C O R E Metadata, Provided by Research Papers in

TOWARDS THE ADOPTION OF TECHNOLOGICAL INNOVATIONS: DECISION PROCESSES IN TRANSPORT POLICY DEFINITION

Giovanni Circella, *Dept. of Roads and Transportation, Politecnico di Bari*, Bari, Italy

Keywords: Decision processes, transport policies, innovation, environment, local development.

Abstract

The widespread of technological innovations is rapidly changing the way modern societies are organized. Such phenomenon highly affects the economies of most developed countries (and, more recently, of developing countries, too), influencing work organization and habits. Besides, technological innovations modify the way in which transport systems are organized, by introducing new transport solutions as well as by upgrading the performances of the existing transport systems, in accordance to a more efficient organization. Several tools have been designed to predict the effects of the adoption of technological innovations in transport. The aim of this paper is to deal with the decision processes involved in the definition of the transport policies for the introduction of such technological solutions. To do this the way in which the new transport solutions affect the local context is analyzed. In particular, this work aim to identify the most relevant attributes which influence the decision processes on the adoption of such technological solutions, with reference to their impact on the territory and on the economic activities. To do this, the analysis focuses on the effects involved by the use of wireless technologies and radio frequency identification into seaport infrastructures. Such technologies enable an easier identification of goods in transport terminals; this implies advantages in the organization of the terminal activities, allowing lower time and costs for handling, and at the same time it ensures a greater compliance to security requirements, thus upgrading the level of the performances in these transport systems. On the other hand, the effects of the improvements in transport systems affect the economic context in which transport infrastructures are set. Thus, the adoption of such a technological innovation can represent the chance for local development of the region, due to the better performances of the transport system and to the consequent increased territorial accessibility.

1. INTRODUCTION

Maritime transport nowadays conveys a very relevant part of all freight transport over the world, representing one of the fundamental elements in good distribution chains of most part of the commercial products we are used to managing. Thus, seaports and maritime transport infrastructures plays an extremely important role in the organization of the economic life all over the globe.

However, the organization of the seaports and the levels of service of such infrastructures are still rather heterogeneous in different countries, presenting

large gaps between the excellence of the most active *hubs* and the obsolete features of many secondary harbours.

Freight transport and good distribution have been a fundamental component of the contemporary changes of modern economics. They supported the development of the economies of the most developed countries, allowing their products to reach the final customers in the tight time required by the market laws.

The evolution of freight transport, influenced by the objectives of efficiency and reliability of transport services, has gradually leaded to more organized transport systems, in which the traditional origin-destination trips are conveyed by the operators through main transport nodes, selected for their higher levels of service. Thus, transport activities become specialized activities, which are not independent from production phases and are recognizable as an internal part of an integrated demand.

Implemented management systems confer the needed flexibility to transport activities in such complex organizations. The efforts to extend distribution chains to reach every country of the world in the shortest available time are leading processes of automatism and standardization of the operations in seaports, dry ports and other transport terminals. Containers represent nowadays the most common way to carry goods in every distribution chain. The need for fast speed transport services and lower costs are pushing operators to operate into the biggest hubs, enriched in automatisms, where goods are handled in very short time with reliable results. The physical displacement of goods is committed to fast container ships, which operate regular links between the hubs and with the smaller feeder nodes.

Information Technologies play a relevant role in the management of these transport infrastructures; they allow reducing travel costs due to the optimization of the use of existing infrastructures, improving reliability and cutting transshipment and handling times. Technological innovations are deeply affecting the organization of transport, affecting the use of transport systems in many fields (Choo *et al.*, 2005) as well as improving the capacity of the existent infrastructures (Stough and Rietveld, 1997). The application of ICT solutions to freight distribution systems permits indeed to confer higher dynamism to these systems, conferring the needed flexibility, particularly important in capturing the market demand. (Hesse, 2002; Hesse and Rodrigue, 2004). The best performances in such processes are reached where the greatest efforts in optimizing processes were carried out, e.g. in Singapore (Airries, 2001) and in Honk Kong (Lai *et al.*, 2004).

