

STRUCTURAL FACTORS FOR A THIRD-GENERATION PORT: PLANNING INTERVENTIONS FOR RESEARCH AND DEVELOPMENT IN GIOIA TAURO, ITALY, TEN-T NODE

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ABSTRACT

Maritime transport is a complex system that plays a relevant role in the supply chain. Commercial ports are strategic nodes that facilitate international interchanges of goods at the global level. The port's efficiency influences the choices on the entire transport system. By considering the strategic role played by ports, it is necessary to define a set of material and immaterial interventions that support its growth. This paper focuses on the Gioia Tauro port, one of the main hub ports in the Mediterranean Sea. According to UNCTAD's classification based on the definition of port-generation, the paper analyses the port's potentialities in relation to the possibilities to increase the production of value-added other than the one linked with transport activities. The strategic perspective for the Gioia Tauro is to become a full third-generation port. In order to achieve this objective, some material and immaterial intervention are needed. In particular, this paper focus on the contribution of research development for the port's growth. The territory around the Gioia Tauro port is the Calabria, a region in Southern Italy and Europe. Transport, agri-food and automotive are the main productive sectors in the port area. The development of the research, like the most advanced best practices in maritime transport at the international level, should support the productive sectors. Universities and research centres present have a low level of interchanges with the Gioia Tauro port and productive sectors actually operating in the region. This paper contributes to defining a development perspective for Gioia Tauro port in order to realize a systematic connection between research and production. The strategic perspective comprehends a set of interventions aimed to activate and consolidate interchanges of knowledge and skills among public administrations and private companies.

Keywords: maritime transport, research, regional planning, third-generation port.

1 INTRODUCTION

Maritime transport is a complex system that includes material and immaterial components that play a relevant role in the supply chain. Ports are strategic nodes that facilitate international interchanges of goods at the global level. The port's efficiency influences the choices on the entire transport system. By considering the strategic role played by the ports, it is necessary to define a set of material and immaterial interventions that support its development. Moreover, port's development facilitates regional economic growth, contributing to sustainable development goals at the global level.

According to UNCTAD (United Nations Conference on Trade and Development, 1994 [1], 1999 [2]), a port can be classified in relation to their generation. The port generation' depends on a set of quantitative characteristics [3].

The first generation includes the ports born together with the city and developed until the 19th century. Ports belonging to this class are characterized by a strong port-city relationship.

The second generation of ports evolves during the second part of the 20th century. The ports serve large industrial sites that require large transport capacities and efficient interconnections without constraints. The second generation of ports evolves with new generation of ships (e.g. tankers, suitable for the transfer of large quantities of goods in the



liquid or gaseous state). These ships need different port with specific physical characteristics (e.g. large, deep and specialised docks).

The third-generation of ports is related to the container revolution [4], [5] that occurred in the last two decades of the 20th century. The introduction of the united container (TEU) facilitated interchanges of goods at the international level and then the globalisation of the economy. The first- and second-generation ports are not suitable for container ships and are not equipped with areas for handling millions of containers. For this reason, a third-generation of ports is needed. Ports are characterised by deep docks, gantry cranes, large squares parking, intermodal equipment, spaces of service.

The development of a third-generation port requires the creation of a high level of services that are not limited to transport functions. A set of material and immaterial activities are needed to improve the port's efficiency and productivity. These requirements imply the implementation of continuous innovation processes that is a relevant driver of firm competitiveness in advanced economies. Innovation processes are supported through research activities that produce advancements in technological and non-technological solutions concerning services, people and organisations.

This paper focuses on the contribution of research to port's development. Maritime transport research, integrated with descent education programs can contribute to developing potentialities of a port, where inside maritime research must be considered also the ones relative to the logistics of specific sectors (linked with maritime sectors).

This paper focuses on the specific case study of Gioia Tauro port, which is one of the main hub ports in the Mediterranean Sea. The presence in the same area of a university that has historically developed research in the transport sector, with particular reference to the transport of people and goods at the national and international scale, is relevant.

