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A LOGISTICS PATTERN FOR FRUIT AND VEGETABLE TRANSPORTATION FROM ISLAND REGION: THE CASE OF SICILY

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ABSTRACT

The globalization of markets regards many sectors in the E.U. and among them also the fruit and vegetable in the face of growing and increasingly intense competition exerted by the products of countries with emerging economies. But, at the same time, the globalization can also lead to the opening of new potential markets for the products, when and where the transport system, more than other things, appears to be efficient and effective and makes possible to reach the target markets in the shortest time possible and at the lowest possible cost. It is therefore very useful to create a model that takes into account the peculiarities of the different modes of transport between the different origins/destinations and that allows a comparison in real-time, in terms of cost and time (eventually by the use of different ICT systems of easy access) for the evaluation of different alternatives of travel. These technologies, by promoting the *grouping* of goods, allow facilitating the formation of the load and, in the same way, of sorting the incoming as well as to make more efficient the total journey by helping to speed up the operations of embarking or of disembarking in the case of transportation combined "road-sea" type ro-ro. The proposed model, establishing an effective basis of information for trucks drivers, allows the development of alternative cheaper transports, before neglected because less rapid; as in the same time it may also allow to simulate the benefits of new actions on the supply of transport system (activation of new lines, reduction the time of boarding or of ferrying, etc.).

Keywords: logistic, fruit and vegetable transport, combined transport road-sea.

INTRODUCTION

In the transport of goods, it is not always easy to find the best modality to use on the base of the cost and the distance. This is particularly true when the modality is related to multiple factors of interest for the time and the cost, which become fundamental in the case of goods that are highly perishable the and of low intrinsic value.

In this context, it is very important the role of supply chain of transport structures to realize the *grouping* or the sorting of goods (as logistic platforms, freight terminals, etc.).

By the use of ICT systems, it is possible to conform the demand to the supply of transport, taking in due account the different possibility of modal choices and of itineraries, even through the choice of the value of some level of service, obviously dependent by time and cost.

It is very useful to realize, for this purpose, an IT platform and software easy to use, able to provide to trucks drivers, in dependence of the origin and destination of the cargo, the best modal alternative in terms of time and cost. So, it becomes possible to compare the different solutions of travel between the "all-road" (taking into account of the time wasters and of the rest periods required by law) with the different alternatives of combined transport "road-sea", taking into account of the different lines departing from the considered ports.

Then, through the adoption of specific measures identified, defined as "pilot projects", it is possible to minimize bottlenecks. Those are, for example, all the current critical issues in the system that slow down the total transport time, especially in the case of combined road-sea (type ro-ro).

In this case, the waste of time (especially in the loading and unloading actions) is very determinant in the choice of transport typology, especially in relation to the need not only to reach the destination as soon as possible, but within a prefixed time, otherwise there is the possibility to reach the markets over maximum time.

LOGISTICS OF PRODUCTS AND SYSTEMS ICT

For fruit and vegetable production, characterized by a short biological-life, the issue of logistics is yet more important because it is necessary to coordinate the timing of distribution with the biological characteristics in order to maintain the quality of these products.

The logistics becomes, therefore, one of the main factors that influence the competitiveness of enterprises, because, between the various factors that make up it, the transport is that of greater relevance for being the most significant part of the total logistics costs.

In this framework, it is of fundamental importance the use of support systems of logistics such as ICT. The purpose of which is the probability of interfacing the various players in the industry of fruit and vegetable, particularly the companies of manufacturing and those of transport, realizing the *grouping* of the goods at the departure. That allows the formation and consolidation of the load, while enhancing the distribution of incoming ones, in order to rationalize and optimize the logistics chain.

For this purpose it is need to provide a system of the type "multi-step" which unlike the system "single-step", it appears to be more efficient and with lower global costs of transport.

