Innovative cargo unit for vehicles transport: technical and economic considerations

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A new intermodal container specifically designed to carry cars by both land and sea has been recently presented. This unit is a collapsible, 40-foot, ISO container with two decks and space for six cars. Because of its standard sizes, the unit will allow cars to be carried door-to-door (from factory to showrooms) by the same transportation means which carry containers all over the world. Cars were traditionally delivered using specialised land vehicles and vessels; such modes were not integrated and this fact led to multiple lashing and handling operations as vehicles were transferred from one mode to another. This paper analyses the benefits of car containerisation, mainly in terms of lower transportation costs and lesser space requirements for land storage.

1 Introduction

The transportation of new vehicles, from production centres or maritime ports to distribution areas, shows some critic points.

In fact, the current transport modality involves a high number of manual operations in the load/unload points as well as in intermodal areas; that means high specific transport cost, demand for even wider parking areas and high damage rate.

As the containerisation of general cargoes led to large advantages, several improvements are expected in the new car transportation field from the introduction of a containerised cargo unit. Even though this kind of unit does not dominate the current market, recently an innovative container has been presented. This technology can be helpful in order to overcome current difficulties for container diffusion in this transport field.

2 Supply chain of vehicles in Italy

With 2.331.075 registrations in 1999, Italy takes its rightful place among the greatest producing countries worldwide, behind USA, Japan and Germany.

The non-catalytic vehicles substitution process, currently in progress (in Italy there are 15 million cars to be replaced), could even improve the sales of new cars in the next future.

In fig. 1, the sales trend in Italy in the period 1991-1999 is shown; the off-road vehicles are included, even if they represent a very small market share (less than 4%).

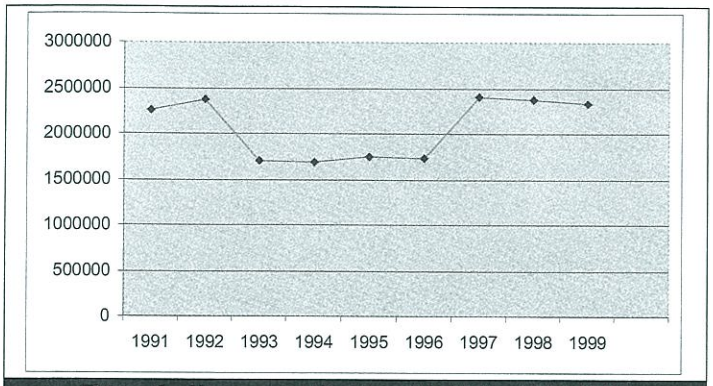

Figure 1 - New cars sales trend in Italy, 1991-1999

Fig.2 highlights the dominance of North Italy sales share, that represents over 50% of the total market; at the same time, sales of foreign vehicles grew in importance, getting 65% of the Italian market in 1999 (fig. 3).

Italian vehicles production is dominated by FIAT, whose industrial centres are concentrated in the Southern regions; those industrial points get 70% of units produced (fig. 4). As stated previously, the majority of sales are centred in the Northern areas; this situation led to a strong flow imbalance along the North-South direction. Empty returns from North to South constitute a very big share of specialised carriers moves; in the case of railway carriers, this quota even reaches 50% of total moves [1]. Therefore the main object of this transportation sector is knocking down the incidence of empty returns, which represent the critical factor of the supply chain diseconomy.