The paper presents some elements of the research program discussed between public and private stakeholders to support Gioia Tauro port development the last years during elaboration of the Regional Transport Plan (RTP) and of Logistic Integrated Area (ALI). The interdisciplinary character of maritime transportation related to research is emphasised. In this way, it needs to consider the general logistics [6], the specific logistics sectors as agri-foods [7] and the automotive and mechanic logistics [8]. These fields are developed by the enterprises located in the Gioia Tauro area and then it needs to check the university laboratories that work on the same themes.

2 CONSTRAINTS AND POTENTIALITIES OF THE GIOIA TAURO PORT

2.1 The adopted methodology

Research plays a relevant role in the port's development in the direction of a third generation's port. Crucial to creating a third-generation port is, as previously introduced, to modify the added value (AV) for goods. The increase of AV must be realised not only with the transport actions that modify the AV for the new spatial positioning but through new processes introduced in the goods produced. In literature, AV is the measure of the increase in value that occurs in the production and distribution of final goods and services thanks to the intervention of production factors. Product and process modifications can be induced by internal knowledge within the company or imported from outside. Innovation can therefore be generated by advancement of knowledge: for internal company developments; by contribution from the economic district; by contribution from research centres.

This note focuses on the increase in AV given by external research centres. To activate these virtuous processes, as a first step, it is necessary to survey the economic sectors directly



involved in port activities because they increase the AV precisely for the transport actions, this action is done by analysing the existing transport plans at the various scales. Obtaining a set, I of industrial sectors, being i the generic sector.

The second step is to survey the research centres present in the study area, that carry out research relating to the economic sectors identified in the first survey. Obtaining a set R of research centres, being r the generic centre.

Then, given:

$$i \in I; r \in R,$$

can be obtained the set C of centres to settle in the port, being c the generic center, as:

$$c \in C = I \cap R.$$

Transportation plans at different territorial dimensions (Europe, Italy, Calabria Region) promote the interchanges among research, port and territory administration and enterprises. The RTP adopts a methodology to activate an innovation process, merging potentialities from transport plans at all territorial dimensions, individuating the role of the research and the main sector to develop I (see Section 2.2) and from research's university operate in the territory where the Gioia Tauro port is located, identifying the centre R and the intersection C . The laboratories belonging to C are recalled (Section 2.3). The research program is aimed to realize a set of material and immaterial interventions in order to consolidate and further develop current research lines for port's interest (Section 3), evidencing the cost to organise training and research centre both for immaterial and material interventions inside the port's area. A synthetic representation of the adopted methodology is reported in Fig. 1.

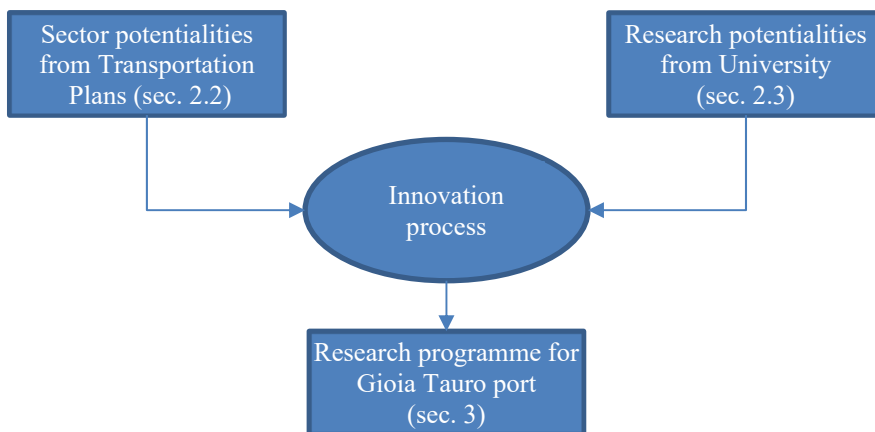


Figure 1: The adopted methodology.

2.2 European, national and regional transportation plans

The main potentialities for the port are referred to the indications given in all the plans, produced at different territorial scale, that identified the central role of Gioia Tauro port (Fig.

2). From another side, important potentialities are linked to the presence, in the hinterland, of university laboratories that develop research relative to the core element of the port (Fig. 3), both for transport and for economic sectors involved.

