Intermodal vs. conventional logistic of refrigerated products: a case study from Southern to Northern Europe

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Abstract: Most of perishable goods, such as fruit and vegetables, are transported in Europe by truck and clogging up the main road networks. The increasing demand for freight transport and the environmental concerns all indicate the necessity to embrace new means of transport such as the intermodal one using swap bodies and reefer containers that allow for the use of interchangeable truck, train, and ship to reduce direct and external costs. This research aims to analyze some essential readjustments that must be made in order to increase efficiency in the logistics of refrigerated fruit and vegetables. To do so, some hypotheses were analyzed and formulated in which the strategic use of the truck was recognized and inserted as part of an intermodal transport system. The transport options of a combined use of ships and trains in association with trucks were evaluated with respect to the current prevalent conventional solution of exclusive use of trucks. The results of the comparison between the intermodal and conventional transport were shown to be economically more convenient with respect to both legal and illegal transport by exclusive truck transport, presenting lower per unit costs (swap body or semi-trailer, containing the same amount of goods). Moreover, the intermodal solution scores equal or higher transit times in the comparison with the "transit by regulation compliance" and much higher transit times if compared with the "illegal" option. Therefore, the regulation compliance aspect would partially promote the use of intermodal options in a future fair competition. In addition, besides reducing the direct costs, it produces several other positive effects in terms of external costs to the society such as to reduce road crashes, noises, atmospheric emissions and greenhouse effect.

Keywords: intermodal, freight logisticcentre, truck haulage, rail hub; terminal

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1 Introduction

Most of the perishable goods such as fruit and vegetables are transported in Europe by truck, producing as a result the clogging up of the main road networks. Lately, the increasing demand for freight transport and the environmental concerns all indicate the necessity to embrace new means of transport (Garcìa et al., 2007). The transport using standard containers or swap bodies is one of the solutions available, known as intermodal transport. Due to the different handlings of the swap bodies during this kind of transport, new research based on Radio Frequency Identification (RFID) technologies is being developed with the possibility to support the intermodal selection of both tracking and monitoring parameters throughout the shipment, e.g. temperature level (Costa et al., 2013; Aguzzi et al., 2011). To precisely track the shipments, RFID technologies can be paired with geographic information technologies (GIS) (Menesatti et al., 2012). The implementation within the workflow of such parameters will further improve the intermodal management, so-called info-tracing (Papetti et al., 2012).

Transportation affects in a considerable manner the entire development of the fruit and vegetables supply chain. In fact, the cost of transport accounts for 20% of

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the turnover within the main fruit and vegetables sectors, reaching 33% in the case of the refrigeration as reported by Lanini (2004) in Table 1. Improving the control and management over the transportation phases could represents a concrete improvement to strengthen competitiveness and reducing the operational costs (Menesatti et al., 2012).

Table 1 Logistic costs percentages with respect to the total turnover for the main fruit and vegetables sectors in Italy (Lanini, 2004)

Main Fruit and vegetables sectors costs				
Fruit	Transportation costs	Refrigeration costs	Total logistic cost	Turnover
Citrus fruit	22%	16%	38%	100%
Legumes	18%	7%	25%	100%
Total	20%	13%	33%	100%

As reported by Lanini (2004) in Figure 1, the transportation of vegetables and fruit in Italy is mainly carried out by truck (72%), showing a higher percentage as compared to other European countries. Indeed, the rail transport accounts only for 10% of the freight transported (while in France it accounts for 25%) and only 13% is transported by boat as compared to 56% in the Netherlands.

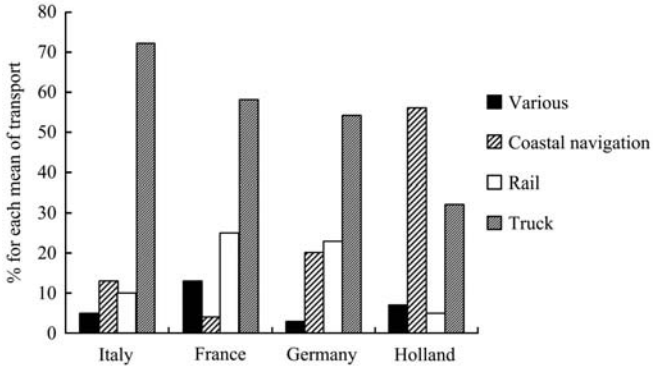

Figure 1 Subdivision of the percentages of the different means of transport used for fruit and vegetables by the main European countries (Lanini, 2004)

The recourse of such almost exclusive modality of transport till today has been justified by its considerable flexibility and by the absence of dedicated sector regulation. This allowed a market policy with lower costs guaranteeing compressed transit times. In such an organized system, more rigid alternative modalities of transport either have been marginalized or never truly took a proper share within the chain with unmistakable consequences in terms of clogged traffic, pollution levels, and on other external costs connected with a savage use of this transport typology.