The system "single step" is characterized by the presence of a number of receiving points of the loads, constituted by various producers, which the carrier must reach for fill gradually the capacity of the truck and, after, make the next direct transport to the final receiving point (market of destination).

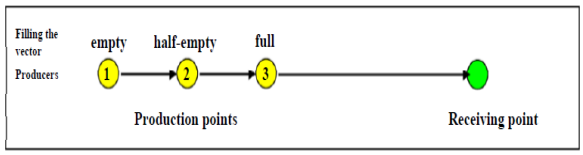


Figure-1. System “single step”.

The second scheme, called "multi-step", requires the use of a logistics facility for cargo consolidation and the subsequent transport to a receiving point from where, after, can take place the deconsolidation of the cargo for distribution.

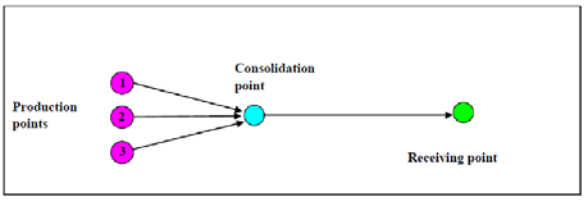


Figure-2. System “multi-step”.

In both schemes considered, the final receiving point can then become the point of division of goods to the points of final distribution of the products.

To this end, in addition to the known systems of tracking and tracing of goods, aimed at providing information to the customer, it is also useful to develop a decision support system for truck drivers, that allows to them to identify the strategy more affordable of travel in terms of cost.

This strategy must be also compatible with the requirements of the time available, including the use of types of intermodal transport as an alternative to the transport “only-road”, by means of the knowledge, pre-departure and in real-time, of the origins/destinations of the cargo ships and of the comparison of their times and costs [1, 2].

Only-road path with eventual ferry

The total cost of transport can then be determined using the aggregation of costs and prices elementary, which characterize the different modes of transport, relative to standard vector data (i.e. articulated by 16.5 meters).

The cost of transport mode "only road" from the region island of production (for example Sicily) to the destinations considered for the marketing of products is equal to:

$$C_{TS}^{O/D} = C_{pe} + C_{pn} + C_{mr} + C_{ts}$$

Defined:

$C_{TS}^{O/D}$ = Total cost of given relation O/D - street mode
C_{pe} = tolls cost
C_{pn} = tires cost
C_{mr} = Maintenance and repair cost
C_{ts} = Minimum cost of the ferry between the island region of production and the system of access roads to markets

As for the calculation of the time needed to conduct the entire trip, including the origin and destination of the same, the total journey time will be equal to:

$$T_{TS}^{O/D} = T_{vn} + T_{r45} + T_{ts} + T_{is} + T_{r8}$$

Defined:

$T_{TS}^{O/D}$ = Total travel time for a given relation O/D – street mode.
T_{vn} = travel time net.
T_{r45} = break time of 45 ' every 4.5 h.
T_{r8} = daily rest time equal to 8h in 24h.
T_{ts} = minimum time of the ferry between the island region of production and the system of access roads to markets.
T_{is} = eventual delay time for embarkation and disembarkation.

Where, in the calculation of the time between the point of consolidation at origin (O) and the target market (D), for the transport "*only-road*", are also taken into account, the eventual time required to ferry and related to delay times for the embarkation and disembarkation (for example from Sicily).

While, obviously, this model does not take into account possible delays due to exceptional events such as the possible congestion of the traffic or the presence of any temporary construction site along the motorway network that slow down the normal flow of vehicles. Therefore, their considered values are as “optimistic” about the real total time of travel. However, for this last purpose, the model could take into account of the vehicular delay’s costs due to intersections along the road and, yet, of the environmental costs due to pollutant emissions [3, 4, 5, 6, 7].

Combined path road-sea

The costs and times of the combined path "road - sea" must take account also of the total amount supported on the road and determined by the methodology explained in the previous section. Of course, they are relative only to the sections of road traveled from the origin to the port of embarkation and from the port of landing to the final destination, plus the cost of transit on Ro-Ro vessels.