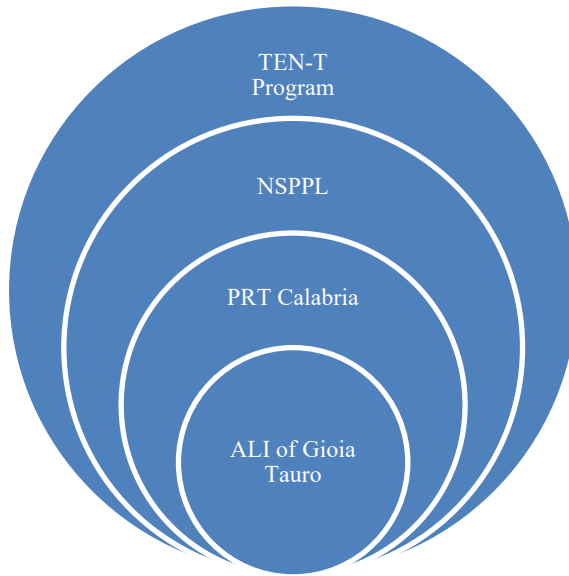


Figure 2: European, national, regional and local plans.

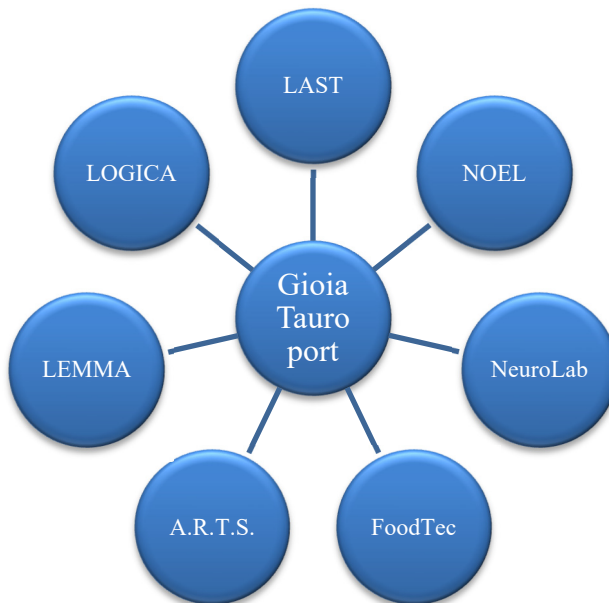


Figure 3: Laboratories of port interest.

The crucial research themes that need in a port are the one relative to the transport at national and international scales [9]–[11] and the one relative to the organisation of the port [12].

The current situation is characterised by different obstacles and lacks. A first lack concerns systematic and direct links among port operators, private business and university research. There are no physical places inside port's area where research and development activities can be realised.

2.2.1 TEN-T programme

European directives for developing trans-European Networks Transport (TEN-T) [13], [14] underline the role of research. In particular, the directives recall the Framework Programme for Research and Innovation, Horizon 2020, that collect European research programmes responding to societal challenges (e.g. smart, green, accessible and integrated transport, secure, clean and efficient energy, and information- and communication technology). Connecting Europe Facility (CEF) and the Cohesion Funds support regional development 'European Territorial Cooperation', 'Research and Innovation' or 'Environment and Climate action' [14]. Gioia Tauro is a TEN-T node as defined in [13] and then interested in Horizon.

2.2.2 National strategic plan for ports and logistics

In 2015, the Italian Government has approved the National Strategic Plan for Ports and Logistics (NSPPL) [15]. The plan proposes a strategy to improve the competitiveness of the Italian port and logistics system. The maritime system can support the development and growth of Southern Italy. It is a driver for sustainability, innovation and support to the production sector of Italy. Objective 6 – *Innovation* incentives links among universities, research centres with territory and industry in relation to port and logistics, according to European Horizon 2020. Even in this plan, Gioia Tauro is considered a strategic node and then a place where to develop objective 6.

2.2.3 Regional transport plan

In 2016, the Calabria Region, after a technical-administrative process, with a deepen and participated public debate, has approved the Regional Transport Plan. The plan sets out vision, objectives, actions and measures to enhance the territorial and transport system in Calabria, according to international, European and national sustainable goals (UN Agenda 2030 [16], EU 2020 smart growth strategy [17], Italian transport and mobility plan [18]).