Actually, in Italy the road haulage represents numerous structural limits. For instance, one of these limits is represented by the reduced dimension of the business company working in the sector often represented by self-employed truck drivers or owners of an average of two trucks (Clerici, 1999).

The dimensional limit precludes, or makes harder, a business improvement on the base of the expansion of the company offer, and therefore the embracement of a wider range of logistical services. This confines the operator within his own niche without serious growth possibilities.

The number of companies is capable of offering complex and efficient logistical services, including the intermodal solutions, which are low in Italy, while most of these companies are currently owned by foreign investors.

Certainly, the necessity for taking advantage of intermodal operators is still innovative worldwide since the fruit and vegetables sector has fragmented origins due to the difficulties met by the producers of building a critical mass. Moreover, such a cooperative way to operate will be more and more required in the future where the market will be oriented to the request of full services that are economically more competitive. The Italian companies, leading the fruit and vegetables market in Europe, must consider the necessity of aggregation to satisfy these new growing needs to avoid losing an important market share.

Furthermore, the problems of exclusive highway transport are starting to make the truck transport less and less efficient in terms of cost and time. This is to the detriment of the smaller companies (self-employed truck drivers) with respect to the bigger ones which are not limited to the exclusive use of trucks but they can take advantage of other transport modalities.

The aim of the research was to formulate and analyze logistic hypotheses recognizing both the strategic use of the truck transport, due to the configuration of the Italian road network, and the interest in an intermodal context. Furthermore, the present work evaluates the possibilities

to use trains and coastal navigation as a supplement to trucks. Such options were evaluated comparing them for different scheduling hypotheses and on the base of costs and transit times.

2 Materials and methods

The evaluation of the competitiveness among the options formulated has been based on the total costs and the transit times as key parameters measuring the system efficiency.

The two transport hypotheses include (Figure 2):

1) Intermodal transport organized with the consecutive order truck-ship-truck-train (through two slightly different routes);

2) Exclusive truck use.

In relation to the second hypothesis, since in Europe (and Italy more often) not always truck drivers comply with motor vehicle regulations, the hypothesis has been split in two: truck transportation by law and truck illegal transportation.

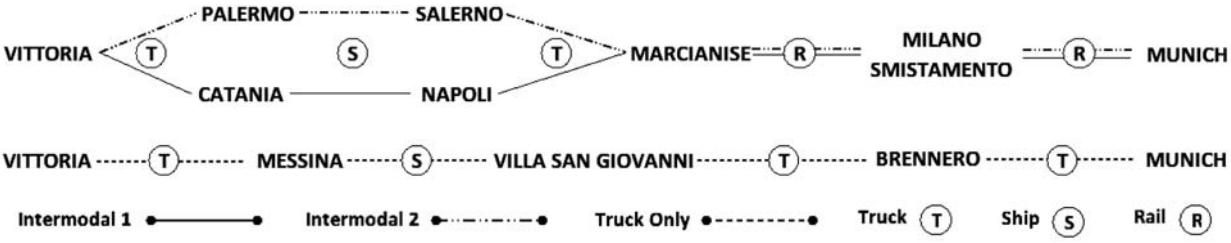

Figure 2 Scheme of the selected itineraries and means of transport adopted

2.1 Loading analysis parameters

The input data and the data sources relative to the utilized parameters necessary for the analysis together with the lorry and containers characteristic and type are listed. In order to easily compare the different hypothesis, two different unit loading types were identified.

The first, used for the hypothesis 1 was a refrigerated swapbody 13.60 m long with a loading capacity of 33 EUR-pallets or so called EPAL-pallet as specified by the European Pallet Association (EPAL) (measuring 80 × 120 cm) and the second, used for the hypothesis 2, a refrigerated semi-trailer 13.6 m long (15 m if tractor mounted) with the same loading capacity as the first. Both options were charged as normal with perishable fruit and vegetables products.

