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The Positive Implications for the Application of the International Ship & Port Facility Security and its Reflects on Saudi's Ports

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ABSTRACT

The research paper summed up on the requirements of the application code security and safety of ships and ports (ISPS) and the technical aspects necessary for the application by the Saudi marine Ports. The requirements of the international code of safety and security of ships and ports such as:

Additional tasks to be undertaken by port management. Activities and tasks that will port authorities. The impact of the elements of the maritime transport. Application and amendments to the deck. Government requirements. Special requirements for the management of ships. Application optimized for the requirements of the code.

Also interested in the research paper the mechanism of how to put these requirements into effect and the positive impact associated with the application. And also the requirements of the bridge on the ship, beside clarification of the interconnections between the parties to the transfer process, such as administration of the commercial maritime fleet operations, control to the owners and how the administrative process for the crew to apply the appropriate code on the deck of ships and mutual relations with the insurance and chartering operations as well as the role of the port facility, to arrive. How can the ports of Saudi Arabia to benefit from the positive application of code requirements and to enable these requirements with the parties to the process of maritime transport.

1. Maritime security in Saudi's ports

This paper is intended to serve as a conceptual piece that draws from the interplay between engineering and supply chain approaches to risk in the context of recent maritime security regulations. It is hoped that cross-disciplinary analysis of the perception and impact of the security-risk will stimulate thinking on appropriate tools and analytical frameworks for enhancing port and maritime security. In so doing, it may be possible to develop new approaches to security assessment and management, including such aspects as supply chain security. The framework and methods reviewed in this paper could serve as a roadmap for academics, practitioners and other maritime interests to formulate risk assessment and management standards and procedures in line with the new security threats. Of particular importance, new relevant approaches can be developed to assess the reliability of the maritime in the context of the complex network theory (Bichou, 2005; Angeloudis et al., 2006; Bell et. al, 2008). Equally, further research can build on this to investigate the mechanisms and implications of security measures on port and shipping operations, Companies, ports and other parties active in today's international supply chains face a large number of regulations and private initiatives prescribing measures to be taken in order to raise the level of supply chain security. These measures range from putting up a fence around the terminal facilities at a seaport, to establishing a certified security programme at the production facility ('point of stuffing') in order to be admitted to the "green lane".

a) The Scopes which Saudi's efforts should be coverage: Important Tasks for Maritime Administration.

b) Ideal Means of Stable Marine Transport in future: On the Assurance of Stable International Marine Transport.

2. Efforts to assure the global competitiveness of Saudi's ocean-going shipping service operators and a planned increase of Saudi's flagships and Saudi's seafarers

Consultation in search for the "Ideal Means of Stable Marine Transport in future" was Conducted by the Minister of Land, Infrastructure and Transport to the Council of Transport Policy on February 8, in order to ask the Council to discuss the means of assuring stable marine transport indispensable for Japan to accomplish continued sustainable growth as a maritime and trading nation in a global international economic

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community. Following the consultation, an "International Marine Transport Task Force" was established, composed of members with wide knowledge, representing various circles, such as individuals of experience and academic standing in the areas of trade of resources and energy, finance, traffic economy and so forth.

The policy aims were drastically condensed into "Assurance of the global competitiveness of Saudi's ocean-going shipping service operators" and "Securing Saudi's -flag ships and Japanese seafarers", while as for measures to achieve the policy aims concerned, the introduction of the laws for, among others, the introduction of a tonnage-geared standard tax system, securing of Saudi's -flag ships and Saudi's seafarers and so forth were enumerated. Hereafter, the decision was taken to work on constructing an institutional framework to target stable international maritime transport based.

2.1. Efforts to Secure and Nurture Human Resources for the Sound Development of the Maritime Industry

Efforts to gather, nurture seafarers and target their career development to support them in transforming themselves into land-based ocean engineers Marine transport, which is indispensable for the society and economy of Japan as a maritime state, is supported by seafarers engaged in ship navigation and ocean engineers who manage and support it on land. In securing the safety and stability of marine transport, the role played by seafarers (ocean engineers) as the human infrastructure is considerable. Since the valuation related to the navigational safety of Saudi's -flag ships and ships served by Saudi's seafarers on board is extremely high in these days, the government should positively promote:

Efforts to secure and nurture excellent Japanese seafarers (ocean engineers). With this in mind.

The Human Infrastructure Task Force was established within the Maritime Affairs Subcommittee of the Traffic Policy, which investigated and discussed an ideal maritime policy to secure and nurture human resources in the field of maritime affairs, focusing on securing and nurturing excellent Saudi's seafarers (ocean engineers).Subsequently, an interim to the effect that efforts were required mainly for four measures, namely nurturing seafarers, gathering them, targeting their career development and supporting their transformation into ocean engineers on land, with the necessary institutional revision and so forth scheduled to be carried out in future. Moreover, with a view to nurturing young seafarers, who will play a key role in the Saudi's marine transport of the next generation.