The total cost, for the combined mode "sea-road", is equal to the cost of the journey by road from the origin O to the port of embarkation I (O/I), the cost of the ferry

for the carrier between the port of embarkation and landing and the cost from the port of landing at the destination:

$C_{TC}^{O/D} = C_{TS}^{O/I} + P_{16,5}^{I/S} + C_{TS}^{S/D}$

Defined:

$C_{TC}^{O/D}$ = Total cost for given relation O/D – mode combined "sea road".

$C_{TS}^{O/I}$ = Total cost from the origin to the port of embarkation - street mode.

$C_{TS}^{S/D}$ = Total cost from the port of landing at the destination - street mode.

$P_{16,5}^{I/S}$ = Price in Euro for delivery of a lorry standard 16.5 meters long, between the ports of embarkation and disembarkation.

Similarly, the total time on the combined "sea-road" is equal to:

$T_{TC}^{O/D} = T_{TS}^{O/I} + T_{TS}^{S/D} + T_{ts} + T_{is}$

Defined:

$T_{TS}^{O/I}$ = Total travel time from the origin to the port of embarkation - street mode.

$T_{TS}^{S/D}$ = Total time from the port of landing at the destination - street mode.

T_{ts} = time on ro-ro ferry

T_{is} = delay embarkation / disembarkation

Comparison of costs of "only-road" - including eventual ferry - and of combined "road-sea"

The main factors that determine the competitiveness of combined transport are obviously either of a technological nature either of organization and management. The correlation between the cost and time according to the different modes of transport is represented in the following graph where we consider the costs of terminal K_t lower for transport with the handling of "ro-ro" type than those of the type lo-lo at a cost of transport by sea similar. Thus, in this case, the generalized cost for unit of distance on the sea is less in the case of "ro-ro" with respect to the lo-lo [8].

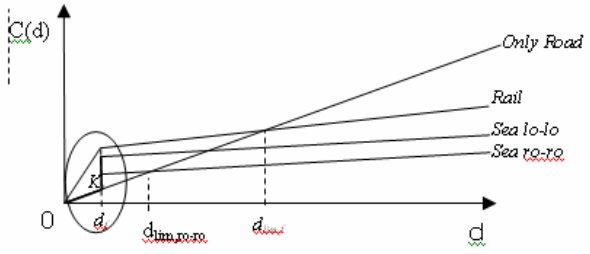


Figure-3. Performance cost / distance for the combined road / sea.

The $d_{lim,ro-ro}$ is the distance beyond which the path "only-road" no longer is cost-effective in terms of cost, compared to the combined road-sea-type ro-ro.

Similarly, the $d_{lim,f}$ is the distance beyond which the transport "only-road" is not cheaper than rail.

The pattern proposed is then a choice algorithm of minimum travel cost expressed by: min $C_{TK}^{O/D}$ where the mode K equals C or S alternatively.

Obviously, the transportation costs are also function of the organizations of the railway's nodes [9] and many other design and management parameters. However, the generalized cost per km is always greater than the combined road-sea.

A CASE STUDY: THE PRODUCTION SYSTEM AND PROPOSED STRATEGIES FOR THE MARKETING OF FRUIT AND VEGETABLE PRODUCTS FROM SICILY

The system of production and marketing of Sicilian fruit and vegetables

The fruit and vegetable sector in Sicily contributes significantly to the production of wealth of the entire Sicilian regional agriculture (47.7%) and in the same time plays a strategic role in terms of employment and earnings for employees engaged not only in the production phase, but also, in many induced activities.

This importance, however, is in stark contrast to a structural and commercial framework characterized by evident deficiencies that affect the competitive potential of regional companies of fruit and vegetable both in domestic and foreign markets. We must add to those difficulties the problems due to the insularity and, especially, to the not always adequate infrastructural facilities.