Today ICT offers several ways to support the evolution of these systems. Intelligent technologies aimed at identifying goods in transport networks and logistics are able to attain high traceability levels, even concerning single items within complex containers. This is aimed at better supporting the management of movements and accountancy of the highly granularity and responsibility of complex supply chains. Integrated systems for good identification and traceability allow increasing the transport terminal capacity. From the operators' viewpoint, they can allow saving money and time, through an increase of the efficiency and of the reliability of transport services.

Radio Frequency Identification (RFID) systems allow a contact-less identification of goods. Such systems, applied in many logistic chains, to upgrade the performances in many production plants (Luckett, 2004), can be adopted into transport system management to improve the system capacity, conferring a grater efficiency and reliability to the operations to transport terminals.

EU policies for trans European Network ask for an increase in the potential of maritime transport. This objective meets the national actions promoted by several countries to pursue the development of maritime transport for a modal rebalance of freight transport. Such interventions are seen as a possible meeting point between economic interests and environmental concerns on the level of sustainability of transport systems (Button and Nijkamp, 1997; Greene and Wegener, 1997). Investments in seaports and maritime transport can create better commercial and transport links, increasing the accessibility of the involved areas, while contributing to readjust the freight modal split and to pursue the intermodality of freight transport.

This paper presents an analysis on the possible interventions for improving the capacity and support the development of the seaport of Bari (South Italy). The objectives of development of the commercial seaports are evaluated with reference to the peculiarities of an *urban port*. Possible scenarios for upgrading the current infrastructure are built, considering possible alternatives for a physical expansion of the infrastructure as well as for the adoption of enabling technologies for good identification.

2. DECISION PROCESSES AND INFRASTRUCTURES

It is not easy to define whether an infrastructure project is worth realization or not, as well as which should be the main features of such a new plant. Transport infrastructures nowadays require great financial investments, which often constitute the first obstacle for their realization. The relevant amount of the required investments entails that, in current times of financial restrictions of national governments, they cannot be always supported only by public interventions. Public authorities are called to face the mobility and transport needs arising from the society, to support the economic growth of the area. At the same time, they should succeed in the provision of acceptable solutions, without exceeding the financial restrictions for public actions, while facing the environmental concerns that every intervention on the territory involves.

Many times, the financial strains of public authorities are bypassed by involving in the infrastructure project and building tasks private companies (Ping *et al.*, 1999). Private companies are directly involved, contributing in the realization of the infrastructures, obtaining a profitable payback through the future management of the infrastructures. Such way of actions can provide fruitful results when a positive agreement between public objectives and private interests is found (May *et al.*, 2000).

The use of techniques like project financing is not always possible in the definition of development strategies for maritime transport nodes and seaports. In fact, only few big maritime operators and shipping companies are interested in the development of their own seaport infrastructures and

terminals directly to manage their own business and trading. Minor operators and independent agents often prefer to operate on existing seaports, in order to cut their budget and to spare on direct operative costs. Thus, they usually set their activities in existing terminals and seaports, selecting the best locations for their business in dependence of the specific features of the existing infrastructures.

Due to the relevant financial investments required in the upgrading of maritime transport infrastructures, when not supported by the convenience of private investments, local authorities are usually assisted by national or international funds for the development of seaport strategies and upgrading.

In European countries, EU policies to support investments in transport field look at maritime transport as a strategic sector to finance. This is related to the need of higher standards for security and safety in freight transport. Moreover, it is based on the increasing environmental concerns, which claim strong actions to rebalance the modal split in transportation (European Commission, 2001). The realization of the Trans European Network and of the "Highways of the Sea" (EU Decision, 1996) implies enormous investments to upgrade the existing infrastructures and seaports, and open new challenges for the realization of new terminals. Financial aids for the realization of such works are usually ensured by the national governments. In the Italian context, which this paper refers to, the implementation of Seaport infrastructures and the optimization of maritime transport activities in deeply encouraged by the actions undertaken by the Ministry of Infrastructures and Transportation. Anyway, in all these cases, limited resources are available for financing all the possible actions and projects. A selection between different projects is consequently required. This task requires a particular attention. It implies the deep analysis of the project features, to be valued in terms of the outstanding priorities pointed out by the funding authorities, in accordance to their specific requirements in terms of effects on the economy, on the society and on the environment.

Several methods have been developed for the judgment of the possible actions to undertake in transport planning. Most part of them is based on the use of evaluation methodologies. They can be extremely useful in the selection of the actions and policies to pursue.