Support program to develop next-generation human resources in the shipbuilding industry.

Since nearly half the skilled technical experts for shipbuilding in the Saudis shipping industry are over 30 years old, an unprecedented rapid and large-scale alternation of generation will take place in the coming decade. If effective countermeasures are not taken under such circumstances, the level of technique at manufacturing sites, which has underpinned the international competitiveness of the Japanese shipbuilding industry to date, will be abruptly degraded, which might lead to the loss of such competitiveness. With such conditions in mind, an intensive training project commenced from fiscal 2004 to ensure "expert workman techniques related to shipbuilding, could be smoothly passed on to the younger generation. Beside that there are a huge governmental toward marine educational such as establish separate faculty specialized in ports and maritime transport, navigation, surveying and marine engineering.

3. Assurance of Safe, Secure and Environmentally-Friendly Marine Transport

3.1. Reinforcement of Safety Assurance Measures

Reinforcement of the audit of safety management and seafarer's labor / guidance system In recent years, there have been intense efforts to ensure navigational safety in the form of the appropriate navigational control of ships and improved working environment of seafarers, Since accidents involving ships, including coastal freighters or ultrahigh-speed vessels, have been Occurring. The safety assurance of vessel navigation is the responsibility of the Inspector for Safety Management and Seafarers Labor, who is appointed in each regional transport bureau and so forth, after the unification of the Inspector of Navigation in charge of inspection on safety Management of passenger boats as well as the freighters and the Inspector of Seafarer's Labor in charge of the working conditions of seafarers. Therefore, an efficient and agile audit can be performed by the executive officer, who has a wide supervisory authority related to the business laws (Maritime Transportation Law, Coastal Shipping Business Law) and seafarers-related laws (Seafarers Law, Seafarers Employment Security Law, Law for Ships' Officers and boats 'operators).

Moreover, the training system has been reinforced, and a new audit system has been Constructed, capable of checking the past audit status, record of contraventions and so forth any time on the spot during the audit, in order to enhance accuracy when the Inspector for Safety Management and Seafarers Labor is executing duties over a wide area, in order to conduct unified planning / gestation and guidance for the services to be provided by the Inspector for Safety Management and Seafarer's Labor.

Measures to prevent recurrence when a serious accident occurs When a serious ship accident occurs, measures are taken, with the cooperation of the Saudi's Coast Guard and so forth, such as prompt inspection, an examination to find out the cause, reprimand or guidance of the party concerned, in accordance with the laws for reconstructing the safety management system, and the implementation of thorough safety management in order to prevent the recurrence of similar accidents on a nationwide basis and so forth oceangoing vessel grounding accident in the offing of the Kashima port and so forth.

Measures to ensure the safety of ultrahigh-speed vessels In recent years, accidents caused by the collision of hydrofoil type ultrahigh-speed vessels, navigating at a high velocity of about 40 knots, and whales and the like have occurred one after the other in the seas around Japan. In consideration of

such circumstances, the Ministry of Land, Infrastructure and Transport established the "Safety Measures Advisory Committee for Ultrahigh-Speed Vessels" in April, 2006 to study how to ensure the safety of hydrofoil type ultrahigh-speed vessels and finalized an interim summary report in August the same year.

Moreover, it was decided that unified guidelines for the content of training and the training period for the navigation personnel of hydrofoil type ultrahigh-speed ships should be provided, and it has also been decided that the "Guidelines for the Training of Navigation Personnel of Hydrofoil Type Ultrahigh-Speed Vessels" are to be formulated to improve the training level by the end of fiscal 2007.

Introduction of transport safety management system "Law Revising a Part of the Railway Business Law etc. for the Improvement of the Safety of Transportation" (Law No. 19 of 2006) was approved in the Diet and put into effect in October, 2006, to deal with circumstances whereby the trust in the safety of public transportation facilities for the nation was seriously eroded and seek to enhance the safety management system. Thereby, the transport safety management system was applied to the marine transportation field in addition to traffic fields, such as rail and air transport.

Implementation of The Voluntary IMO Member State Audit Scheme In the wake of large scale accidents involving oil spillages from tankers, there has been an increasingly urgent need to eliminate substandard vessels. The background involves the present situation having been illustrated, in which the government of the flag state has failed to satisfactorily meet obligations to supervise and oversee ships of its own flag, to ensure they observe the international standard. Which audit scheme by International Maritime Organization (IMO) on the enforcement of the conventions by the flag states, and after considerations under IMO to seek a means to have the government of the flag state meet its obligations under the conventions and subsequently to introduce the audit scheme, the implementation of the audit scheme was adopted at the 24th Session of the IMO Assembly in December, 2005, and has started since September, 2006.in recognition of the fact that the operation is conducted comprehensively and efficiently to meet obligations under the international conventions, from all the viewpoints of flag, port and coastal state, including the construction of the "Maritime Affairs Quality Management System", the nurturing of inspectors, and the establishment of the system of Port State Control (PSC) implementation and so forth.