The profound changes undergone by whole sector of fruit and vegetable at regional and national levels, have certainly contributed to the recognition of the strategic role carried out by the Logistics.

This is true especially with the intensification of the process of liberalization of international trade with the progressive globalization of the consumers and with the increasing assertion of retail within the channels of distribution of the marketed products.

Table-1. Percentage distribution of the main typologies of products in the Sicilian Provinces.

PERCENTAGE FOR THE PROVINCE OF REGIONAL PRODUCTION				
	CITRUS FRUIT	FRUIT FRESH	FRUIT DRY	LEGUMES AND VEGETABLES
TRAPANI	1,6	0,5	0	6,6
PALERMO	8,9	5,9	3,9	16,5
MESSINA	12,3	4,3	19,4	4,8
AGRIGENTO	4,8	23,8	21,1	17,5
CALTANISSETTA	0,5	15,4	12,2	20,9
ENNA	6,5	2,1	20,2	1
CATANIA	35,2	21,2	10,8	5,2
RAGUSA	5,1	17,9	4,3	11,3
SIRACUSA	25,1	8,9	8,1	16,2
TOTALE	100	100	100	100

For the competitiveness of the agro-food system and in particular for fruit and vegetable products, characterized by a reduced biological-life, it would be very important, to coordinate the biological timing with the distribution.

This in order to ensure the maintenance of quality of the product until its final destination, and to reduce the direct costs of transport, which strongly affect the final price of the product; and, then, for minimizing total costs.

The system of the Sicilian fruit and vegetables, is today one of the most significant sectors of regional agriculture both in terms of entity of production both as economic and social source. However, at the same time, expresses the limits of structural, organizational and commercial features, both for manufacturing and for practices of transport that, in addition to the known problems of infrastructure in the region contribute to curb the growth of the sector [10, 11, 12].

Table-2.

Allocation of land for fruit and vegetables in the Sicilian provinces - Values in hectares * (average 2006-08)

	Vegetables	Fruits	Total
Trapani	6.257,30	1.804,67	8.061,97
	6,6%	0,8%	2,6%
Palermo	15.553,29	14.005,67	29.558,96
	16,5%	6,6%	9,6%
Messina	4.546,87	27.007,67	31.554,54
	4,8%	12,7%	10,3%
Agrigento	16.450,75	30.567,33	47.018,08
	17,5%	14,4%	15,3%
Caltanissetta	19.647,70	16.332,33	35.980,03
	20,9%	7,7%	11,7%
Enna	914,57	20.803,33	21.717,90
	1,0%	9,8%	7,1%
Catania	4.923,27	51.521,67	56.444,94
	5,2%	24,2%	18,4%
Ragusa	10.679,00	16.670,00	27.349,00
	11,3%	7,8%	8,9%
Siracusa	15.169,54	33.959,33	49.128,87
	16,1%	16,0%	16,0%
SICILIA	94.142,29	212.672,00	306.814,29
	100,0%	100,0%	100,0%

* Note: The percentages are about total regional product

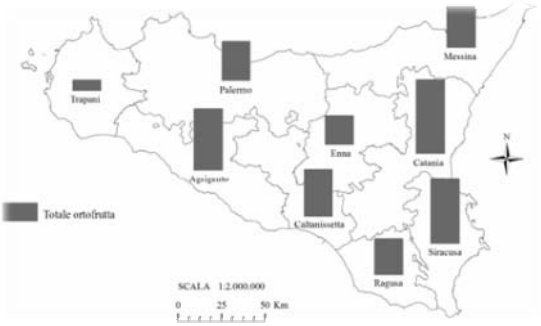


Figure-4. Allocation of land for fruit and vegetables in The sicilian provinces.

By analyzing the productive potential of the various Sicilian provinces, with reference to the following four groupings of categories (citrus, fresh fruit, dried fruit and legume), it is noted as the provinces of Catania, Siracusa and Ragusa are interested by a large part of Sicilian citrus production.

