Introduction
In the course of the years, the passengers and freight transport by sea assumed a growing importance; the increase of road and motorway traffic together with the progress of transport technologies by water way (fast ships) are the principal factors that induce to consider the maritime transport as a concrete alternative to road transport.

The problem of the transport by sea is strongly felt by the European Union (European Commission, 2001) which doesn’t consider the maritime cabotage as a “remedy” to the congestion of the land traffic and “corrective” to the atmospheric pollution problems, but as an “advanced method” of freight transfer through specific techniques (for example, the Roll on – Roll off services) to offer the users a higher service standard, reaching conditions of frequency, speed and cheapness comparable to those offered by the freight road transport. Recently, the European Commission has instituted a Group of High Level (Van Miert, 2003) to which has been assigned the mandate to identify the priority projects and the themes of fundamental importance for the TEN-T network and organize them in 4 lists according to the time horizon fixed for their completion. “List 1” includes the priority projects which are going to start before 2010 and be concluded by 2020. In this list there is the “sea motorways project, defined by the European Union as “freights and passengers transport by Ro-Ro service on short distances aiming to the integration of the European road, railway and maritime network”.

So, the maritime cabotage development represents, in Europe, a priority to reorganize the transport system; consequently there are many studies about these themes. Some of them deal exclusively with the expansion of the European ports for the increase of cabotage services (report committed by Ministry of Public Transport and Navigation, 1999; study within the community initiative Interreg, 1997); other studies propose actions to increase short sea shipping and sea motorways (reports elaborated by: Sviluppo Italia, 2000; Centro Studi Confetra, 2000; Union trasporti, 2000; AA.VV., 2001; Union trasporti, 2001; Cetena – Co-Fi.R., 2002; Eurotrans, 2003).

This paper is part of a research activity within the EU project “Reports Medoc” (Interreg III B) that examines in details the theme of the short sea shipping and the potentialities related to the fast navigation for the development of the commercial relations by sea in the western Mediterranean sea.

The aim is to provide a methodological contribution based on theoretical models in order to orient the sector operators in the identification of efficient and effective cabotage services. Some reference parameters concerning Italian cabotage are marked in the first part of the report; in the second part, a methodological approach is proposed in its general formulation whose models are referred in the next chapters; in particular, in the third part, the supply models are specified for sea, road and railway modes; these analytical models are described from the points of view of the transport firms and the user. In this last case, the analysis

Theoretical models and operational procedures for feasibility studies of new cabotage lines

Domenico Gattuso - Antonella Polimeni
Mediterranea University of Reggio Calabria
Engineering Faculty
Dept. of Computer Science, Mathematics, Electronics and Transportation (DIMET), Italy

The present condition of freight transport system, unbalanced strongly toward the road transport, with remarkable costs both in terms of environment impact and of safety, pushes a relaunching of the combined road-sea transport and so of the maritime way. The paper proposes a methodological approach, founded on theoretical models, for feasibility studies of new cabotage lines, useful to orient the sector operators in the identifying efficient and effective cabotage services.

After a short recall to the problems concerning the cabotage, some transport supply models are illustrated for sea and road transport as alternative modes. As concerns the transport demand, an estimation procedure based on RPI/SP surveys, is suggested.

The proposed models are applied for a comparative analysis of the road, railway and maritime transport alternatives between two Italian regions, taking into consideration also two different charge units: lorry with tractor and lorry without tractor. The analysis is made both according to a MTO and a Maritime Operator.

Some feasibility studies of new cabotage lines in the Mediterranean Sea are under widening. The research can turn out a valid tool to orient the sector operators and contribute to avoid failures such as some recent cases in the Mediterranean Europe.
of the costs was ideally attributed to a Multimodal Transport Operator (MTO) or rather to a subject that aims to choose the combination of costs which gives as result the minimum generalized cost. In the fourth part the methodological approach for the estimation of the transport demand is proposed through direct surveys; in the fifth and last part, an application on real contexts is presented, with a comparative analysis, in terms of time and cost, of a hypothetical cabotage service between Gioia Tauro (Calabria) and Piombino (Tuscany) ports.