Drastic reform of the pilotage system As Saudis' seafarers have become increasingly scarce in recent years, a shortage of pilots with sea captain experience is anticipated in the near future, raising apprehension of a potential inability to maintain smooth shipping traffic operations. Furthermore, in view of the increasing demand for improved operational efficiency / accuracy of the piloting service forming part of the port service, and based on the perspective of strengthening the international competitiveness of Saudi's ports, the Pilotage Service System" was established, within which discussions concerning the desirable nature of the pilotage system took place, and a bill partially amending the Marine Pilot Law ("Bill for the Partial Amendment of the Port Law and Others for Strengthening the Basis of Maritime Distribution").

Reinforcement of safety and security measures in the Straits of Malacca and Singapore In order to promote the measures against piracy and armed robbery against ships, the guideline was compiled in March 2006. Based on this guideline, Ministry of Land, Infrastructure and Transport has decided to promote various measures even more strongly in order to reduce the number of the incidents by pirates and armed robbers, through efforts for cooperation with related agencies and shipping industries, and through enhancement of maritime security in international society. As part of efforts for international cooperation in the Straits of Malacca and Singapore, survey of traffic volume was conducted to gage how many ships were actually navigating in the Straits. The results of a survey made clear that beside Saudi, many other countries were the beneficiaries in various ways from the passage through the Straits. For enhancing safety of navigation and environmental protection were proposed by the littoral states, and the "Kuala Lumpur Statement" was adopted, outlining cooperation and so forth, toward establishing mechanism to provide funding for the projects such as replacement and maintenance of Aids to Navigation. In order to establish a new framework for international cooperation including foundation of Aids to Navigation Fund, Japan, as one of the major user states of the Straits, contribute proactively to the future progress of discussions at international conferences and so forth.

4. Tackling Environmental Problems

4.1. Countermeasures against global warming

In order to attain the targets for reduction accordance Protocol through the promotion of a modal shift from transportation by truck to coastal shipping and so forth, the targeted goal in the maritime transportation-related sector is a reduction of around 1.4 million tons in the CO_2 emission volume by fiscal 2010, and the Maritime Bureau is implementing "Comprehensive Measures for the Greening of Maritime Transportation" in order to attain the said reduction target. In addition, in order to prevent any increase in the CO_2 emission volume from the transportation sector, such as from automobiles and ships, using petroleum and similar fuels, the Energy Saving Law was revised in fiscal 2005 (put in force on April 1, 2006), which obliges shipping service operators with a transport capacity exceeding a certain scale (holding ships with gross tonnage of 20,000 tons or more) in the maritime transportation-related sector.

4.2. Tackling ship recycling system at an international level

Since the poor conditions of the related labor environment, sea pollution originating from recycling yards and so forth are viewed as problems related to ship recycling (the dismantlement of ships) conducted in developing countries, in recent

years, a study is underway in international organizations, such as the United Nations Environmental Programme (UNEP), International Maritime Organization (IMO), International Labour Organization (ILO) and so forth to try and solve such problems. In particular, the IMO has decided to formulate a new convention concerning ship recycling in 2008-2009, and discussion of the convention draft is progressing.

4.3. Efforts to ratify the ILO Maritime Labour Convention

At the 94th (Maritime) Session of the International Labour Organization (ILO) Conference held in February, 2006, the Maritime Labour Convention 2006 was adopted, which consolidates all the 60 or so conventions and similar bodies that have been adopted to date since the 1919 establishment of ILO, to ensure they reflect the present era, and simultaneously improve their effectiveness. It has been decided that future efforts for the preparation and study required to ratify this convention, such as the arrangement of domestic laws, an enforcement system and so forth for governing inspections of flags state or PSC, etc. will be advanced, and, at the same time, coordination and cooperation with the countries in the Asia region will also be promoted in order to expedite ratification by the same.

5. Tackling Maritime Policy and Regional Revitalization and so Forth in the Area of Maritime Affairs

5.1. Dealing with Basic Act on Ocean Policy Basic Act on Ocean Policy

Which contains the basic concepts of ocean policy, government responsibility, local public bodies and so forth, as well as basic measures etc., (put in force on July 20, 2007). While the Maritime Bureau has been promoting such various measures to date, including improvement in the environment of international competitiveness, assurance of stable transportation, promotion of the marine business and support for various kinds of research and development as well as nurturing and securing human resources, it has been recognized, in view of the enforcement of the "Marine Basic Law", that various measures toward the realization of a sea-oriented state shall be promoted concentrically and comprehensively in future, as in the past and the decision has also been taken to diligently strive for the further development of the marine industry as a whole and reinforcement of its international competitiveness.