The above provinces have a prominent role also in reference to other productions of fresh fruit, nuts and legumes, and vegetables, as indeed is in evidence from the analysis of the cultivated areas for fruit and vegetable of the single provinces.

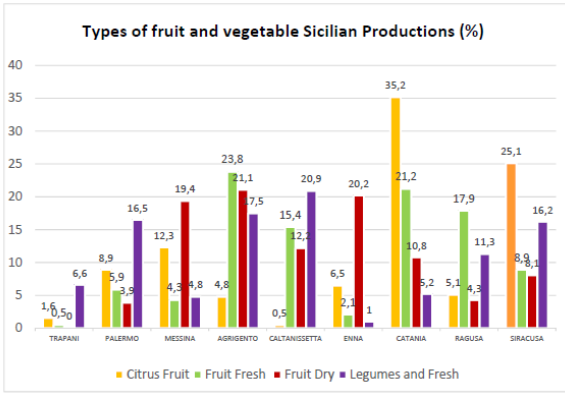
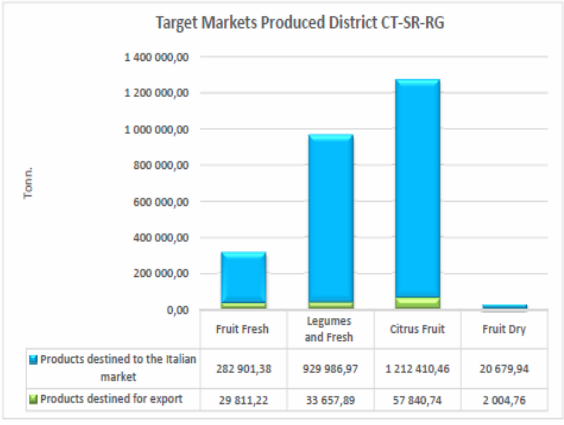


Figure-5. Types of fruit and vegetable Sicilian Productions (%).

With reference to the manufacturing district composed of the provinces of Catania, Siracusa and Ragusa, which constitute the bulk of the regional production, we have the following volumes in output for the national markets and for foreign markets; there is an evident preponderance of the former than the latter.

The quantities of fruit and vegetables Sicilian forwarded to these foreign markets (expressed in tons. as the average of the years 2006-2008) according to recent studies, manifest a strong commercial ties especially with some European countries, such as Germany, France, Austria, Switzerland and the United Kingdom.

Table-3. Target Markes Produced by District CT-SR-RG.



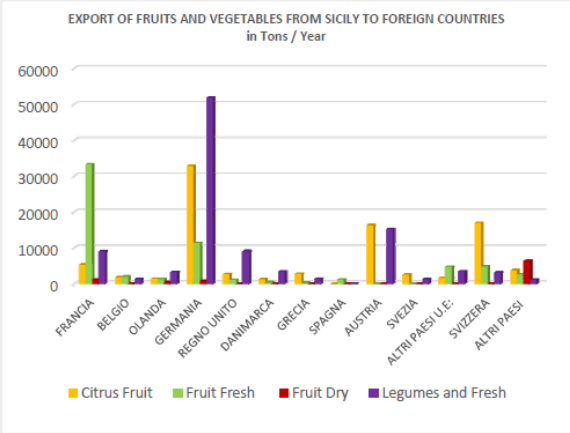


Figure-6. Export of fruits and vegetables from Sicily to foreign countries in tons / year.

As far as the main Italian markets taken as a reference, divided in three main geographical areas, intense exchanges of freight traffic to the north of Italy are detected, while a good part of productions is intended for the market of southern Italy.