2.2 Selected itineraries

The analysis is referring to specific routes that were selected keeping into consideration the importance of the production and destination sites for the transportation of vegetables and fruits as shown in the map represented in Figure 3.

The distances were specifically given by the itineraries chosen and equal to the ones covered for the transportation of such products. The choice of Marcianise road rail hub (InterportoSud Europa ISE SpA, Marcianise, Caserta, Italy), was made considering its volume exchange capacity. In fact, rail transportation creates the necessity to gather specific volumes to be shipped together. All the information relative to the shipments and management of the goods passing through Marcianise were collected on the base of different interview to the ISE commercial manager (ISE, 2007).

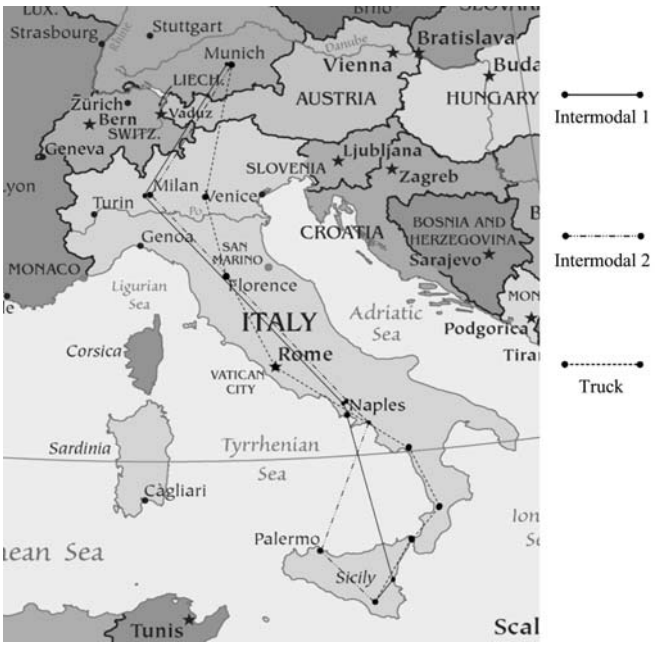

Figure 3 Routes chosen for the two intermodal transportation options and the exclusive truck starting from Vittoria (Ragusa), Italy and arriving to Munich, Germany

The Intermodal Marcianise-Maddaloni (InterportoSud Europa) is located in the center of Campania, 15 km north of Naples and 4 km from Caserta, being developed over an area of over 4 million m^2. It represents one of the major platforms situated in mainland Europe participating to a program leading to optimize the integrated use of truck and rail with the aim to reduce the level of environmental pollution and increasing the road safety.

The importance of the Intermodal Marcianise-Maddaloni is represented by its strategic crossroads position between the Mediterranean and Europe, in one of the richest areas of road, rail, and port of Italy, making it a natural bridge for traffic coming from Italian southern regions as well as Asian ones with northern Europe. The intermodal terminal is placed next to one of the largest Italian train stations, the goods yard Marcianise-Maddaloni, with a unique capacity across the country and being one of the main poles of the network of European hubs. Moreover, such area was chosen for the strong concentration of fruit and vegetables due to the high productivity of the surrounding regions.

To compare and evaluate the intermodal (hypothesis 1) and the conventional logistics option (hypothesis 2), slightly different paths running along the Tyrrhenian Italian sea side were taken into account. Figure 2 summarizes throughout a scheme of how the perishable goods were transported starting from Vittoria (Sicily) and arriving in Munich as final destination and through which means on transport.

2.2 Data gathering

The access to data within the logistics sector is extremely difficult and needs request addressed to operators often doubtful about giving information to external entities. The sources through which the data were gathered depended on the means of transport and the particular routes mentioned above. Therefore, the source of the information was the operator managing each particular path. This was done keeping into consideration the transport of a full swap body or semi-trailer and considering as analysis parameters the costs and time. The information were gathered by the MAGSISTEM S.r.l. (Gricignano di Aversa, Caserta, Italy) a logistics company involved in the AGROLOGIS project developed to strengthen the intermodal logistic chain dedicated to agro-food system of southern Italy.