5.2. Efforts for regional revitalization

In view of the severely worsening circumstances surrounding public transport in local areas, the "Act for Revitalizing and Reviving Local Public Transport" was enacted in May, 2007 for the purpose of implementing measures for the smooth introduction of a new form of passenger transport service suited to local needs, as well as comprehensive government support for the joint efforts of related local parties led by the municipality, so that they may create attractive regions through the revitalization and revival of local public transport.

6. Efforts Exploiting the Advantage of Marine Transport

a) Enhancing the appeal of voyages by sea and the promotion of coastal passenger ships, including encouragement of sightseeing tours to and from remote islands In view of the interim proposal compiled at the "Roundtable Conference for Reviving the Attractiveness of Voyage by Sea" in June, 2006, the topics of "Enhancing the appeal of Voyages by Sea" and "Promotion of Sightseeing Tours to Remote Islands" have been positioned as the most important measures of fiscal 2006. With a view to enhancing the appeal of "Voyages by Sea in Casual Wear".

b) Promotion of a future business model for coastal shipping the coastal shipping industry has faced various problems, such as securing seafarers, building ships for replacement and safety assurance. However, under present circumstances, it is difficult for coastal shipping operators, who are mostly medium, small and micro enterprises, to work on these problems individually. Under such circumstances, a movement for the loose grouping of coastal shipping operators, utilizing ship administration companies, is attracting attention. It is important to promote these grouping movements as a new business model of coastal shipping for the future, in order to ensure stable marine transport and revitalize coastal shipping. For this purpose, the national government has positively started striving for its propagation and promotion.

7. Efforts to Promote the Construction of New Coastal Vessels to Replace Old Ones

Coastal shipping is one of the trunk distribution industries in Japan which supports its economy and national life, accounting for about 40% of domestic distribution, and in particular, about 80% of transport of fundamental goods for industry (steel, petroleum, cement and so forth).In recent years, the tendency toward an "aging population combined with diminishing birthrate" has advanced rapidly in the coastal shipping sector, which supports the above-mentioned activities. Given the importance of revitalizing coastal shipping in order to realize the construction of new coastal vessels replacing old ones on a stable and adequate scale, an "Action Plan for Promoting the Construction of New Coastal Vessels to Substitute Old Ones" was formulated in March, 2006 to solve those problems.

8. Maritime security in ports

8.1.Examples of maritime terrorist

There are some examples of maritime terrorist attacks that we all remember such as e.g.:

The USS Cole bombing was a suicide attack against the US Navy guided missile destroyer USS Cole (DDG 67) on October

12, 2000 while it was harboured in the Yemeni port of Aden. A small craft approached the port side of the destroyer and an explosion occurred, putting a 35-by-36-foot gash in the ship's port side. The blast hit the ship's galley, where crews were lining up for lunch. Seventeen sailors were killed and 39 others were injured in the blast.

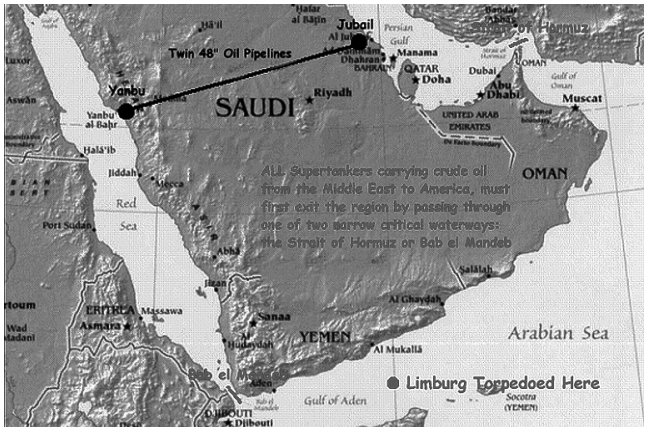
Source: USA Navy

Figure 1: USS COLE.

Source: USA Navy

Figure 2: USS COLE - impact of small suicide launch.

On October 6, 2002, the m/t Limburg was carrying 397,000 barrels of crude oil from Iran to Malaysia, and was in the Gulf of Aden off Yemen to pick up another load of oil. It was registered under a French-flag and had been chartered by the Malaysian petrol firm On October 6, 2002, the Limburg was carrying 397,000 barrels of crude oil from Iran to Malaysia and was in the Gulf of Aden off Yemen to pick up another load of oil. It was registered under a French flag and had been chartered by the Malaysian petrol firm Petronas. While it was some miles offshore, an explosives-laden dinghy rammed the starboard side of the tanker and detonated. The vessel caught fire and approximately 90,000 barrels of oil leaked into the Gulf of Aden .A 38 year-old Bulgarian crew members was killed and 12 other crew members were injured.