1. Analysis of cabotage experiences

In order to identify a methodological approach for planning new cabotage lines it is very important to understand some characteristics of the cabotage services nowadays existing in Europe. Since it was impossible to analyse the whole universe of European cabotage lines, the attention was directed to the only lines whose origin and/or destination is in Italy. The ports analyzed are interested by ro-ro traffic and they have been selected in relation to the quantity of carried freights, the traffic typology and the strategic importance for Italian economy.

Once identified the ports, the attention was directed to the regular cabotage lines; the survey was based on the specifications supplied from the shipping companies; in particular: period of activity of the line, timetables and sea routes, fares and, when possible, number of operative ships and stop time of the ship in port.

On the whole, 21 Italian ports and 96 cabotage lines were examined; among these, 38 lines grant a direct link between national ports and 38 a connection with foreign ports placed in the Mediterranean basin.

The investigation on the cabotage lines permitted the identification of all those variables that can affect the users’ choices and a statistical analysis among these variables: the trip speed, the travel length, the trip time, the cruise speed, the number of operative ships for each shipping company which offers regular service, the total capacity (passengers, cars, heavy vehicles and total linear meters), the fare (it is different if the vehicles of transport is full or empty), the kind of traffic (lorry with or without tractor) are some of them. All this created an organic framework of quantitative reference parameters useful for modelling and evaluation analysis.

The first evaluation arisen from the statistical analysis concerns the well known link between speed of the ships and trip length; it was possible to observe the increase of the cruise speed with the travel length.

Another correlation is between the fare paid for a heavy vehicle and the trip length. For long distance travels, the trip fare increases; the shipping companies have to amortize with the tickets all the operations of control and maintenance to which the ship must be exposed before making the trip. Besides, always for long distance travels and so for high trip times, the ship must be equipped with many accessory services in order to offer to the users a more comfortable trip. Another important correlation arisen from the statistical analysis is between the speed and the capacity of the ship; the ships with high loading capacity are generally also very fast and they are used for the longest trips.

From the statistical analysis, it was furthermore possible to observe the reciprocity link between the service frequency and the travel length or the trip time. Naturally, for short distance travels there is a great possibility of performing a high number of weekly trips, while the service frequency is generally low for long distances.

At last, studying the supply of the maritime service it was possible to notice that many links having a total “one way” time above 12 hours (and therefore unable to complete the cycle in 24 hours) offer a service with departure from the origin port during the night hours. This because, in general, the users prefer to rest during the travel, to arrive to the destination port in the morning and, from here, to take again the road trip. For this reason, the occupation rate of a ship in departure at night is, in general, higher than the occupation rate measured on the same ship in the daytime. For this reason, the shipping companies often differentiate the fare in relation to the time of departure in order to make the service more desirable also during the hours with low demand.

2. Methodological approach

In this chapter a standard methodology for a feasibility study of a new cabotage line is proposed. The first step of this methodological approach consists of an analysis of the territory taken into consideration in order to study the land-use variables and its social-economic context to determine the potential gravitation basin of the two ports origin/destination of the link. The following step consists of the analysis of the existing transport supply: the attention is devoted both to the existing maritime links developing a service like the planned service, and to the supply attributes of the land transport modes. This allows to elaborate a first proposal of sea transport supply which is more competitive than the existing supply. To avoid failures, however, it isn’t sufficient that the maritime transport is attractive in terms of time and cost compared to the alternative transport modes, but it is indispensable that there is a real transport demand. Therefore the last step of the process consists of the analysis of the potential demand through suitable surveys in the ports gravitation basins; if there isn’t a suitable demand, and so suitable revenues, a supply redesign is necessary.

In figure 1 the proposed approach is shortly described.
In the following chapters the attention is mainly devoted to the analysis of transport supply and potential transport demand.

3. Transport supply analysis

The analytical models which allow to evaluate the time and monetary cost for a ro-ro service differ according to whether the analysis is executed from the point of view of the operator (maritime or terrestrial one) or from the point of view of the user. In this last case, the analysis of the costs can be ideally operated by a Multi-modal Transport Operator (MTO) or by a kind of agency which aims to evaluate the combination of mono-modal or multi-modal costs which gives as a result the minimum generalized cost for the user.