The sustainability framework of the PRT Calabria is translated into ten objectives and relative strategic actions.

Education, research and training are the first priority actions of the plan. The 6th priority action concerns the Gioia Tauro port's development. In the action the specific measure 6.4 addresses research development. It is necessary to recall the measure 6.9 that is related to the research and to the operative applications [19]–[21]. In this measure, specific indications were given to the: research centre for transportation, university departments, promotion of start-up and spin-off.

2.2.4 Integrated logistics area

In the context of structural funds allocation, Italy and the European Commission subscribed an agreement aimed to develop the port and intermodal system in Southern Italian regions. The proposed measures are structured in Integrated Logistics Areas (ALI), introduced with the main goal to improving the competitiveness of Southern regions. Five integrated logistics areas have been defined. For each ALI, there is an investment programme concerning

harbour, inner harbour and inland terminal material and immaterial infrastructures, in order to enhance the quality of connections to the multimodal corridors of the European transport network and to develop activities in the port and in the hinterland area.

One specific ALI includes the Gioia Tauro Logistics area. The planned and programmed investments consider the increase of the traffic through the port and the sea-rail intermodal node. For this reason, a set of material and immaterial interventions are set out in different fields: transport, general logistics, agri-food and automotive-mechanic logistics. This paper focuses on the immaterial interventions concerning research programmes.

According to European, national and regional goals, vision and objectives, the ALI of Gioia Tauro must include specific investments in research interrelated with production developing sectors.

2.3 Research lines of port interest

The research line interesting the port are, in fact, developed by the laboratories of the Reggio Calabria University, in the following, there is a synthesis of the reference research laboratories. In Table 1 some elements of the laboratories are reported, with the papers that registers the highest citation score.

Table 1: Laboratories at Reggio Calabria University with research lines of port interest.

Laboratory	Department	Structured employed	ERC theme	Paper with high score
LAST	DIIES	5	SH3_8, SH3_9, PE7_4	[22]
NOEL	DICEAM	4	PE3_16, PE8_5, PE2_14, PE8_3, PE8_6	[23]
NeuroLab	DICEAM	6	PE7_8, LS2_14, LS5_10	[24]
FoodTec	Agraria	5	LS9_5,	[25]
A.R.T.S.	DIIES	5	PE6_2, PE7_8, PE7_6, PE7_8, PE7_9, PE7_8, PE7_6, PE7_8, PE8_1	[26]
LEMMA	DIIES	4	LS7_2, PE2_6, PE5_8, PE10_15, PE1_16	[27]
LOGICA	DIIES	2	SH3, PE7, LS9	[28]

2.3.1 LAST: Laboratory for Transport Systems Analysis

The research activity concerns sustainable mobility of people and goods at urban and extra-urban level. The laboratory works in the field of intelligent transportation systems applied in different contexts (smart city, smart mobility, city logistics, road safety, maritime freight transport and ports). The laboratory has developed methods and models for supporting transport and logistics planning, programming and design. The research's outputs have impacts at the national and international level since 1987. The laboratory is the founder of the diachronic network approach for the analysis of transport service networks.

2.3.2 NOEL: Natural Ocean Engineering Laboratory

The research activity concerns ocean/marine engineering, focusing on wave modelling related aspects and wave energy harvesting. Since 1989, the laboratory works in the field of marine and civil engineering for developing methodologies in the analysis of the wave phenomena. In the last decades, the research's group has performed small-scale field experiments in a natural basin, where sea waves are not generated by an artificial wave. Thus, the researchers have gained unique experimental skills necessary for dealing with experiments in a natural environment.

Since 2018, the laboratory is certified ISO 9001:2015 by Bureau Veritas Certification.

2.3.3 NeuroLab

The research activity concerns the study of biological phenomena that govern the human body during its normal activities. The laboratory works in the field of remote with applications in the health context. This is an interdisciplinary laboratory developing systems based on the development of deep learning, neural networks and soft computing systems.