Source: USA Navy

Figure 3: Offshore location of m/t Limburg attack.

Source: USA Navy

Figure 4: Impact of dinghy on m/t Limburg.

By far the most lethal maritime terrorist incident this millennium was the attack on the m/v Super ferry 14 in Manila by the Abu Sayyaf Group on 27 February 2004. Just after midnight local time, a bomb exploded on board the passenger ferry, which had left Manila Bay two hours earlier. The resulting fire caused the ship to capsize and more than 116 people were killed in the attack. On that day, the 10,192 ton ferry was sailing out of Manila with about 900 passengers and crew. A television set filled with 8 lb (4 kg) of TNT had been placed on board, 90 minutes out of port, the bomb exploded, 63 people were killed immediately and 53 were missing and presumed dead.

The November 5, 2005, pirate attack on the Seaborne Spirit cruise ship 100 miles off the Somali coast was the 25th such incident in the last six months. Six vessels are currently

Source: MNS News

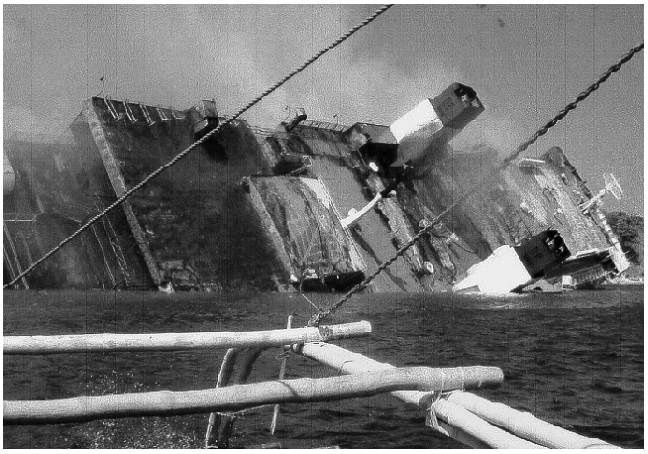


Figure 5: M/V Superferry 14 after bombing

Source: MNS News

Figure 6: M/V Super ferry after capsizing

being held by pirates, one of them captured at a distance of 120 miles from the coast. The Seaborne Spirit managed to evade being boarded by two boatloads of pirates on inflatable speedboats armed with grenade launchers and machine guns. The ship, with more than 300 people on board, was on its way to the Kenyan port of Mombasa where it was due to pick up more passengers, including Australians. The ship came under attack at 5.30 a.m. as the pirates approached in at least two speedboats shooting at the ship with grenade launchers and machine guns. They were repelled by the ship's crew who set off electronic countermeasures, described as "a loud bang" by one of the passengers. One crew member was slightly injured in the early-morning incident. There was at least one RPG that hit the ship, one in a stateroom. There were calls for a naval task force to try to stop attacks in Somali waters - among the most dangerous in the world.

In Southeast Asia in particular, since the September 11 attacks a number of worst case scenarios have been postulated by the media and academics alike. The formation of a terrorism-piracy nexus was, and still is, seen as a potential alarming development. It was believed that given the high rates of piracy seen in the region's waterways, coupled with the valuable knowledge and skills of the pirates, it was only a matter of time before terrorists teamed up with pirates. The possibility of terrorists blocking strategic waterways like the Malacca and Singapore Straits was also seen as a real threat. Predictions were made that militants could sink a large vessel at a narrow chokepoint in one of the region's waterways, block the passage of shipping and cause widespread economic chaos. Despite these isolated incidents of maritime terrorism and the predictions of worst case scenarios, maritime terrorist attacks are, and have remained, quite rare. They constitute only two percent of all international terrorist incidents over the last three decades. While there is no doubt that a number of terrorist organizations have the desire or motivation to carry out attacks of this kind, in general there is still currently a lack of capability in this area of operation and it is likely to remain the case in the immediate future. Attacks against maritime targets require specialized equipment and skills; they also might require some knowledge of local shipping patterns, boat operation and maintenance, and boarding techniques. Even the attack involving the USS Cole, conceivably one of the simplest methods of attacking a maritime target, failed in its first attempt. The original intended mark was in fact the USS The Sullivan. However, in their first try at launching the suicide boat, the al-Qaeda operatives underestimated the weight of the explosives they were carrying on board and the boat sank as it entered the water. Although, at present, the probability of a large-scale maritime attack is low, the threat of maritime terrorism must not be ignored altogether. There is evidence that preliminary steps have been made by the al-Qaeda network in particular to develop some competency in this area. Recently, a basic diving manual was recovered in Kandahar in Afghanistan and it is believed that this is evidence of a larger plan to set up and run a diving school. J.I. (Jemaah Islamiyah's) has also been conducting training in the southern Philippines in order to develop underwater destruction capability. In addition, J.I. and a number of other jihadist groups based in Indonesia already fully exploit the maritime domain for the purposes of transporting people and arms to and from the Philippines. The threat of terrorist acts against the shipping and port industry is real and not imaginary. It is for these reasons the Assembly of IMO, in November 2001, decided that the organization should review measures and procedures to prevent acts of terrorism that threaten the security of passengers and crew and the safety of ships. It is also obvious that the Contracting Governments to the 1974 SOLAS Convention, when they adopted the special measures to enhance maritime security in December 2002, were well aware of potential threats.