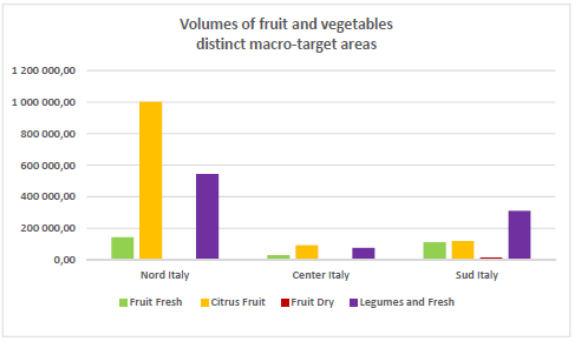


Figure-7. Volumes of fruit and vegetables for distinct macro-target areas.

Known the productive and commercial realities of Sicilian fruit and vegetable sector and known the main target markets for products, national and international, it is more than ever necessary to identify those policies and those transport infrastructures aimed at the optimization of existing resources and, then, to enable their use as effectively and efficiently as possible.

In this case, for the export of highly perishable goods such as fruit and vegetables, the transport systems that are most widely used, and that lend themselves to the use, appear to be the "only-road" or the combined "road-sea" type ro-ro. The other types of transport require in fact, for such use, a series of infrastructural facilities that do not yet exist in Sicily.

To aim at these objectives, taking account of the framework of the regional context of the productive sector, target markets and different modes of transport, we have developed a modeling system, designed to allow users a constant control in real time of the various alternatives possible according to their origin and their destination.

The pattern makes a specific comparative analysis of transport between the two main alternatives for this type of goods: that intermodal "road-sea" with the use of ro-ro ships, and the "only-road" in order to allow for each case identifying the best opportunities to reduce travel times and overall costs of transport.

In this sense we have developed the following applicative software, able to provide, in dependence of the origin and destination of the cargo, the best possible alternative in terms of time and cost by comparing the different possible solutions of travel, taking into account of the road's network and of the various lines departing from the different Sicilian ports. For each of those alternatives it is possible to prepare, therefore, the modal matrices of times and cost to the prevailing destinations of national or international markets, implementing thus an incremental database for the application software; the simulation scheme is reported schematically below:

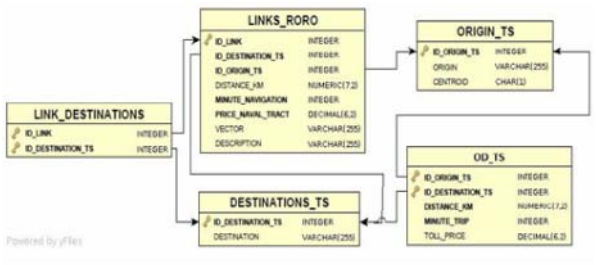


Figure-8. Scheme of applicative software.

For the purposes of achieving the target markets, the information system will be able to realize the correlation between all available information relating to the supply of transport in terms of time and costs in relation to the opportunity to travel with the "only-road" or with combined "sea-road". Obviously, the database contains the information about the times and costs for each relationship "Origin-Destination" assessed as significant. Through the comparison of the different alternatives, in fact, the system can identify the alternative that produces the condition min $C_{TC}^{O/D}$ (minimum total cost of travel for given O/D) or to lower cost of travel between the generic origin and the generic destination among those considered in the simulation, (performance evaluation of the system).

The system will assume that also it serves as a tool to aid decision-making for the trucking companies with the aim of achieving cost optimization and of improving the entire chain of production and distribution.

The ICT systems, in addition to be able to allow the realization of the *grouping* of goods at the consolidation platforms of the load, may be employed for the creation of special tools to facilitate for example the loading and unloading in the ports, avoiding the wasters that affect the combined "road-sea" [13, 14, 15, 16].

The operating logic of confrontation between the two main alternatives "all-road" and "road-sea", can be represented in the following block diagram [17].