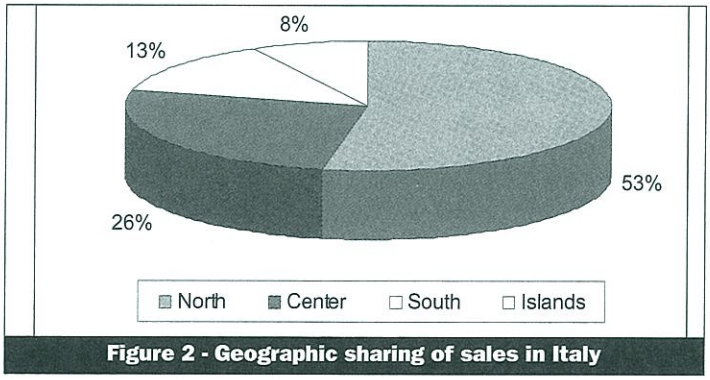

Figure 2 - Geographic sharing of sales in Italy

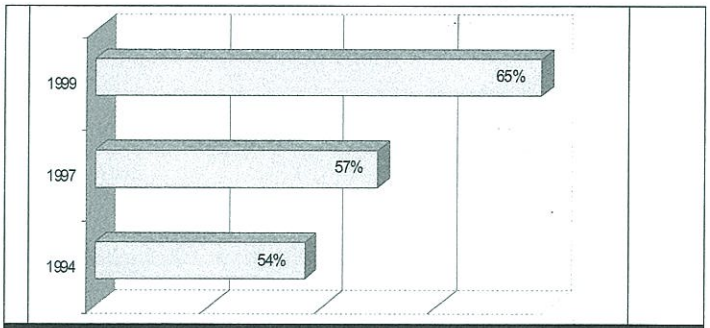

Figure 3 - Foreign vehicles rate sale

FIAT have production centres abroad too: France, Poland, Turkey, Brazil, Morocco, Argentina, Egypt, South Africa, India. A part of these productions is destined to pertinent domestic market, while a part is imported in Italy (Table 1).

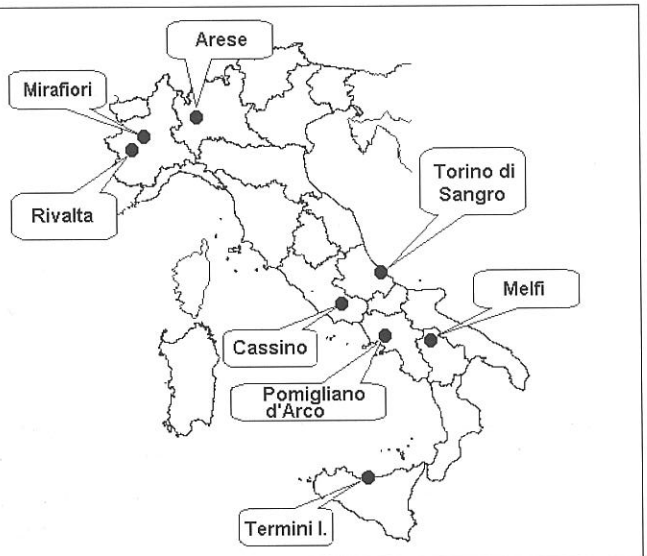

Figure 4 - Geographic distribution of FIAT production centres

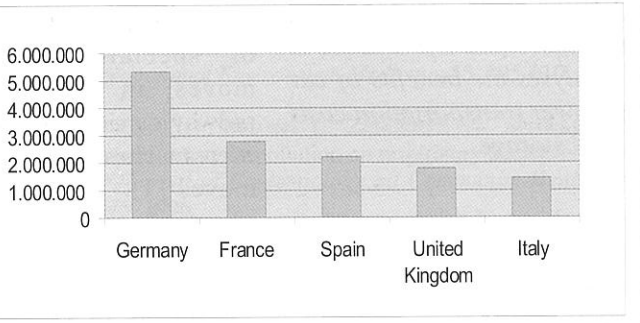

Figure 5 - First five European producers (units produced in 1999)

The first five European producers are also at the top for sales (fig. 5); Germany leads both charts. Good sale results are being obtained by Japanese (1.744.916 units in 1999) and Korean (483.306 units) producers too.

	Production	*Sales in Italy*
Italy	1.481.000	758.000
France	54.000	19.000
Poland	341.000	99.000
Turkey	63.000	3.000
Brazil	407.000	41.000
Others	84.000	-
TOTAL	**2.430.000**	**920.000**

Table 1 - Production and sale results of FIAT (year 1999)

3 Present vehicles distribution modalities

Road modality is today extremely prevalent in the distribution of new cars in Italy; the use of dedicated equipment brings some inefficiency in this sector, connected to high incidence of empty returns shown before.

3.1 By road

In this field, dedicated car transporters are utilised, which can hold from 8 to 12 vehicles, depending on their size. In Italy there are presently about 2000 car transporters; the high level of fragmentation in this field makes any statistic survey really difficult. Nevertheless it is a common opinion that this condition leads to a large underutilization of these dedicated means of transport, increasing the number of empty returns.

The price of a car transporter (whose length is about 20 m) ranging from 100.000 to 150.000 Euros, depends on the complexity of hydraulic devices necessary to obtain a convenient charge flexibility (telescopic, reclining or overhang ramps).

Charge operations for 12 vehicles can take up to 40 minutes; also discharge operations need a long time, because the cars have to be driven in reverse over the ramps and operators must be very careful to avoid any contact between the bodywork and ground.