9. Maritime Transportation Security Act of 2002 (MTSA)

After the terrorist attack of 9/11 in 2001 on the WTC twin towers the fear of imports of mass destruction weapons or terrorists transported by ships in containers was imminent and the US took measures by installing the Maritime Transportation Security Act of 2002 (MTSA) in January 2002. The goal of MTSA is to prevent a Maritime Transportation Security Incident (MTSI) with: Loss of life. Environmental damage. Transportation system disruption. Economic disruption to a particular area.

MTSA calls for a series of plans on the national, port and individual vessel/facility level - this "family of plans" concept worked well for oil spill response and was used to increase MTSA awareness throughout the maritime community to coordinate information and to deal with potential threats. Vessels and facilities that load/carry certain dangerous cargoes (flammable, potentially explosive, caustic or environmentally hazardous) must have individual security plans that address fundamental security measures such as access controls, communications, restricted areas, cargo handling and monitoring, training and incident reporting.

The "port plan" called the Area Maritime Security Plan covers facilities and waterway venues such as parks or public piers that are not required to have individual security plans. The AMS plan is developed and implemented by an Area Maritime Security Committee with representatives from federal, state, and local governments as well as industry and the public sector. These Committees and the AMS plans are the backbone of communicating and coordinating surveillance and preparatory measures as threats to our maritime infrastructure warrant.

10. CSI/CTPAT (Supply Chain Security)

One of the Customs and Border Protection (CBP) programmes is the Container Security Initiative (CSI) programme for CBP-inspectors at large overseas ports. The duty of such inspectors is to pre-screen cargo containers being shipped to the United States, i.e. identify and inspect high risk containers before they are loaded on ships at their port of origin. The programme focuses on four core elements:

1. Using automated information to identify and target high-risk containers.
2. Pre-screening containers as high risk before they arrive at a US port.
3. Using detection technology to quickly pre-screen high-risk containers.
4. Using smart, tamper-proof containers.

Companies and organizations become participants in the programme by defining and implementing a formal internal supply chain security programme based on a self-assessment against guidelines provided by the CBP that address various items such as procedural security, physical security, education and training, access controls, manifest procedures and conveyance security. Customs and Border Protection instituted the 24-Hour Rule, which requires information on cargo destined for the United States to be submitted through the CBP Automated Manifest System (AMS) by the carrier or by a "non-vessel operating common carrier" if they are AMS certified. The rule requires detailed descriptive information for all cargo. It requires cargo vessels entering ports to provide a cargo manifest 24 hours before leaving their last foreign port. A "Do Not Load" order may be issued for the carriers at the foreign port for cargo that does not meet the 24-Hour Rule. Some new programmes focus on point-to-point verification of the global supply chain. Operation Safe Commerce (OSC) and Safe and Secure Trade Lanes (SST) both aim at finding reliable and cost effective procedures and technologies to track containers from their point of origin to their final destination. Operation Safe Commerce (OSC) is a public/private partnership implemented by the Transportation Security Administration. OSC is dedicated to finding methods and technologies to protect commercial maritime shipments from the threat of terrorist attack, illegal immigration and other contraband while minimizing the economic impact on this critical transportation system. It is a federally funded programme providing a test-bed for new techniques to enhance the security of containerized shipping, from the overseas point of origin throughout the supply chain to the US point of distribution. Those security techniques that prove most successful under the programme will then be recommended to create international standards for secure and efficient containerized shipping.

11. CSI: Container Security Initiative (12-04-2002)

Containerized shipping is a critical component of international trade. According to the CBP: about 90% of the world's trade is transported in cargo containers almost half of incoming US trade (by value) arrives by containers onboard ships nearly seven million cargo containers arrive on ships and are unloaded at US seaports each year. As terrorist organizations have increasingly turned to destroying economic infrastructure to make an impact on nations, the vulnerability of international shipping has come under scrutiny. Under the CSI programme, the screening of containers that pose a risk for terrorism is accomplished by teams of CBP officials deployed to work in concert with their host nation counterparts.