Therefore some analytical models for the calculation of the time and monetary cost are specified for the transport modes (sea, road and railway); the calculation differs according to the two different points of view (operator and MTO).

3.1 Time and monetary cost models from the point of view of the service operator

The evaluation of the costs can be made in two ways; on the one hand it is possible to make the calculation of “generalized cost”, that is a set of heterogeneous costs (monetary, time, etc.) made homogeneous through appropriate parameters; on the other hand, it is possible to make a separate and independent evaluation of heterogeneous cost components.

The advantage of the first approach is the availability of a synthetic indicator which can be useful to compare choice alternatives. The second approach, instead, based on the separated analysis of the variables, allows to distinguish the different cost components to which it isn’t always easy to find out homoegeneity coefficients valid in every context; this approach can make the comparisons less immediate, but it can facilitate the interpretation of the phenomena. For this reason, this second way was preferred.

3.1.1 Time costs

From the point of view of the service operator, the time cost includes the real service time and some time waste strictly depending on the nature of the transport. Some models are afterwards proposed to estimate the time cost for the service producer for three alternative transport modes: road, railway and maritime modes. A mixed mode is excluded from the analysis, even if it could be present in the reality.

Road mode

The total time on a road network (Russo, 1997) can be calculated, according to law, adding to the average travel time “on road”, additional times due to brief occasional stops and longer stops for the rest, variable in relation to the kind of freight:

\[ t_{tot,road} = \sum t_i + t_{b-s} + t_{l-s} \]

The above-mentioned expression is extended to the set of all the links belonging to the minimum time trip on the generic path considered.

In general, the trip covered by vehicle is divided in part on motorway links and in part on extra-urban roads; for such a reason, for the calculation of the time “on road”, it is opportune to assign an average travel speed different in relation to the typology of the road links.

Instead, the determination of the times for occasional stops and longer stops, changes in relation to the territorial context. The European Union countries must refer to CEE Regulation 3820/85 which states:

- For all kinds of freight there must be a stop of 45 minutes out of 4,5 hours of travel; the stop time can be calculated as it follows:

\[ t_{b-s} = 0,75 \times \left( \frac{\sum t_i}{4,5} \right) \] [h]

- it is compulsory to make a stop of \( \alpha \) hours out of 10 hours of travel; it is considered only if the trip exceeds the 11 daily hours and it is evaluated as:

\[ t_{l-s} = \alpha \times \left( \frac{\sum t_i + t_{b-s}}{10} \right) \]

if \( \sum t_i + t_{b-s} > 10 \);

with \( \alpha \) standing for 2,5 hours for perishable freight and 7,5 hours for other freight.

Railway mode

The expressions for the calculation of the time cost for the railway mode are extremely different in relation to the transport technique; the railway transport services, in fact, can be classified in the following categories:

- complete train: the freight travel without intermediate stops from the origin to the destination stations;
- lotissement: the train is organized for exchanges of truck and/or groups of trucks among the shunting stations;
- other trains (traditional).

Some formulations are herewith described for the calculation of the time attributes supposing that only “complete trains” are used, blocked on the whole path to cover in order to allow the railway mode a greater competitiveness level as regards the alternative transport modes. Even if, according to this hypothesis, the calculation of the railway transport time doesn’t include the shunting time in the intermediate stations, it is however correct to include the loading times in the origin terminal. Some models for the calculation of the railway travel times (Russo, 1997) express the trip time in relation to the distance \( L_{rail} \) through a parametric expression:

\[ t_{rail} = \beta_1 L_{rail} + \beta_2 L_{rail} \]

In the hypothesis to consider only “complete trains”, in first approximation it is possible to assume the railway transport
time as a ratio between the distance to cover and the average travel speed to be added to the time for the loading operations.

\[ t_{v, rail} = L_{rail} / v_{rail} + t_{c, rail} \]