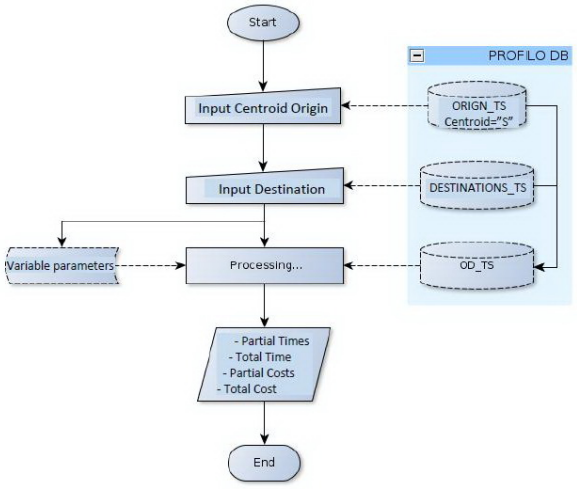


Figure-9. Flow-chart for path "Only Road".

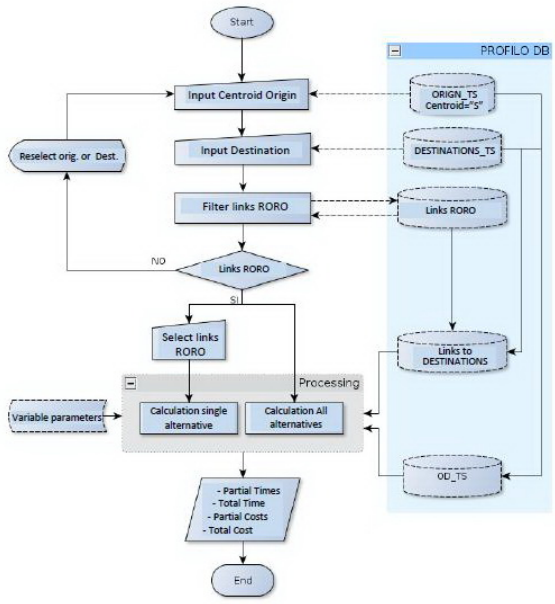


Figure-10. Flow-chart for path "Combined road-sea".

This objective could be achieved through the equipping of vehicles with appropriate badge to facilitate the operations of access to the embarkation ports, with barriers of access to dedicated lanes, thus constituting a "fast line" for road transport using the combined mode "road-sea."

In order to encourage this type of transport, we may provide specific measures, such as incentives for manufacturers, with lower costs or more services for the transport of their goods, to those companies, which make use of intermodal systems or of pre-arranged transport.

We can consider other actions of regulatory measures considering any waiting time for embarkation and time not devoted to driving on the ferry as a "rest time" or "breaks from driving": and any other specific measures to incentive the use of transport by sea .

CONCLUSIONS

The research on the offer of transport and optimization of loads and cargo handling of the fruit and vegetable sector has addressed the issue of identification of pilot projects that contribute synergistically to overcome the difficulties.

Acquired, therefore, the importance of the search for alternative solutions to those practiced today and oriented towards the rationalization of the supply chain; in order to this finality we have also implemented a software application able to facilitate and streamline the relationship between supply and demand on the system of freight transport, referring to the case study of Sicily.

From these considerations, and given the characteristics of the geographical location of Sicily, we have estimated that the reduction of transport costs inevitably passes through the development of intermodal services and a better utilization of the ro-ro ships.

Are been thus, identified all the essential elements for the preparation of a supply model of the transport system limited to those modal alternatives today significantly practicable consisting essentially in the "only-road" or "combined "road-sea."

For each of these modal alternatives was therefore prepared the matrix of times and costs to the prevailing destinations of national markets, those matrices may constitute an incremental "data-base" for the developed applicative software.

In this context, also, we expect to be appropriate the use of telematics systems dedicated to truck drivers, for example, through the allocation of appropriate devices such as "badge-pass" to facilitate access operations to the pier.

Additional facilities concern, finally, the composition of the loads at the consolidation platforms (*grouping*) with the use of adequate infrastructure and equipment [18, 19, 20].

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