11.1. CSI consists of four core elements

1. Identify high-risk containers. CBP uses automated targeting tools to identify containers that pose a potential risk for terrorism, based on advance information and strategic intelligence.
2. Pre-screen and evaluate containers before they are shipped. Containers are screened as early in the supply chain as possible, generally at the port of departure.
3. Use technology to pre-screen high-risk containers to ensure that screening can be done rapidly without slowing down the movement of trade. This technology includes large-scale X-ray and gamma ray machines and radiation detection devices.
4. Use smarter, more secure containers that will allow CBP officers at United States ports of arrival to identify containers that have been tampered with during transit.

The initial CSI programme has focused on implementation at the top 20 ports shipping approximately two-thirds of the container volume to the United States. Smaller ports, however, have been added to the programme at their instigation and participation is open to any port meeting certain volume, equipment, procedural and information-sharing requirements. Future plans include expansion to additional ports based on volume, location and strategic concerns. The CSI

programme offers its participant countries the reciprocal opportunity to enhance their own incoming shipment security. CSI partners can send their customs officers to major US ports to target ocean-going, containerized cargo to be exported from the US to their countries. Likewise, CBP shares information on a bilateral basis with its CSI partners. Japan and Canada are currently taking advantage of this reciprocity. CSI has also inspired and informed global measures to improve shipping security. In June 2002, the World Customs Organization unanimously passed a resolution that will enable ports in all 161 member nations to begin to develop programmes according to the CSI model. On 22 April 2004, the European Union and the US Department of Homeland Security signed an agreement that calls for the prompt expansion of CSI throughout the European Community.

12. C-TPAT-Customs-Trade Partnership against Terrorism

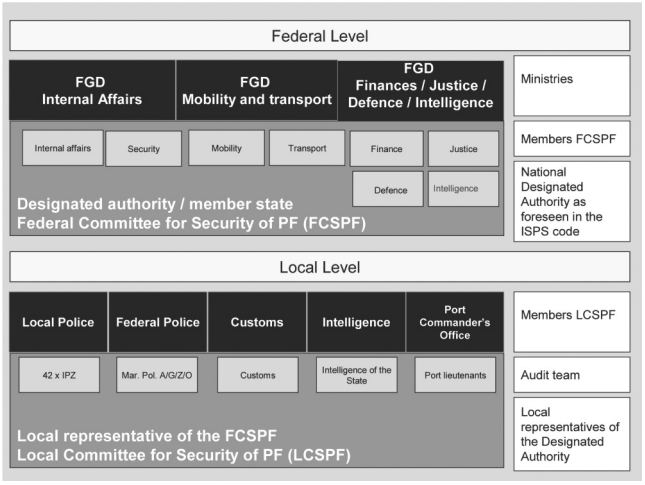
C-TPAT is a joint government-business initiative to build cooperative relationships that strengthen overall supply chain and border security. C-TPAT recognizes that Customs can provide the highest level of security only through close cooperation with the ultimate owners of the supply chain: importers, carriers, brokers, warehouse operators and manufacturers. Through this initiative, Customs is asking businesses to ensure the integrity of their security practices and communicate their security guidelines to their business partners within the supply chain. C-TPAT offers trade-related businesses an opportunity to play an active role in the war against terrorism. By participating in this first worldwide supply chain security initiative, companies will ensure a more secure and expeditious supply chain for their employees, suppliers and customers. Beyond these essential security benefits, CBP will offer benefits to certain certified C-TPAT member categories, including:

- A reduced number of CBP inspections (reduced border delay times).
- Priority processing for CBP inspections (front-of-the-line processing for inspections when possible).
- Assignment of a C-TPAT Supply Chain Security Specialist (SCSS) who will work with the company to validate and enhance security throughout the company's international supply chain.
- Potential eligibility for CBP Importer Self-Assessment programme (ISA) with an emphasis on self-policing, not CBP audits.
- Eligibility to attend C-TPAT supply chain security training seminars.
- International Ship and Port Facilities Security Code (ISPS code).

The ISPS code is limited to ships over 500 gt. the main objectives of the ISPS code are as follows:

- To detect security threats and implement security measures.
- To establish roles and responsibilities concerning maritime security for governments, local administrations, ship and port industries at national and international level.
- To collate and promulgate security-related information.
- To provide a methodology for security assessments so as to have in place plans and procedures to react to changing security levels.