**Sea mode**
In general, the transport time cost for the maritime operator is the sum of the maritime steaming time and the time necessary for the handling operations in the ports; like the railway:

\[ t_{v, sea} = \beta_{1, sea} L_{sea} + \beta_{2, sea} \]

or:

\[ t_{v, sea} = L_{sea} / v_{sea} + t_{n, sea} \]

in which:
- \( v_{sea} \) is the average travel speed of the ship; some specific studies (Gattuso and Musolino, 1998) showed that the speed \( v \) increases uprightly with the loading capacity and consequently according to the tonnage of the ship;
- \( t_{n, sea} \) is the time spent in the port node; it is divided into five components corresponding to the following five phases:
  1. access of the ship in port, including the possible waiting time in the roadstead and the pilotage, tow and mooring operations;
  2. unloading;
  3. stop for various activities;
  4. loading (or stowage);
  5. ship egress from the port, including the time required for unmooring, towing and pilotaging.

The stop time in the port \( t_{n, sea} \) depends on several factors, some of them are properly operative, others involve political-economical aspects, concerning agreements between the ship-owner or the charter (ship hirer) and the terminal manager.

**3.1.2 Monetary costs**
The determination of the monetary cost for the service operator is very important because the service fare derives from it and the profitability analyses are based upon these data. In general, the production costs include the costs of the vehicles acquisition and management costs, which include those regarding the activities connected to the trip (additive component) and the part concerning all activities in terminals (not additive component).

Some analytical models are herewith described for the calculation of the service operator costs for the three transport modes: road, railway and sea.

**Road mode**
The estimation of the monetary cost can be done through a linear expression that can be broken up into an additive and a not additive share:

\[ C = C_A + C_{NA} \]

The additive part of the monetary cost is calculated multiplying the unitary cost of the single road link by the distance to cover:

\[ C_A = \sum c_{u, i} \cdot \Delta L_i \]

The calculation of the unitary cost \( c_u \) can be done using a model (Torrieri et alii, 2002) which considers the cost of the fuel, of the possible toll, of the maintenance, of the consumption of tyres and lubricants and various expenses.

\[ c_{u, road} = c_f + k_f c_{toll} + c_{tyr+lub} + c_{main} + c_x \]

with:
- \( c_f \) unit cost of the fuel;
- \( k_f \), constant that assumes value 1 if on the road link there is a toll, value 0 otherwise;
- \( c_{toll} \) unit cost of the toll;
- \( c_{tyr+lub} \) unit cost of tyres and lubricants;
- \( c_{main} \) unit cost of maintenance;
- \( c_x \) unit cost for general expenses.

The expression is more complex if one considers the variability of the components in relation to the territorial context (for example, the variability of the tolls in relation to route). This cost has to be added to the not additive cost share represented by the sum of the cost of the driver of the vehicle, that may be calculated in relation to the total trip time (including the stops), the tolls not bound to trip length and the share of amortization of the cost of the vehicle.

A study by Confetra (Fermecri, 2003) identified the total management cost, for unitary distance, of a heavy road vehicles in the principal European countries (Fig.2).

![Fig. 2: Unitary management cost of a heavy road vehicles](source: Confetra, 2003)

In this case the monetary cost of the road transport can evidently be calculated as:

\[ C_{tot, road} = c_{u, road} \cdot \Delta L \]

being \( L \) the distance to cover, expressed in km, \( c_{u, road} \) the unit road cost.

**Railway mode**
In the case of the railway transport, in the hypothesis in which the producer of the service doesn’t coincide with the manager of the infrastructure, the calculation of the operative
cost can be done referring to the costs for product (train and/or traffic categories) and to the costs for functional sector (operations into terminals, operations for the trains composition, operations for the circulation of the trains). The direct operative costs can be calculated for line by the following expression (De Luca, 2000):

\[ C_{\text{rail}} = C_t + C_v + C_f + C_C \]

in which:
- \( C_t \) includes the costs for travel and accompanying staff, electric energy and fuels, lubricants, heating, lighting and cleanliness, maintenance;
- \( C_V \) includes the costs for trains manoeuvres and control;
- \( C_f \) includes the costs for the maintenance of the electric systems, jobs, commercial activities;
- \( C_C \) includes the costs for movement, material and traction, electric systems, jobs service.