Several evaluation methods are nowadays available; they can be divided into several main groups, depending on the number of alternatives they can take into consideration and the criteria they use in the valuation of the alternatives (Korhonen et al., 1993). A very rich literature is available on the available tools of evaluation methodologies (Nijkamp *et al.*, 1990). Some of these approaches admit the use of fuzzy measures for the evaluation of the alternatives and some other do not do it (Munda, 1995). Such methods cannot define the optimum for a specific problem of planning; but they are useful in generating an order of preferences between the available alternatives, with the related argumentation to support it, for the selection of the actions, policies and interventions to adopt.

Moreover, the selection between different alternatives in planning can be carried out with the use of Mathematical programming models, too. This kind of models, such as Multi-Attitude Decision Making, Multi-Attribute Utility

theory, etc., can be usefully applied in decision making for the evaluation of different projects, considering multiple objectives. The main limitation to the use of such methods is given by the difficulty in defining crisp input data to obtain meaningful results. For the reason, such approaches are not very often used in the selection for interventions in transport fields, in which usually a high level of uncertainty is associated to the available alternatives.

The objectives of environmental sustainability can be pursued in the selection of transport projects through the use of specific criteria in evaluation methods. Moreover, policy and project selection can be carried out through processes of scenario building, which aims at defining the future development of the transport system by joining the selected key elements to form the desired structure of the future system (Shiftan *et al.*, 2003). On the other hand, to introduce mechanisms of compensation between the different objectives, compensatory models have been applied for the selection of policies and projects. They allow evaluating the compensatory effects of the projects with reference to the different objectives, allowing tradeoffs between the different objective values. Also for this kind of methods, the use of fuzzy set theory has been proposed (Avineri et al., 2000).

3. EVALUATION PROCESSES IN TRANSPORT PLANNING

In this paper, the future implementation of a commercial seaport is discussed through the analysis of alternative development scenarios involving different technological solutions. The attention is here focused on the seaport of Bari, in the South of Italy. The alternative scenarios are built with reference to the need of the seaport to upgrade its features, in order to host new transport activities and regular shipping activities. The proposed scenarios are analyzed with reference to the objectives of optimizing the interaction of the seaport with the adjacent urban area.

For its location inside the urban area, the seaport of Bari can be referred to as an *urban port*. This port is set on the seacoast directly in front of the city, not far from the historical center. The current location of the seaport is contingent to the original one, since the modern commercial seaport grew up as an expansion of the old seaport, which had represented for a long time a source of economical growth with its trade activities for the whole commercial city of Bari.

The urban location of the seaport of Bari creates several difficulties to the management of the activities carried out in the seaport. In particular, terrestrial connection of the infrastructure to the road and railroad network looks hard to be upgrade. The interaction of the transport flows to/from the seaport worsen the conditions of congestion of the city road network. Further limitations to the physical expansion of the existing seaport are due to the location of the seaport inside the urban area.

In such a situation, the need for an increase of the capacity of the existing seaport is not of easy solution. Every action on the seaport implies relevant effects on the near city. At the same time, the paucity of available areas outside the existing seaport areas do not allow direct expansions of the port area to realize new structures and plants.

In order to analyze the complex interrelations between the seaport and the near urban area, in case of an implementation of the features of the existent seaport, a multicriteria methodology of evaluation is in this work applied. Multicriteria methodologies are commonly applied in research and evaluation studies. They allow evaluating the effects of alternative projects, in dependence of several different criteria and indexes, also when they cannot be expressed in terms of economic or monetary value. In this work, due to the necessity to manage scenario attributes which are not easy to be defined in a quantitative way for each criterion, the Regime Method (Nijkamp *et al.*, 1990) is applied.

4. BARI AND THE ASPS

The seaport of Bari is one of the main seaports of southern Italy. It is set in the region of Apulia, in the Southeast of Italy. Both passenger and freight transport services are operated in this seaport, from where regular lines leave everyday on several national and international routes.