3.2 By sea

While the majority of new cars are transported by road, the combined rail-road and sea-road traffics are currently growing. Maritime transport is irreplaceable over the long distance, and the transport is made both by specific unit (car carrier) and by multipurpose vessel.

The storage capacity of these units ranges from 600 (feeder ship) to 6000 cars (deep-sea vessels, with up to 10 decks). The course Asia-Mediterranean Sea represents the principal maritime car transportation flow; others important directions are North America-Mediterranean Sea and Mediterranean Sea-South America. In table 2 and 3 is shown the maritime traffic regarding Italy, divided into import and export flows.

The most important Italian harbours for car are Salerno, Livorno, Savona and Genoa. Salerno and Livorno constitute important terminal points of long distance courses, both for import and for receiving FIAT vehicles produced abroad.

Country	*Units transported (1994) [× 1000]*	*Units transported (1997) [× 1000]*
South America	109	18
Spain	46	75
Ex- Yugoslavia	33	30
Greece	14	38
France	12	13
Israel	12	n.a.
Asia	10	17
Total export	**236**	**191**

Table 2 - Italian export flows of new cars

Country	*Units transported (1994) [× 1000]*	*Units transported (1997) [× 1000]*
Spain	205	352
Asia	43	128
South America	18	n.a.
Ex – Yugoslavia	n.a.	27
Turkey	n.a.	16
Total import	**266**	**523**

Table 3 - Italian import flows of new cars

In the Italian scenario, Genoa and Savona play a secondary role, with smaller import/export volumes, as they are intermediate stops on the feeder courses.
Fig. 6 shows the vehicles moved on North Tirrenic harbours in the years 1995-1999; the port of Salerno has been excluded from this chart because the data provided by the Port Authority are expressed in tons, a very useless way to catalogue and survey this transportation field.

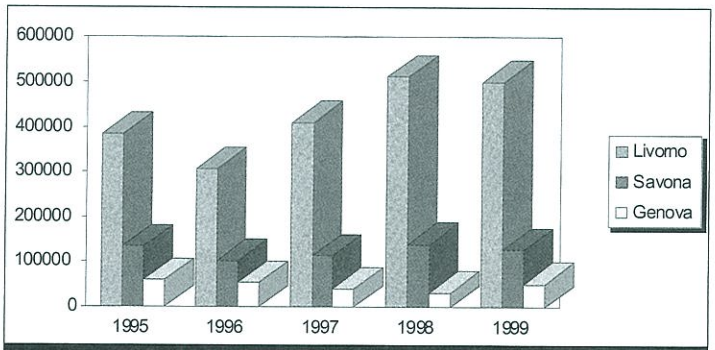

Figure 6 - Vehicles moved on North Tirrenic harbours

Actually, the maritime sector is dominated by the *ro-ro* (roll on-roll off) technique: charge/discharge and storage operations are made manually, by dedicated teams, each of about 18 people. Those *ro-ro* moves, opposed to *lo-lo* (lift on-lift off) techniques, make the car transport field a specialised sector, causing some restriction, first of all the discontinuous use of stocking areas. Average areas needed for stocking cars is 10 m2 / vehicle; charge/discharge operations need a special team of drivers which moves the cars between storage areas and internal ship decks. In a six hour shift, one of these teams can discharge 500 cars; in a full day several teams can work simultaneously, reaching the quota of 3.000 cars discharged by day.

3.3 By rail

Car transportation by rail constitutes a sector with a strong traffic volume: about 16.000 special wagons transport 8 millions cars per year. These 1 or 2 decks dedicated wagons prevalently belong to private companies. Therefore this transport field is characterised by a high number of actors: the rail network administrator, specialised rail wagon owners, car producers and forwarding agencies.
Rail wagons can be divided into three categories, depending on the loading deck length:

- wagons up to 23.4 m
- wagons between 23.4 and 27 m
- wagons over 27 m

The capacity of these rail wagons is 10, 12 and 14 vehicles respectively. Table 4 cites as an example the data traffic of Sitfa, one of the most important Italian rail wagons owner.

Year	*Vehicles transported*	*Wagons utilised*
1995	350.000	29.000
1996	320.000	26.500
1997	372.000	30.500
1998	366.000	30.000
1999	351.000	29.300

Table 4 -Traffic data of a rail wagon owner

Rail transport of vehicles is made prevalently by complete trains; whereas on the one hand that leads to a more economic service, on the other hand it makes the delivery time longer, because they must wait for a convenient number of cars with the same destination before the train can leave. This fact seems in contrast with the flexibility needed by the *just in time* policy production.