2.3.4 FoodTec: Food technologies

The research activity concerns the enhancement of food products, through the study of the chemical-physical and sensorial composition of food matrices, as well as on conservation techniques. In the laboratory advanced technologies related to some food processing chains are studied such as: conservation and packaging; stabilisation technologies of food products using conventional and innovative methods and study of the qualitative variation of the product; transformation technologies such as dehydration, extraction, controlled fermentation on food; the chemical, physical and sensorial characterisation of food production. Some attention regards the enhancement of the agri-food in the Calabria region.

2.3.5 A.R.T.S. Laboratory (Laboratory for Advanced Research into Telecommunication Systems) ICT: CNIT

The research activity concerns protocols and applications for advanced telecommunication systems and services. The laboratory studies innovative protocols, algorithms and architectures analysed through simulators, emulation tools, analytical models and optimisation methods. The laboratory is one of the founders of IoT emerging technologies.

2.3.6 LEMMA: Laboratory for ElectroMagnetic Methodologies and Applications

The research activity concerns the framework of inverse synthesis problems (with application spanning from the telecommunication field to the biomedical one), inverse retrieval problems (non-destructive diagnostic for civil engineering), high-performance antennas and advanced microwave devices design. LEMMA studies problems in the fields of electromagnetic theory, Information and Communication Technology. Nowadays, there are many outputs gathered from the research activities both in terms of international collaborations (e.g. European Space Agency, European Defence Agency, CNIT and Livorno port Authority) and scientific papers.

2.3.7 LOGICA: Tecnological Laboratory of Logistics in Calabria

The research activity concerns interdisciplinary topics related to the processes of development for the Technological District of the Logistics in Gioia Tauro. Research line supports the companies operating in sector as transport, logistics, agri-food, mechanics, and industrial technologies. The laboratory works on models, technologies and tools with a specific focus on freight mobility, Intelligent Transportation Systems (ITS) and Information



Communication Technologies (ICT), technologies to support the productive industry, logistic and the agri-food activities. The research has impacts at national and international levels.

3 TOWARDS A FULL THIRD GENERATION

3.1 Strategic development directions

In order to transform the Gioia Tauro port in a full third-generation port, specific strategic development directions can be followed. One direction concerns the development of research that support the growth of new production sectors. Merging economic sectors individuated by plans and laboratories presented in Section 2, it can be possible to obtain a programme work. The programme includes interventions to realize a research centre and a university campus where research to support economic, transport and logistics activities can be developed.

The campus will facilitate the activation and consolidation of knowledge's exchanges and skills between business (located enterprises), public administrations (Metropolitan City of Reggio Calabria, Calabria Region), territorial management bodies (Gioia Tauro Port System Authority), directly linked university (Mediterranean University of Reggio Calabria).

The basic research lines, functional to the economic activities of the Gioia Tauro ALI, will be implemented on the campus and on the research centre, also through agreements with national university departments, promoting international mobility of researchers.

The main operational applications will concern the following aspects:

- strategic and competitive research connected to the port activities and in the industrial area;
- strategic and competitive research related to transport and logistics to support the main sectors settled: general external logistics, agri-food, manufacturing with particular reference to automotive, mechanic, energy, ICT;
- observatory to support the analysis of logistical phenomena for regional planning and programming; and
- promotion of start-ups and spin-offs connected to the research centre, to the university system of Calabria, and to other public and/or private bodies present in the area.

3.2 Material and immaterial infrastructures

The proposed interventions on immaterial infrastructures (education and research) aim to activate and consolidate interchanges of knowledge and skills among different previously recalled actors. The interventions pursue the objectives to support research related to the evolution to become a port of full third-generation, in terms of:

1. security and communications,
2. transport,
3. maritime infrastructures,
4. ship maintenance,
5. green energy production,
6. general logistics,
7. agri-food logistics,
8. mechanical-automotive, and
9. ICT.



Table 2 reports a summary of intervention on material and immaterial infrastructures for supporting Gioia Tauro port development, for a total cost of about 40 million Euro.

Table 2: Interventions on material and immaterial infrastructures.