The seaport is part of the Apulia Sea-Port System (ASPS). The ASPS is formed by the 3 main seaports: Bari, Brindisi and Taranto. The seaports of Bari and Brindisi share similar features. They are both commercial seaports located on the eastern coast of Apulia, in which both freight and passenger transport are operated. Taranto presents a different situation: it is a big industrial port, located inside a natural bay. Besides, in the surroundings of the main industrial port, it hosts an important military port. In recent years, all seaports of the ASPS experienced a noticeable growth. Bari and Brindisi increased their total amount of passengers and freight serves. The seaport of Taranto opened to commercial service, rapidly becoming an important hub for containerised freight transport.

In 2005, the seaport of Bari counted almost 1,5 million of passengers served, 8,5% more than in the previous year, which were the result of both ferry line services and cruise lines. Cruise services have recently become an important activity in the seaport of Bari. Due to the increase of the number of cruisers, the port management has been forced to upgrade the cruise facilities available for tourist and cruise travellers.

On the other hand, ferry lines represent a traditional activity in the port of Bari. They are operated through traditional daily links, leaving from Bari for the major ports of Croatia, Montenegro (former Republic of Yugoslavia), Albania, Greece and Turkey. Ferry lines are operated all over the year, even if services boast an increased frequency during summer. This kind of shipping offer a mixed transport service, carrying passengers but also trucks and other commercial vehicles, thus playing a relevant role in freight transport, too.

In the same year, 2005, the total amount of goods handled in the port of Bari reached 4,4 million of tons. This result is quite surprising, since it means increased traffic of almost 15%, rather than in 2004, in spite of the closure of the activities of the local container terminal.

The gradual increase of the transport activities hosted in the port has already pointed out the necessity of an empowerment of the maritime infrastructures of Bari. The existent infrastructure has almost spontaneously grown in front of

the city, occupying the available areas in the north-eastern part of the city. The result is a not well organised infrastructure in which the main functional parts are located quite sparsely depending on the time of their construction.

The whole infrastructure is parted into several different quays, which host different services directed to dedicated targets. The most important are: ferry services, cruise lines, commercial freight shipping, sailing and pleasure crafts. Being the seaport an important gateway for the European Union, further relevant activities are dedicated to security checks, good inspections, and customs controls for international transport.

Except for sailing and tourist boats, all the activities are run inside the commercial port, without a proper specialization of the different areas. Each activity, therefore, tend to interfere with the other, thus reducing the efficiency of the whole structure and reducing the total capacity of the quays. Also to improve the internal organization of the seaport, several projects to upgrade the infrastructure have been designed. The port authority has focused its efforts in obtaining a physical expansion of the seaports. Some minor interventions in this direction have recently been carried out. Anyway, they have not been able to elevate the capacity of the seaport neither to improve the organisation of the seaport. Thus, the seaport still needs onerous intervention for the re-organisation of the activities.

The need of interventions to upgrade the seaport plants is supported also by the previsions of traffic flows for the future. Current trends of traffic flows show a gradual increase in both passenger and freight flows. Moreover, the future development of maritime transport looks promising.

The realisation of the “Highways of the Sea” needs the upgrading of the existing infrastructures for hosting increased transport flows on these routes. A shift of the freight transport towards maritime transport, as designed by the European Union policies and as desirable from an environmental perspective, will increase more good flows in seaports.

Besides, commerce and trade with the eastern Union are expected to grow considerably in the near future. Bari is located on the route of EU Corridor 8. The development of such an infrastructure, which is included in the TEN – Trans European Network, will strengthen the commercial relations between Italy and the other countries crossed by the corridor (Albania, Macedonia, Bulgaria).

More controversial is the result of the enlargement of the European Union to several countries of Eastern Europe. Even if this will cause stronger exchanges with the new member countries, the effects on the traffic flows in the seaport of Bari are not sure. In fact, the realization of new terrestrial infrastructures in the eastern countries to ease movements and trades will probably bypass the traditional flows directed from Central Europe to Greece and Turkey. For this reason, many elements suggest a reduction of this type of traffic flows in the seaport of Bari in the near future.

5. FUTURE SCENARIOS FOR THE PORT OF BARI

Four different scenarios for the future development of the seaport of Bari are hereafter presented. They have been defined through the analysis of the

possible intervention applicable for the upgrading of this urban port. They all tend to increase the capacity of the existing seaport by realising different interventions. The first scenario which is proposed involves a physical expansion of the seaport. In the second scenario, the port capacity is improved through the adoption of Identification Technologies to elevate the performances of the infrastructure. The third scenario is a mixed scenario in which combines the main solutions of the previous scenarios. Finally, the latest scenario represents the condition of reduced interventions, consisting in a basic reorganisation of activities inside the seaport, without involving expensive projects of expansion.

