days	0	Saturday or Sunday	0	Week days	0	Week days	0
Truck drivers' choice	*0%*	*100%*	*0%*	*100%*	*0%*	*100%*	*6%*	*94%*
Transport companies' choice	*0%*	*100%*	*3%*	*97%*	*8%*	*92%*	*77%*	*23%*

The Base1 scenario comprises, to the best of our knowledge, the current prevailing market data. It includes a RoMo price equal to €1700, made up of two components €1200 as RoMo costs (a reasonable estimate according to our informal sources) and a €500 fixed truck costs (see Table 3). The RoMo trains are assumed to leave at 19 p.m. on a week day. The travel time is 22 hours. Road transport is assumed to cost €1055 (see Table 3) with a travel time of 26 hours. The estimated market shares when the decision makers are the truck drivers or the transport companies are reported in the last two rows. Both actors would almost certainly opt for road transport.
The Base2 scenario differs from the Base1 scenario only in one respect: the trains leave on Saturdays or Sundays instead of on weekdays. Since this represents a very interesting opportunity for the transport companies, the model predicts that their RoMo market share would increase to 3%. On the contrary, truck drivers, who do not like to ride on weekdays, would certainly keep on choosing road transport.
The Tax increase scenario allows for an increase in the road costs due to road taxes of €300, imposed by the countries crossed by the trucks, on the top of the Base1 scenario (trains on weekdays). This would mean the Hungary and Slovenia, in order to collect revenue from the crossing freight traffic, obtain from the EU the permission to considerably increase their highway tolls. It is not a completely unrealistic scenario. The resulting change of market share for the RoMo when the truck drivers would make the decision is still 0% while it is 8% when the transport companies would decide.
The last scenario assumes a road tax of a level equivalent to the one used in Switzerland or Austria and motivated by the need of protecting the fragile Alpine valleys from heavy-truck traffic. In this case the RoMo market share would increase to 6% for the truck drivers and to 77% for the transport companies.

7. Conclusions

The RoMo as an alternative to road transport or to unaccompanied combined transport has, so far, proved successful in a limited number of cases.
In the specific case of the Trieste Fernetti intermodal center the management has considered the possibility of using the RoMo to connect Trieste Fernetti (Trieste, Italy) with Chop (Ukraine). Such a service would represent an interesting case of a long range

RoMo service between a western European and an eastern European country along corridor of increasing economic and transport activity.
This paper has studied the potential demand for such a service by interviewing both the truck drivers and the transport companies which currently perform the road service along this corridor to understand their level of knowledge of what a RoMo is and the factors which would play a role in their decision making process.
A number of interesting quantitative and qualitative findings resulted.
As expected, the monetary cost factor plays a very important role. However, it is not the only factor. The transport companies appreciate travel time savings as a way to optimize their use of their production factors and, on this respect, the RoMo has a small advantage (which could be estimated in 4 hours). The day of the week in which the RoMo is available is also relevant. As obvious, the possibility of running the service during the weekend would be of value to transport companies, while the truck drivers would not like it. The comfort of the train ride, measured as the number of people hosted in a train compartment, does not play a clear-cut role. Finally, only the drivers show some resistance to the service, whereas the transport companies do not seem to have any *status-quo* bias.
Based on the modeling estimates, the simulative scenarios allow us to draw the conclusion that under the current market and technical conditions a weekday RoMo service would have no potential demand. Some prospects do appear when a weekend RoMo service is considered. There would be a demand for a RoMo service only if the monetary road costs increase, either fuel costs or, more likely, highway tolls. A road tax equivalent to that used for crossing the Alps in Switzerland and Austria would alter the balance in favor of the RoMo. In summary, the prospects for the RoMo service are, as obvious, very much dependent on the contextual fiscal conditions.
A further element of interest for the management of the Trieste Fernetti terminal is that the level of knowledge and experience with the RoMo service is medium-low, hence, a strong informative and promotional campaign would be needed as well as a direct contact with the potential users in order to set up the service in accordance to their needs.
This paper has shed some light on a topic on which there is a scarcity of scientific literature: the factors which could play a role in the decision making process between RoMo and road transport. However, more research work is certainly needed both to assist the policy debate on how to shift freight traffic from the road to the rail and to provide decision makers with relevant business information. We feel that, while the point of view of the truck drivers has been thoroughly tested, more work is required in order to better grasp the point of view of the transport companies and of the freight forwarders, who represent a crucial decision maker. The focus on a specific corridor has limited the population of shipping companies who could be interviewed. In particular, it proved not possible, although the language barrier was overcome, to interview in a reliable way and in a sufficiently large number the Ukrainian and Russian companies which might be interested in using the RoMo service. However, the authors feel that the findings against the economic viability of the service under the current market conditions are quite robust.

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