**Sea mode**

In the maritime transport, the operative costs can be split in fixed costs and in variable costs (Gattuso et al, 1998); while the first ones are generally connected to the purchase of the ship, the second ones are bound to the management of the shipping service and they can be distinguished into operating costs and travel costs:

\[ C_{\text{sea}} = C_a + C_r + C_{\text{ins}} + C_{\text{main}} + C_{\text{gen}} + C_p + C_{\text{f}} \]

with:
- \( C_a \) amortization of the ship cost;
- \( C_r \) cost of the crew;
- \( C_{\text{ins}} \) insurance cost;
- \( C_{\text{main}} \) maintenance cost;
- \( C_{\text{gen}} \) cost for general expenses;
- \( C_p \) cost for port expenses (for the use of the infrastructures and the pilotage, tow and mooring services; these are established, generally, on the basis of the gross tonnage of the ship and they vary from port to port);
- \( C_{\text{f}} \) cost for loading/unloading; they are usually different for each port;
- \( C_f \) fuel cost for principal propeller and diesel oil for auxiliary engines.

### 3.2 Time and monetary cost models from the MTO point of view

Following an order analogous to the one concerning the description of the cost models from the point of view of the service operator, analytical formulations for the calculation of the costs for a MTO are herewith proposed.

#### 3.2.1 Time costs

For a MTO, the time costs don’t change substantially as regards the case in which the analysis is made from the point of view of the service operator. The substantial difference is that the elements that allow the determination of the total time cost are reported to the whole trip chain from the origin to the destination and not only the phase of the primary transport service.

**Road mode**

The total time can be calculated in the same way as in the producer of the service. However, whereas one considers the transport between two logistic centres of collection/distribution, it will be necessary to add to the road trip time (already including stop times), the cost components concerning the access/egress links.

**Railway mode**

The total time can be calculated adding to the time obtained for the producer of the transport service (sum of the railway trip time and the waiting time for the loading), the access/egress times between the two railway terminals and the origin/destination of the travel, determined on road ways:

\[ t_{\text{tot,rail}} = t_{\text{acc}} + (t_{\text{rail}} + t_{c,rail}) + t_{\text{egr}} \]

**Sea mode**

For the user of the transport, the trip time increases according to the time of access/egress to the port terminals by land transport modes:

\[ t_{\text{tot,sea}} = t_{\text{acc}} + (t_{\text{sea}} + t_{e,sea}) + t_{\text{egr}} \]

From these functional expressions it is possible to observe that the time competitiveness among the three alternative transport modes is mainly function of the distance to cover. A qualitative trend of time cost for the three transport modes is represented in fig.3 in relation to the distance. As one can notice, the time cost share for the railway and sea modes can be represented as a linear function of the distance in which the links of access/egress to the two terminals of origin/destination have the same gradient as in the road links since it is supposed they are covered on road.

![Figure 3: Diagram time/distance for road, railway and maritime trip](image)

Also for the road mode, the time can be assumed depending on the distance even if the function which represents it is discontinuous owing to the rules of the highway code imposing compulsory stop times. So, for a road travel time so low that it doesn’t need stop time (about 300 km), the road mode is winning on any alternative transport modes;
for longer trip, the competitiveness of railway and sea modes increases.

3.2.2 Monetary costs

The fare of the transport practised by the operators to the user (MTO) can be estimated like the cost of the operator (c) plus a profit margin.

Road mode

The monetary cost of the road transport for the user can be calculated through the following expression:

\[ C_{\text{tot.road}} = \alpha \cdot c_{u,\text{road}} \cdot L \]

being \( L \) the total distance to cover, expressed in km, \( c_u \) the road unit cost already expressed for the operator and \( \alpha \) an amplification coefficient expressive of the profit margin of the operator paid by the user.