The 4 different scenarios are briefly described in the following paragraphs.

5.1. Scenario A: Physical Expansion

Being the seaport of Bari an *urban seaport*, it is hard to find available areas for a physical expansion of the seaport from the existing location. This is a strong limitation to the growth in capacity of the seaport, since it does not allow any enlargement of the areas outside the current borders of the port. Moreover, it creates several limitations to the conjunction of the seaport infrastructures to the road and railway network, since the necessary links should cross built areas with high density of population.

Figure 1 – the port of Bari

As a consequence, the physical expansion plan of the seaport of Bari requires the realisation of further seaport infrastructures in a satellite area out of the urban area. The available areas for the expansion of the port terminals are

findable more along the coast at north. A satellite terminal should be built in this low density area, 4 km north from the city centre. The area is enough wide to host a quite large amount of quays, docks and other structures to support shipping and handling activities. The geographical location is favourable to the connections to the national railroad and to the highways, in correspondence of the northern gates of the city. The large area would allow to satisfy the increased demand for freight transport in the new terminal, displacing all freight commercial activities into the new satellite. This would contribute to reduce congestion in the urban area, while dedicating the existing port to tourist port, cruise services and ferry services, conferring efficiency to the new seaport area, also in case of a great increase of transport demand.

5.2. Scenario B: Technological Solution

Radio Frequency Identification (RFID) is an enabling technology, which is currently implied by manufacturers and supply chain operators to identify units of goods in all the steps of the supply chain. RFID provides the way to identify uniquely each container, pallet, case and item being manufactured, shipped and sold, thus providing a better visibility throughout the supply chain. The high potentials of RFID technologies in tracing and tracking products has been recognised by many manufacturers and retailers (Luckett, 2004). Thus, several major retailers and government agencies (including Wal-Mart, Tesco and the US Department of Defence) have announced that they expect their suppliers to be 'EPC compliant' (i.e. using RFID tags). The wireless properties of RFID tags provide several advantages for the use in logistic chains: they allow a contact-less identification at a distance, continuous or intermittent tracking, real-time information control and hands-free operations. The application of RFID technologies into a logistic node could upgrade the level of service of the infrastructure, ensuring a reliable organisation of the system and considerably cutting the time for handling. But technological solutions in maritime transports are not only directed to the optimization of transport services and to travel time reduction. They assist operators in assuring both safety and security to maritime freight transport. The availability of technologies for tracking would improve the level of security, with reference to homeland security checks, cargo security (integrity of goods and thefts) and property rights security (against counterfeited products). Thus, such a technology can help in increasing the level of security, developing secure and "smart" containers and allowing operators and authorities to check good flows on commercial trades, acting on one on the main problems to be secured in distribution supply chains (Lee *et al.*, 2005; Strickland *et al.*, 2005).

The availability of such a technological solution will slightly increase the capacity of the seaport, conferring a greater level of efficiency in the operations carried out in the terminal. The cost for interventions will be not as high as for the physical interventions on the infrastructures described in the first scenario. Anyway, the use of RFID technology will imply the participation in the technological costs of the economic operators who want to comply with the use of RFID tags. However, not all the operators are expected to adopt the identification technology, using tags to track their good movements. So, a double framework is advanced, in which the operators that accept the

technological costs will benefit from the greater efficiency in transport services, while the remaining will go on operating with the current rule.

5.3. Scenario C: Integrated Development

This scenario is defined by the integration of the two previous solutions, thus obtaining an efficient seaport system through the adoption of Radio Frequency Identification systems, and at the same time building a new satellite terminal in the northern part of the city, to host the commercial shipping activities. This scenario involves the features that have been described previously. It is the scenario which involves the maximum cost, but it is also the most efficient scenario, in which the highest capacity of the seaport is reached with separated flows in the commercial terminal and in the urban passengers' terminal. The interaction in the urban areas with the urban transportation flows is reduced, as an effect of bypassing a relevant part of the transport activities far from the city centre.