ID	Title	Financial resources (MEuro)	Priority level	E: Education R: Research
1	Services integrated centre for supporting education and research activities	3.00	1	E–R
2°	Training centre: realisation of laboratories	2.50	1	E
2b	Training centre: technical expertise (HTS)	2.00	1	E
2c	Training centre: upper secondary schools	2.00	1	E
3°	Campus: Research & Development infrastructures (I step)	10.00	1	R
3b	Campus: human capital Research & Development	6.50	1	R
3c	Campus: human capital for university courses	4.00	1	R
3d	Campus: Research & Development infrastructures (II step)	10.00	2	R

Making a synthetic assessment, it is easy to see how the expected investment cost is equal to 1 euro/ton of goods handled in the port, considering an increase in the VA of 0.2 euro/ton for the process and product innovations introduced, in a few years. The investment would be recovered. Note that it is considered, on sureness, an extremely low value for the VA increase.

The realisation of the interventions can be considered of a wide urban regeneration plan that aims to increase territorial sustainable growth interconnecting university, port administration and enterprises [28].

In the following, there are further details about interventions.

1 *Services integrated centre for supporting education and research activities*

The intervention includes the regeneration of the existing building, near the old Eranova railway station, where residential services for students, teachers and visiting professors will be located.

2 *Training centres for education*

The intervention includes the enhancement of the training centre operating in the region.

2a) *Realisation of laboratories*

The intervention includes the realisation of a multimedia IT laboratory and a simulation laboratory for activities relating to the naval sector.

2b) *Technical expertise*

The intervention includes the enhancement of the current training centre operating in the Calabria region, and in particular the centre that provides training for Higher Technical Institutes in order to produce experts on port activities.



2c) *Upper secondary schools*

The intervention includes the enhancement of the current training centre operating in the Calabria region, and in particular the centre that provides training activities on the maritime sector for upper-grade schools.

3 *Campus for research*

The intervention includes the realisation of a university campus dedicated to education and research about transshipment, intermodal transport, territorial logistics, energy, maintenance, agri-food, metalworker-automotive, ICT.

3a) *Research & Development infrastructures (I step)*

The intervention includes the realisation of a build that constitutes a physical place where research activities are developed.

3b) *Human capital Research & Development*

The intervention includes an investment in human resources (research, technical and administrative personnel) to support the realisation of research programs on transshipment, intermodal transport, territorial logistics, energy, maintenance, agri-food, metalworker-automotive, ICT.

3c) *Human capital for university courses*

The intervention includes an investment in human resources to support realisation of education programs for engineers with specific reference to territorial logistics, transport of goods by sea, road and railways, Intelligent Transport Systems.

3d) *Research & Development infrastructures (II step)*

The set is completed by the realisation of intervention with belonging to the second level of priority. In particular, in this subset, there is the second step to complete the campus for innovation in the sector of maritime transport, automotive and ICT.

4 CONCLUSIONS

The achievement of a full third-generation for Gioia Tauro port is a goal that can be achievable. The main theme of this evolution is the creation of the port area of value-added from other activities than the classical relative to transshipments.

To support the development of other activities, it needs to create conditions to offer at the enterprises locating in the port area advanced education and useful research. The results obtained, in this work, are the identification of the intersection between the economic sector individuated in the transportation plans with potentialities from the location in the port, and the university laboratories able to develop research on the selected sectors and to transfer the research to the enterprises.

In the paper, all the external (plans) and internal (laboratories) conditions present in the area have been analysed. To create the bridge between research and enterprise, it needs to develop inside the port a research centre linked with a campus. For these initiatives, aggregate costs and detailed elements have been established. In this way, research can explicate her potentiality as structural factors to evolve Gioia Tauro in a full third-generation port. Some conclusive elements can be drawn: 1 the proposed methodology can provide valid results as it allows to limit the research areas to be allocated in the port, finalising the available resources; 2 developing education and training on the lines of research is crucial because it allows increasing the skills and knowledge within the company; 3 investments in research, inside the port, to increase the added value of goods can be recovered in very few time.

The proposed methodology, considering the conclusive elements recalled, can be applied to all ports that are evolving towards the third generation. The work is therefore useful both to planners and researchers, and more generally to politicians and university managers.

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