Railway mode

The fare concerning the railway transport is obtained multiplying the unit fare \( c_{u,\text{rail}} \) by the quantity \( Q \) of transported freights. For the evaluation of \( c_{u,\text{rail}} \) the following model is proposed:

\[ c_{u,\text{rail}} = \beta_5 + \beta_6 \cdot L \cdot \beta_7 \cdot L^2 \ [\text{€/t}] \]

in which \( \beta_5, \beta_6 \) and \( \beta_7 \) are parameters calibrated for the Italian railway network (Torrieri et alii, 2002) and \( L \) is the distance, expressed in km.

An alternative expression for the calculation of \( c_{u,\text{rail}} \) is proposed by Picard and Gaudry (1993):

\[ c_{u,\text{rail}} = \alpha \cdot L/Q + \beta \cdot Q \]

in which \( \alpha \) and \( \beta \) are parameters calibrated.

For short distance travel the two models provide similar results; the differences increase for long distances.

Sea mode

From the point of view of the users, the total monetary cost is the sum of the transport fare and the road monetary cost to reach the port terminals.

The sea monetary cost is different as it is possible to make the transport of the lorry with or without tractor. The second transport typology, in fact, allows a considerable reduction of the costs both for the reduced length of the transported vehicles (avoiding the transport of the tractor may imply a fare reduction of about 25%), and for the possibility to use the driver and the tractor for other transport services. The driver, in fact, has the possibility, once loaded the freights from the charger/customer, to reach the maritime port to load on the ship the only lorry and use the tractor for other services. In the destination port, another driver will have to unload the lorry from the ship, deliver and gather the load for the return trip. A big obstacle to the development of the transport of lorries without tractor in Italy resides in the existence of a very high number of mono-vehicular firms which, therefore, are not able to manage the organization of the service in the final nodes.

The transport with tractor is usually carried out on the maritime services whose competitiveness lies on the possibility of combining passengers and freight traffic; this is instead hard to realize with services dedicated to the only freights, except on short trips.

The shipping fare can be expressed in function of the length of the transported lorries and the total distance to be covered by sea. The results arisen from the analysis of the Italian cabotage (chap.1) allowed the determination of a model to estimate the fare concerning new cabotage lines.

\[ C_{\text{tot.sea}}^s = c_{u,\text{road}} \cdot L_{\text{acc}} + c_{\text{tot.ml}} \cdot l_{\text{veic}} + c_{u,\text{road}} \cdot L_{\text{egr}} \]

\[ C_{\text{tot.sea}} = c_{u,\text{road}} \cdot L_{\text{acc}} + c_{\text{tot.ml}} \cdot l_{\text{veic}} + c_{u,\text{road}} \cdot l_{\text{tot.ear}} + c_{u,\text{road}} \cdot L_{\text{egr}} \]

in which:

- \( C_{\text{tot.sea}}^s \) is the total transport cost in the hypothesis of lorries without tractor;
- \( C_{\text{tot.sea}} \) is the total transport cost in the hypothesis of lorries with tractor;
- \( c_{u,\text{road}} \) is the unit cost concerning the road mode to be applied for the calculation of the monetary costs of the access/egress links;
- \( L_{\text{acc}} \) is the access distance (origin-port terminal);
- \( L_{\text{egr}} \) is the egress distance (port terminal-destination);
- \( c_{\text{tot.ml}} \) is the total maritime cost for vehicle linear meter;
- \( l_{\text{veic}} \) is the length of the transported vehicles (average of 12m for the transport without tractor and 16,5m for lorries with tractor);
- \( c_{\text{driver}} \) is the cost of the driver per hour;
- \( l_{\text{tot.ear}} \) is the total maritime time.

Also for the monetary cost it is possible to estimate qualitatively the range of competitiveness of the three transport modes expressing the monetary cost in function of the distance to cover (Fig.4).

![Fig.4-Diagram monetary cost/distance for road, railway and maritime trip](image)

Like for the time attribute, also for the monetary attribute
it is possible to do some considerations. In general, the road mode is winning on any alternative transport modes for low road travel times because there are not fixed costs independent from the trip length; for longer trip, the competitiveness of railway and sea modes increases as the variable costs (or rather that depending on the distance) are sensitively lower as regards those of the road mode and the incidence of the fixed costs is considerably reduced as concerning longer travel.