For the sea transport and specifically for the route Palermo-Salerno the operator responsible was Grimaldi Lines SpAbased in Napoli while for the route Catania-Napoli was Tomasos. Both companies were interviewed (Grimaldi Lines S.r.l., 2007; TomasosS.r.l., 2007).

Concerning the acquisition of the data relative to the rail transport for the routes Marcianise-Milano Smistamento-Munich, numerous meetings were organized with Trenitalia CargoS.p.A. (Trenitalia, 2007), CematS.p.A. (Cemat, 2007)ed Omnia LogisticaS.p.A. (Omnia Logistica, 2007) managing both intermodal transport and door to door transport.

The identification of the costs and time relative to the truck transport was more difficult due to the fragmentation of the sector into small self-employed truck drivers, and moreover, the fact that often such company operates partially illegally. The latter refers to the lack of respect for the speed limits and to truck drivers who are often driving too many hours. This explains the need to define the two different specific analyses regarding driving by regulation compliance or illegally as mentioned above. Therefore, the presented work takes into consideration both theoretical values respecting regulations and real ones. The firsts were evaluated on the base of the costs reported by CONFETRA(ConfederazioneGeneraleItalianadeiTrasporti e dellaLogistica, Roma, Italy; CONFETRA, 2007; CONFETRA, 2001) asking different big truck societies working from Sicily with truck transportation several quotations. Moreover, the organization ANITA (Associazione Nazionale Imprese Trasporti Automobilistici) (2007) was interviewed concerning the small self-employed drivers working on the same chosen itineraries. From these latter ones emerged the situation of the illegal transport by truck.

3 Results and discussion

3.1 Ship transport

The Grimaldi Lines worked with a weekly frequency of a ship leaving Palermo each Wednesday 02:00 a.m. and reaching Salerno by 10:00 a.m. and the trip lasting

around 8.5 h utilizing a speed of 23 kn (knots). For Palermo it relies on the colleague Palermo Euro Terminal that offers a series of complete services ranging from warehousing for containers to rental services or expeditions. For the route, Catania-Napoli the operator responsible was Tomasos that normally leaves Catania each day of the week at 00:00 with the exception of Sunday when it leaves at 07:30 p.m., with a trip of 11 hours. Table 2 and Table 3 report the two path costs and times evaluated, respectively.

Table 2 Costs of transport for the Ro-Ro (Roll-on the ship, Roll-off the ship) routes considered.Elaborated by MAGSISTEM Srl

Routes	Operator	Costs, €/m		Company charge, €		
		Full charged	Empty	Fixed	Terminal	Handlings
Palermo-Salerno	Grimaldi Napoli	16.5	13	0	0	0
Catania-Napoli	Tomasos	25.00	22.5	8.00	0	35.00 per unit

Table 3 Transit times and distances.Elaborated by MAGSISTEM Srl

Routes	Operator	Distance, km	Time, h	Wait time loading, h	Wait time unloading, h
Palermo- Salerno	Grimaldi Napoli	267	8.5	max 1	max 1
Catania-Napoli	Tomasos	358	11	2	2

3.2 Rail transport

In the case of the rail transportation, the costs reported in Tables 4 and 5 are inclusive terminalization to destination guaranteed in a range of 150 km. The costs are calculated on a basic price of 1.27 €/km for the route to Munich and applying the price given by OMNIA LogisticaSpA (Roma, Italy) concerning the route to “Milano smistamento” that is the main rail logistic hub in Milan, Italy. The calculation was not inserted the price for renting the swap body due to facilities promoted by the law L166/2002.

Table 4 Costs of transport for the swap bodies.Elaborated by MAGSISTEM Srl

Routes	Distance, km	Price, €	Terminalization to destination, €	Total, €
Marcianise-Milano smistamento	816	493	179	672
Marcianise-Munich	1190	941	191	1132

Table 5 Rail transit times and distances.Elaborated by MAGSISTEM Srl

Routes	Distance, km	Latest loading time (h:min)	Availability UTI (Intermodal transport Unit)	Total time (h:min)
Marcianise-Milano smistamento	816	16:30	7:30	15:00
Marcianise-Munich	1190	12:00	5:30 or8:45	41:00

3.3 Truck transport

The costs relative to the transport complying with current regulations (Table 6 and 7) were evaluated a basic price of 1.21 €/km plus an increase of the 5% for the refrigeration (around 1.27 €/km). The time was assessed taking into consideration a commercial speed average of 60 km/h and trucks driven by two drivers. The pauses considered are those defined by the European regulation CEE 2002/157CE. The illegal transport option was evaluated ona basic price of 1.10 €/km instead, plus the same increase for the refrigeration (Tables 8 and 9). The time needed was defined through interview with self-employed drivers.