Cars produced in Italy and sold abroad have to pass through Alessandria sorting centre; foreign cars entering Italy arrive in one of these receipt centres:

- Carimate (Como)
- Verona
- Arena Po (Pavia)
- Vercelli
- Villastellone (Turin)
- Fiorenzuola (Piacenza)
- S. Polo di Torrile (Parma)
- Bologna
- Civitavecchia (Rome)
- Pontecagnano (Salerno)

From these centres cars reach dealers by road; the stronger presence of receipt points in Northern Italy gives these areas more chances for importing. So charge operations dominate in Southern Italy, while discharge operations in Northern Italy; empty wagons are concentrated prevalently in Alessandria to provide charging zones afterwards.
This flow imbalance is an Italian peculiarity, while in other countries (like in Germany) charge and discharge zones coincide.

4 A new cargo unit for vehicles

Some cargo unit prototypes, specific for vehicles, already exist, with the aim to obtain the same advantages brought by the introduction of container in other transport fields [2].

- In the USA, *Thrall Car* designed and realised an innovative wagon, *Universalcar*; it is a double deck articulated vehicle, which can hold any type of car. It is also compatible with all others types of double deck wagons, very diffused in North America.
- In 1998, American company Kar - *Trainer Internacional Inc.* produced 3000 special containers for single vehicles, 200 for 2 vehicles and 600 with portable ramp; with the first ones the Company forecasts a traffic volume of 60.000 cars/year on the course Germany - South Africa. The 2 vehicles model is utilised on the route West Coast- Hawaii.
- Another American company, VTI (*Vehicle Transport Inc.*), projected the VTAR (Vehicles Transport Adaptable Rack). It consists in a welded rail and rack set which makes a container fit for one car transport. The system aims of maximising the container capacity and optimising the operation time (five minutes per car)

In some cases it is advantageous to transport cars in a standard container; in fact, liner *car carrier* services do not cover all possible destination of vehicles sale market. Moreover some conjuncture might make the price of a slot container very favourable.
Recently a new cargo unit has been developed: a complete ISO container which is collapsible. It has two cargo decks and space for 6 vehicles, and five folded containers can be carried on a single ISO 40" module for a cheep empty returns. Standard containerised operations are possible: handling with cranes, stacking up, transport by containership, container rail wagon and truck.

5 Economic analysis

That market is characterised by a strong utilisation of dedicated means of transport and a high incidence of empty returns. The containerisation could lead to a scale economy advantages due to the enormous vehicles traffic volumes moved worldwide. Among the maritime traffics, the containerised sector is just the one that presents the most dynamic growth, with a project trend toward bigger and bigger ships.
World fleet is composed of 6.823 units [3], for total 5.878 TEU; cellular ships form 40% of fleet (corresponding to 73% of global capacity). Over 4.500 TEU sector grew of 52.2%, and is expected that 16,9% of fleet will be constituted by Post-Panamax units in 2002.
Surveys made by Drewry Shipping Consultant state that slots specific cost on a 6.000 TEU Post Panamax is lower by 20% than those of a 4.000 TEU unit. Also the prices of those ships have decreased by 25-30% in the last three years. Furthermore, over 10.000 TEU containerships are theoretically feasible [4]. All these factors could bring to a further decrease of prices in the future.
Italian containerised vehicles traffic could benefit from the growth of Gioia Tauro hub port and the intermodal traffic development. For example, freight from Far East to North Italy takes 14 days (12 days by sea and 2 by rail); by transhipment (deep sea vessel from Far East to Gioia Tauro and feeder to Genoa, then by road) takes 3,5 days more with a higher price.
That technology could bring to utilisation of container trucks rather than of current car transporters. A direct comparison between those two modes is not very easy, because the costs depend on length trips, volumes moved and on possibility to exploit empty returns too. Nevertheless suitability of that technology is supposable by a re-organization of this transport field.
If the transport by rail wagons in Italy is certainly compatible with the weight limits of rail network, there are some problems with the gauge; those problems are solvable if the rail network presents PC 45 code at least. The advantages are maximised utilising the 3 TEU railwagons (named Sgns in Italy).
Traditional double deck wagons hold a higher number of vehicles, but on short-medium distance the containerised transport can result more convenient; at the moment researches about that are being developed.
As regards maritime mode, several voices form the transport cost:

a. the freight, that is the ship owner hire price for one cargo unit journey
b. the *terminal handling charges* (THC), including discharge, move on dock and charging on other forwarder (or transhipment transfer)