The sum of the two diagrams represented in the Figg.3 and 4 allows to know the trend of the generalized cost of the transport in function of the distance to be covered, once it is calibrated the monetary time value.

4. Analysis of demand

The failure which many shipping companies are meeting after only few months from the start of the service is very often due to the bad knowledge of the transport demand potentially attracted by the service itself.

For this reason, before planning a new cabotage line, a feasibility study is always opportune. It includes, among other things, a preventive estimation of the transport demand in order to understand how many, of the existing road transport firms working in the gravitation basin of the new cabotage line, would be ready to leave the road transport mode in favour of the maritime mode.

The most consolidated methodology for finding the above-mentioned information is represented by the direct survey; this consists of direct interviews, through questionnaires, of samples of individuals representative of road transport firms in order to understand the characteristics of the trip and therefore go back to the characteristics of the whole universe of reference.

Hence, the first step is the delimitation of the investigation area or of the gravitation basin of the two port terminals in order to find, after contacting several public authorities and private companies, the universe of the road transport firms therewith operating.

Such a preliminary phase is followed by the definition of the survey questionnaire to be handled to a sample of road transport companies extracted by the found list.

The questionnaire to adopt for the survey about the mobility of the freight in the survey area must necessarily include the following three components:

1. Present transport demand (RP survey): this section of the questionnaire aims at determining some mode and trip attributes; the first questions are directed to notice the "big numbers": average quantity and typology of freights transported in a year, total number of annual trips, use of combined transport; the next questions are useful to describe the characteristics of the last trip executed by the transport operator in terms of: origin and destination of the trip, transport typology, vehicle typology, moved freights, trip frequency, possible ties of times in departure and/or arrival, time and cost, presence of intermediate stops, trip length.

2. Potential transport demand (SP survey): this section of the questionnaire is directed on the comprehension of the users preferences interviewed as regards the hypothetical transport scenarios. Three possible ways of using the SP exist:

- choice: the interviewee is asked to choose only one among the n hypothetical situations proposed;
- ranking (or order for preference): the alternatives are ordered by the interviewee in preferential order;
- rating (or estimate of preference): the interviewee is asked to give an estimate of preference for all n alternatives (according to an opportunre pre-definite measure scale) indicative of the utility value associate to each alternative.

The approach “choice” is the simplest both in terms of date elaboration (or rather in the procedures of estimate of the unknown parameters of the models), and in terms of comprehension of the user interviewed. In general, a SP survey questionnaire is articulated in several parts in relationship to the attributes of the hypothetical maritime trip chosen for the analysis; in the questionnaire used for the next application on a real context, it was chosen to consider the following variables as factors which define the alternatives:

a. loading time: it is convenient to propose to the interviewee the departure times from the origin port opportunely studied both in relation to the users preferences (from the analysis of the Italian cabotage a preference emerged for the night trip) and to the market of reference (and so the time in arrival);

b. transport cost: so that the interviewee can express the satisfaction of a hypothetical situation and make a comparative analysis with the present situation, it is necessary he knows in advance the transport cost both for lorry with tractor and for lorry without tractor;

c. maritime travel time: it is the other important variable upon which the user often makes his/her choice among several modal alternatives; it is naturally function of the ship speed and directly bound to the arrival time to the destination port.

All the other factors perceived by the users can be considered changing among the various alternatives, and therefore not explicitly considered in the SP questionnaire.

3. Critical situations: in such a section of the questionnaire all the critical elements discovered during the survey phase at the road transport company examined are described.

5. Scenario analysis of new fast navigation lines

This section of the paper describes the technical elaborations and the results concerning the hypotheses of the new cabotage line between Gioia Tauro (Calabria) and Piombino (Tuscany) ports (Fig.5).
As we have several times stated in the previous chapters, the first step of the proposed methodological approach regards the analysis of the territory; potentially, a cabotage line between the Gioia Tauro and Piombino could be extremely attractive. It is probable, in fact, that the Gioia Tauro basin includes most of Calabria and also Messina (East Sicily); on the other hand, the Piombino port could be extremely attractive for all the trips having origin/destination immediately in the North of the above-mentioned port.