Table 6 Truck transit times and costs by law for the itineraryVittoria-Munich.Elaborated by MAGSISTEM Srl.

Routes	Distance, km	Transit time (h:min)	Cost, €
Vittoria-Messina	197	2:48	250.21
Messina Villa S.Giovanni	6	1:41	150.00
Villa S.Giovanni-Brennero	1396	28:26	1773.05
Brennero-Munich	195	2:48	317.47
Total distance	1794	36:13	2490.73

Table 7 Truck transit times and costs by law for the itinerary Vittoria-Milano smistamento.Elaborated by MAGSISTEM Srl

Routes	Distance, km	Transit time (h:min)	Cost, €
Vittoria-Messina	197	2:48	250.21
Messina Villa S.Giovanni	6	1:41	150.00
Villa Milano Smistamento	1220	25:56	1549.51
Total distance	1423	30:25	1949.72

Table 8 Truck illegal transit times and costs the itinerary Vittoria-Munich.Elaborated by MAGSISTEM Srl

Routes	Distance, km	Transit time (h:min)	Cost, €
Vittoria-Messina	197	2:48	216,70
Messina Villa S.Giovanni	6	1:41	150,00
Villa S.Giovanni-Brennero	1396	22:56	1535.60
Brennero-Munich	195	2:48	284.30
Total distance	1794	30:13	2186.60

Table 9 Truck illegal transit times and costs the itinerary Vittoria-Milano smistamento.Elaborated by MAGSISTEM Srl

Routes	Distance, km	Transit time (h:min)	Cost, €
Vittoria-Messina	197	2:48	216.70
Messina Villa S.Giovanni	6	1:41	150.00
Villa Milano Smistamento	1220	20:26	1342.00
Total distance	1423	24:55	1708.70

3.4 Combined results

The analysis evaluates the differences among the intermodal and conventional transportation systems within the fruit and vegetables sector carried between Southern Italy and Southern Germany. The first hypothesis appears to be economically more convenient with respect to both legal and illegal transport by truck presenting a lower unit cost (swap body or semi-trailer, containing the same amount of goods) for all the itineraries considered as shown in Figures 4 and 5.

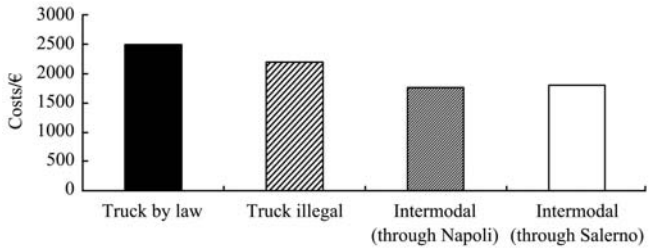

Figure 1 Costs comparison for the itinerary Vittoria-Munich.Elaborated by MAGSISTEM Srl

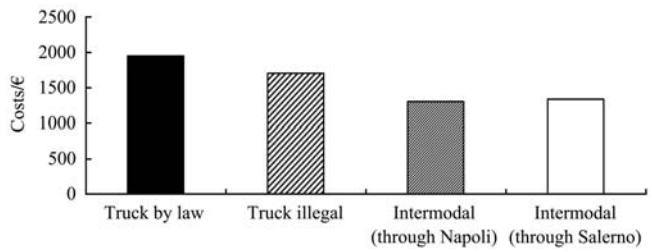

Figure 2 Costs comparison for the itinerary Vittoria-Milano smistamento.Elaborated by MAGSISTEM Srl

The drawback is represented by the longer transit time needed to cover almost all such itineraries in comparison with goods carried by truck especially when taking into consideration points of interruption, such as the logistic centers Bologna Interporto, Verona Quadrante Europa and Munich.