This scenario allows a progressive strategy: the realisation of the interventions, physical expansion and technological development can be implemented not simultaneously. In a first time, when the transport demand is still comparable to the current one, only the technological solution is adopted. Then, after the confirmation of the future trends for maritime transport, the realisation of the physical upgrading is started.

5.4. Scenario D: Rationalization of the Existing Seaport

This scenario is a scenario of light intervention, in which no physical expansion neither technological implementation are designed. This is the case in which, with minimum costs, the existing seaport is reorganised, in order to solve the most urgent problems of the infrastructures. Since the port does not move outside the urban area, the problems of the interactions between seaport activities and transport flows and the urban transport flows persist. They are only reduced by the reorganization of the accesses to the seaport, upgrading the railway link from the seaport to the national network, pursuing the objectives of a better intermodality inside the seaport terminals. Road connections are improved by redesigning the corridors inside the urban area and the access to the seaport, in order to reduce the bnegative impcts on the most populated areas. Moreover, the activities inside the seaport are reorganised from a functional point of view, relocating some docks and plants and reducing the interactions between the different activities.

In this scenario, to lower costs of interventions, worse results are obtained. The capacity if slightly increased, recuperating some efficiency from the relocation of the activities. Anyway, the port which comes back to condition of efficiency, is not able to support great increases of the maritime transport demand.

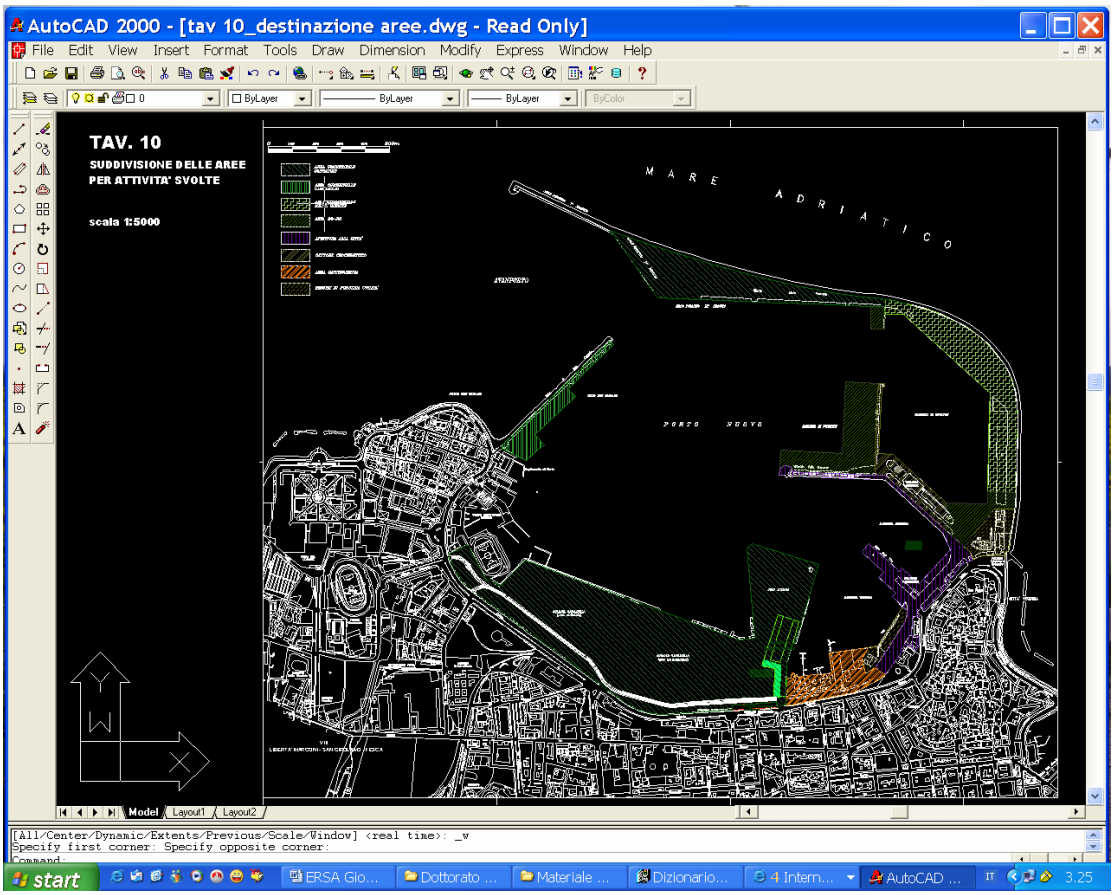

Figure 2 – planned interventions on the seaport of Bari

6. THE EVALUATION OF THE SCENARIOS

In this work, the Regime Method has been chosen to evaluate the alternative scenarios. This evaluation methodology allows defining evaluation analysis through the association to each alternative of a quantitative or qualitative value which expresses the correspondence of that alternative to the analysed criterion.