Economic comparison with *ro-ro* techniques highlight the suitability of containerisation. Besides lower costs, dock *lo-lo* moves are faster than *ro-ro* ones; that means a lower specific cost and a higher staff productivity.
Transhipment of vehicles on *ro-ro* vessel can be a logistic nightmare, not for cars containerisation. Transhipment is a part of any normal container operation, and for new shipment technologies too. If it is one container consignment or 100, any container port can handle it.
For a country like Italy, where most ports are based in historic areas, closed between sea and city, it is plain that finding wide zones for vehicles storage is not easy at all. Present storing mode needs 10 m2 per car, but containerisation can reduce that quota due to the possibility of stacking up the vehicles, with a more efficient exploitation of the harbour areas.
Fig. 7 shows comparison between the space needed by traditional mode and containerisation

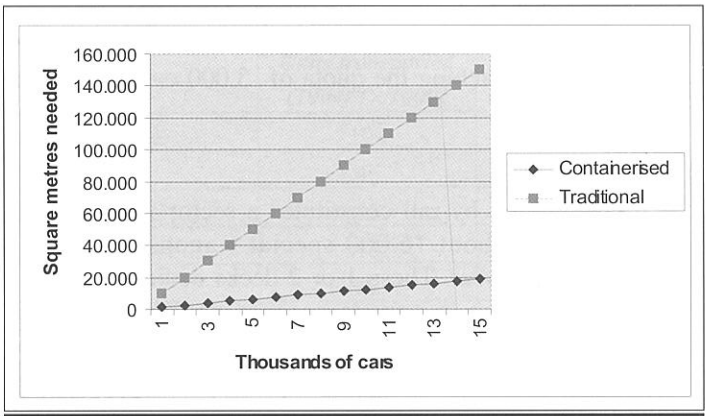

Figure 7 - Comparison of space needed for storing cars

6 Handling damage reduction

Each time an automobile is moved from one transport mode or location to another, it risks damaging. This is prevalently due to the high number of manual operations needed (bad manoeuvring on the vessel decks, collisions during alignment, bodywork creeping on the ramps) and to vandalic acts during the long stop periods on the docks. It is estimated that a five-fold damage reduction in interchanges can be achieved when shipping vehicles by the described new technology. Once loaded in the container, no further car movement is needed. This brings the proven benefits of containerisation of very low cargo damage.

It is possible to assign a single damage probability to each move along the entire supply chain; considering that producer staff minds much more to moving their cars, first phase (from producer storage area to first forwarder) has a probability damage of p, while each other moving have a probability $q > p$. Traditional technique requires 7 charge/discharge operations at least, as shown in Fig. 8 (where the whole supply chain is schematised). That means a total damage probability of $p + 6q$.

By containerisation, cars suffer only one charge move (on producer storage area) and one discharge move (to dealer); that leads to a total damage probability of $p + q$.

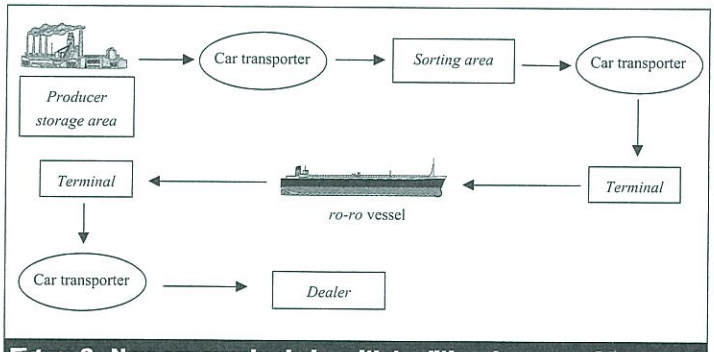

Figure 8 - New car supply chain, with traditional means of transport

7 Conclusions

A new technology for vehicles containerised transport has been presented in this paper; with that cargo unit it is possible to limit the inefficiencies which characterise this field at present, especially in order to reduce storage areas required and empty returns.

Technical comparison between conventional transport (based on *ro-ro* vessels, car transporters and double deck rail wagons) and innovative containerised transport highlighted the convenience of new technology prevalently for maritime mode and intermodality ship-rail.

For this reason a start-up phase is supposable, introducing containerisation on long distance combined transports ship-rail, peculiarity of trades between Europe and Far East; successively, basing on increasing scale economy, diffusion of that innovation will be utilised on the other transport modes too.

Authors state that this technology could be very interesting especially for ship owners who handle containerised traffics, railways companies and intermodal operators. Also ecologist groups and organs of government are involved in these questions, since they are in charge of environmental policies.

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