More specifically in terms of costs, for the route to Munich, the savings were between 28% (through Salerno) and 29% (through Napoli) in favor of the intermodal choices with respect to 19 and 21 h needed to cover the distance considered (Table 10).

Table 10 Comparison of the different transit times along the itinerary Vittoria-Munich between truck "by law" and intermodal transportation.Elaborated by MAGSISTEM Srl

Route	Truck (by law) (h:min)	Intermodal (h:min)	Differences (intermodal – truck) (h:min)
Vittoria-Munich	36:13	57:57 via Napoli	21:44
		55:58 via Salerno	19:45
Vittoria-Milano smistamento	30:25	31:57 via Napoli	1:32
		29:58 via Salerno	-0:27

If considering the case of the itinerary to Milano smistamento the differences in terms of transit times became less evident (half a hour through Salerno and 1.5 hours through Napoli) saving around the 30% of the total costs with the intermodal options. Detailed values of the transit time differences became even more substantial if compared to the illegal driving options (Table 11).

Table 11 - Comparison of the different transit times along the itinerary Vittoria-Munich between truck "illegal" and intermodal transportation.Elaborated by MAGSISTEM Srl

Route	Truck (illegal) (h:min)	Intermodal (h:min)	Differences (intermodal – truck) (h:min)
Vittoria-Munich	30:13	57:57 via Napoli	27:44
		55:58 via Salerno	25:45
Vittoria-Milano smistamento	24:55	31:57 via Napoli	7:02
		29:58 via Salerno	5:03

This underlines that by taking into account the parameters of costs and transit times often lead to conflicting evaluations that make extremely difficult to select, for defined itineraries, univocal results for an optimally efficient transport rationalizing in terms of both time and costs. This is evident for the case of the itinerary Vittoria-Munich. Contrarily whereas the intermodal option it appeared clearly convenient for the

transport from Vittoria to Milano smistamento.

However, it is interesting to notice from some interview with truck operators apparently respectful of current regulations, the result of transit times is almost similar to the intermodal options even for the transport to Munich, though this seems to represent a minority within the fruit and vegetables sector. Therefore, complying with current regulations would promote the intermodal options in this case as well. This kind of management would produce probably an increase in terms of perishable goods intermodally transported in a fair competition situation in the future. This potential has its expression not only in terms of direct out of-the-pocket costs, but in several other positive effects in term of costs that the society as to reduce road crashes, noises, atmospheric emissions, and greenhouse effect just to mention some that should in the future be included within the formulation of the sector policies. The social costs relative to the crashes causing physical damages have been evaluated in 2010 equal to 21.3 billion € (MIT, 2011) ranging around from 1% to 1.5% of the Italian Gross Domestic Product (GDP).

Concerning CO_2 production and primary energy consumption, a research conducted by IFEU et al. (2001) provided a comparison between rail-road combined transport and exclusive road transport taking into consideration goods with no refrigerated transport, showed that energy needed and CO_2 produced are superior. The study, although partially conducted by the International Road Transport Union (IRU), shown on the 19 routes (Italian and German) evaluated in total, only in three cases the energy consumed by the intermodal transport was higher (15%), and not in the cases where full swap bodies and containers were considered, while in the remaining 16 cases the energy needed was inferior. Among the same routes, only two scored a higher CO_2 production (3%) using the intermodal transport, while in 6 cases was lower by the 50%.

4 Conclusions

By taking into consideration only the case of transport complying with current regulation, the route where this could be substituted by the intermodal hypothesis should be as direct as possible due to the key crucial factor of the time transit. Moreover, for future reduction of waiting times and therefore total transit times, rail hubs should be better identified and chosen. Such a reduction could be further improved choosing with ship operators a higher cruise speed and a higher service frequency of the cargo ships. An even more efficient system should be planned taking into account an integrated system of arrival and departure organizing together the schedules of ships and trains dedicated to perishable goods. In fact from the whole analysis it appears that in order to make the intermodal system competitive the key parameter is the transit time, which nowadays is often too long to accomplish an appropriate transport within the time limit that retains the product freshness. This could be done by increasing the transported quantities by allowing dedicating specific shipments and schedules of ship and trains - from individual wagon to block train- and providing incentives for sea and rail transport. A proposal is the stipulation of commercial agreements with train operators, applying a reduction of 30% on the base price, ensuring the delivery of a block train for a specific arranged period.

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