In this case, due to the difficulties of formulating in terms of cardinal numbers the correlation between the proposed scenarios and the chosen criteria, ordinal numbers are used to express the order in which the scenarios better fit the objectives represented by the chosen criteria.

Since the analysed port is an urban port, a quite heterogeneous set of criteria has been chosen. It includes criteria and indexes directly referred to the seaport infrastructure as well as other criteria which are referred to the interaction between the seaport and the inhabited area and the urban environment.

The chosen criteria have been divided into the following four major groups:

A. Local development and employment
B. Building and management costs
C. Interactions with the urban area

D. Environmental impacts

Each one of these groups refers to a type of attributes that plays a relevant role in the selection of the projects to realise in urban area. Twelve sub-criteria have been defined on the bases of the main macro-group that have been exposed:

A. Local development and employment:
   - A1. Port capacity
   - A2. Employment
   - A3. Attraction and generation of new economic activities

B. Building and management costs
   - B1. Building cost of the alternative
   - B2. Management cost of the alternative

C. Interactions with the urban area
   - C1. Impact on urban mobility
   - C2. Use and availability of public areas
   - C3. Enhancement of the value of the neighbour areas
   - C4. Leisure time and sport/tourism facilities

D. Environmental impacts
   - D1. Land consumption
   - D2. Atmospheric pollution
   - D3. Modification on the hydro-geologic system

The correspondence of the different scenarios to the chosen criteria is quoted in table 1.

Scenario	**Criteria**											
	A1	**A2**	**A3**	**B1**	**B2**	**C1**	**C2**	**C3**	**C4**	**D1**	**D2**	**D3**
A. Physical Expansion	**3**	**2**	**2**	**2**	**3**	**3**	**3**	**2**	**3**	**1**	**3**	**1**
B. Technological Adoption	**2**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**1**	**2**	**2**	**2**
C. Integrated Development	**4**	**4**	**4**	**1**	**1**	**3**	**3**	**2**	**4**	**1**	**3**	**1**
D. Rationalization	**1**	**1**	**1**	**4**	**4**	**2**	**2**	**1**	**2**	**2**	**1**	**2**

The regime method has been applied in order to evaluate the different scenarios. Different results have been obtained imposing different vectors of criteria weights, allowing analysing the sensibility to the criteria weights.

The results that are hereafter reported have been obtained selecting specific vectors of criteria weights. First of all, in the hypothesis in which the vector of the weight is unknown, the methodology evaluates the following order among the scenarios:

1. Scenario C – Integrated Development
2. Scenario A – Physical Expansion
3. Scenario D – Rationalization of the Existing Seaport
4. Scenario B – Technological adoption.

The scenario C, the integrated development, is found as the best solutions for the seaport of Bari. Then, the following scenarios are the physical Expansion (Scenario A), the Rationalization of the Existing Seaport (Scenario D), and finally the Technological adoption of a RFID system. Thus, in the case of unknown priorities between the criteria, the evaluation methodology indicates the most expensive solution as the best one. In this case, the adoption of technological solutions is seen as positive in the organization of the seaport activities when combined with a empowerment of the capacity of the seaport through a physical expansion of the infrastructure.

An application of the methodology has been carried out assigning a vector of criteria weights to the macro-groups of criteria introduced above. In order to simulate the effects of some budget-oriented public decisions, the following vector is defined with the macro-group of criteria in the decreasing order of importance: building and management costs, local development and employment, interaction with the urban area, environmental impact.

Also in this case, the scenario which is evaluated as the best one is the scenario C and the order of preference given by the model is the same of above.

A further application of the model is reported, in the case of all criteria are estimated as equally important. In this case, the scenario which is suggested as the best suited for the future development of the seaport is the Scenario A, which presents more homogeneous features with reference to all the criteria that have been introduced.