Some elaborations for a first brief evaluation of the advantages of the new cabotage line are afterwards proposed. At the moment, the application is incomplete since it uses only supply data and does not consider the potential transport demand to be estimated through the acquisition of general informations about the freight transport in transit along the North-South line and through the comprehension of the trends of the lorry drivers by direct surveys in relationship to some hypotheses of alternative arrangement of the freight transportation system.

It is herewith proposed the evaluation, from the point of view of the user of the service of transport, of the times and the costs used to cover the same relation with the three alternative transport modes (road, railway, cabotage) imagining a ray of the gravitation basin equal to 100 km and therefore considering an average length of the access/egress links of 50 km with average speed 50 km/h.

For the calculation of the times and of the costs concerning the land transport modes, the formulations of the existing models in literature and described in the previous chapters were applied. The results are synthetically summarized in tables 1 and 2.

Because of the high number of the variables, the application of the literature models for the calculation of the time and cost attributes for the maritime transport is more complex as regards the alternative modes. In absence of a real ro-ro service that connected the analysed relation and so in absence of irrefutable data concerning the time of stop in port for the pilotage, mooring and tow operations, it was necessary to attribute, in first approximation, values arisen from the study of similar services. Besides, to the variables strongly dependent on shipowner’s choices (cruise speeds, times of departure and/or arrival, etc.), many values were attributed and this implied the analysis of many hypotheses of alternative scenarios.

In the detail, the total time cost for the users is decomposable in the access/egress times to the two port terminals, the times concerning the handling activity (in first approximation equal to 2 hours in each port), the travel time different in relation to the speed of the ship; the service was afterwards analysed for two cruise speed values: 25 knots (46.3 km/h) and 30 knots (55.6 km/h). For the evaluation of the monetary cost it was supposed that the user has the possibility of loading the lorry with or without tractor. In the first case the monetary cost is equal to the sum of the maritime fare (considered 35€/ml; this value derives from the statistical analysis of the Italian cabotage service), handling and port terminal rights, and the cost of the driver (12,91€/h) both during the access/egress times and during the trip. In the case of transport without tractor, the cost concerning the vehicle driver is (except for the access/egress links) set at zero and the length of the vehicles (in the calculations assumed 12,0m) is reduced; therefore, the last solution is the cheapest from the point of view of the user.

In table 3 the time and monetary costs are shown, they are calculated from the point of view of the user of the service, for the analysed path; the voices “Time1”, “Cost1” and “Time2 “, “Cost2” are representative of the two speed hypotheses.
In synthesis, a summary of the times and costs “paid” by the user of the service to cover the Gioia Tauro - Piombino path through the three alternative transport modes is reported in the following table:

<table>
<thead>
<tr>
<th>Mode</th>
<th>Distance (km)</th>
<th>Total time (h)</th>
<th>Total cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road</td>
<td>781</td>
<td>21.00</td>
<td>514.20</td>
</tr>
<tr>
<td>Railway</td>
<td>759</td>
<td>15.00</td>
<td>544.30</td>
</tr>
<tr>
<td>Sea (speed=25 knots; with trailer)</td>
<td>789</td>
<td>21.00</td>
<td>945.39</td>
</tr>
<tr>
<td>Sea (speed=20 knots; without trailer)</td>
<td>789</td>
<td>16.00</td>
<td>514.19</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2359</td>
<td></td>
<td>1514.19</td>
</tr>
</tbody>
</table>

In accordance with the qualitative diagrams (Fig. 3 and 4), for long distances the maritime transport appears competitive as regards the road and railway modes.

Conclusions
The determination of the time and cost attributes in the scenario hypotheses is being refined since they are strongly dependent on the shipowner’s choices (number and kind of ships, speed and capacity, shipping fare, etc.).

An advanced study phase is at present oriented to the determination of the potential transport demand that can be estimated through general informations about the freight road transport along the North-South line and through the comprehension of the behaviour trends of the lorry drivers by means of direct surveys in relationship to some hypotheses of alternative arrangement of the freight transport system (RF/SP surveys).

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