7. CONCLUSIONS

Radio Frequency Identification (RFID) systems have already been applied by many manufacturers and operators to control the traceability of items in distribution supply chains. Analogously, the application of such systems into the logistical organization of transport infrastructures looks promising, as a way to improve the efficiency of the management system and upgrade the capacity of the transport infrastructure.

In this paper, the possible application of RFID solutions to the management of a seaport infrastructure has been discussed, in relation to the need of upgrading the seaport infrastructures to support the increasing demand for freight maritime transportation. The use of technological solutions in the management of a seaport is conjunction with the realisation of other needed interventions on the physical infrastructure of the seaport. The results of the application of an evaluation methodology confirm the possible integration of technological and physical interventions to upgrade the transport infrastructure as a way to increase the capacity and competitiveness of maritime freight transport.

Acknowledgements

The author wishes to thank Carmelo Torre, of the Politecnico di Bari, for his interesting suggestions on the use of evaluation methodologies, also regarding the application of specific software.

References

Airries C.A., 2001, “Regional production, information–communication technology, and the developmental state: The rise of Singapore as a global container hub”, Geoforum, 32, pp. 235 254.

Avineri E., J. Prashker and A. Ceder, 2000, “Transportation Processes Selection Process Using Fuzzy Set Theory”, Fuzzy Sets and Systems, 116, pp. 35-47.

Button K. and P. Nijkamp, 1997, “Social Change and Transport”, Journal of Transport Geography, 5 (3), pp- 215-218.

Choo S., P. Mokhtarian and I. Salomon, 2005, “Does Telecommuting Reduce Vehicle-Miles Traveled? An Aggregate Time Series Analysis for the U.S.”, Transportation, 32, pp. 37-64.

EC Decision No 1692/96/EC “On Community Guidelines for the Development of the Trans-European Transport Network”, Official Journal L 228, 09/09/1996, pp. 0001 – 0104.

European Commission, White Paper: European Transport Policy for 2010: Time to Decide, Office for Official Publications of the European Communities, Luxembourg, 2001.

Greene D. and M. Wegener, 1997, “Sustainable Transport”, Journal of Transport Geography, 5 (3), pp.177-190.

Hesse M., 2002, “Shipping news: The implications of electronic commerce for logistics and freight transport”, Resources, Conservation and Recycling, 36, pp. 211-240.

Hesse M., Rodrigue J. P., 2004, “The transport geography of logistics and freight distribution”, Journal of Transport Geography, 12, pp. 171-184.

Korhonen P., H. Moskowitz and J. Wallenius, 1993, “Multiple Criteria Decision Support: a Review”, European Journal of Operational Research, 63.

Lai K. H., Ngai E. W. T., Cheng T. C. E., 2004, “An empirical study of supply chain performance in transport logistics”, International Journal of Production Economics, 87, pp. 321-331.

Lee H. L., Whang S., 2005, “Higher supply chain security with lower cost: Lessons from total quality management”, International Journal of Production Economics, 96, 3, pp. 289-300.

Luckett D., 2004, “The supply chain”, BT Technology Journal, 22, 3, pp. 50-55.

May A., Shepherd S., Timms P., 2000, “Optimal transport strategies for European cities”, Transportation 27, pp. 285–315.

Munda G., Multicriteria Evaluation in a Fuzzy Environment, Phisica-Verlag, Heidelberg, 1995.

Nijkamp P., Rietveld P., Voogd H., Multicriteria Evaluation in Physical Planning, Elsevier, Amsterdam, 1990.

Ping I., Zhang S., Talvitie A., Yufu C., 1999, ”New models for financing and managing highways: asset-based road corporations in China”, Transportation 26, pp. 67–86.

Schiftan Y., S. Kaplan and S. Hakkert, 2003, ”Scenario Building as a tool for planning a sustainable transportation system”, Transportation Research D, 8, pp. 323-342.

Stough R. and P. Rietveld, 1997, “Institutional Issues in Transport Systems”, Journal of Transport Geography, 5 (3), p. 207-214.

Strickland L.S., Hunt L.E., 2005, “Technology, security, and individual privacy: New tools, new threats, and new public perceptions”, Journal of the American Society for Information Science and Technology, 56, 3, pp. 221–234.