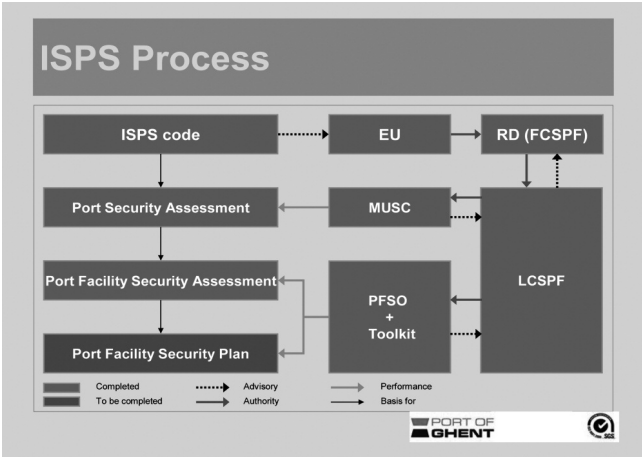
In Belgium they installed a central Federal Committee for the Security of Port Facilities (FCSPF) and a Local Committee for the Security of Port Facilities (LCSPF) for each seaport. The members of these committees are shown below:



Source: FCSPF

Figure 7: Federal and Local Committees for the Security of Port Facilities.

The process and flow chart used by the port authority of Ghent is illustrated below:



Source: Port of Ghent

Figure 8: ISPS Process.

A ship has to give his security level (SL 1, 2 or 3) 24 hours before arrival in port. It is the designed authority of the government of the flag state that decides about the SL of its ships. The master of the ship can take extra security measures if he wants, but he cannot put his SL on a higher level. Only emer-

Source: Port of Ghent

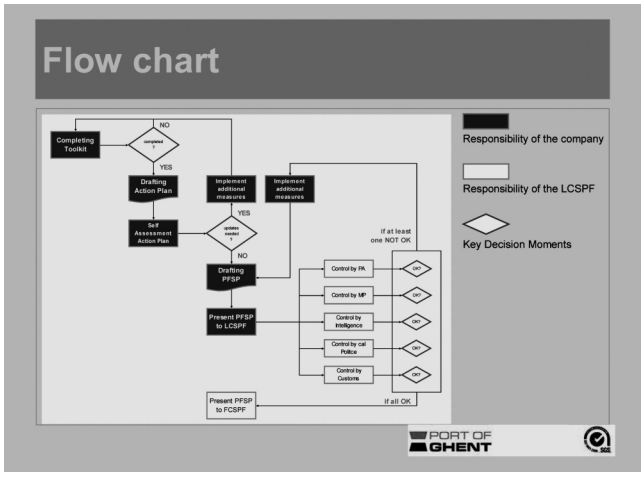


Figure 9: Flow chart.

gency safety measures can overrule the security measures provided in the SSP (Ship Security Plan). If the SL of the port facility is higher than that of the ship, then the SSO (Ship Security Officer) has the obligation to equalize the security level of the ship. When the ship has a higher security level than that of the port facility, the SSO together with the PFSO (Port Facility Security Officer) have to make up a DOS (Declaration Of Security).

It is the designed authority of the government of the port that decides about the SL of the port facilities in the port area. The security measures for each SL are written in a PFSP (Port Facility Security Plan).

The security measures are more severe when the SL is higher and also depend on the risks that can be encountered at the port facility. For instance a dangerous goods terminal, a passenger terminal or a container terminal will be fenced and guarded. An open bulk terminal, with no dangerous commodities, will only be fenced and guarded on the ship/shore interface when we have an SL 2 or 3. At security level 1 we have business as usual, without any economic constraints. The security measures can be visualized in the following templates:

There is always access control to the ship on each security level. This can be done by means of authorised passes delivered by the port authority or the federal government (e-id card) or by the (e.g. alfapass), be it an authorised visitor badge as described in the PFSP.

Source: Author

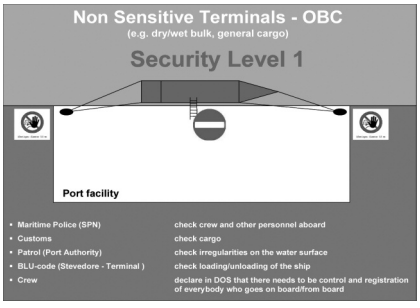


Figure 10: Non sensitive terminals - OBC - SL1.

Source: Author

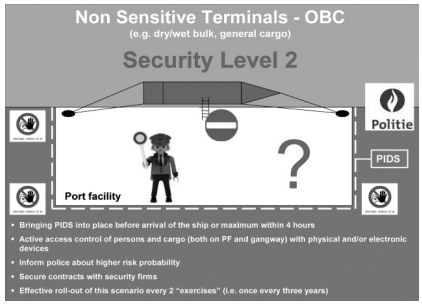


Figure 11: Non sensitive terminals - OBC - SL2.

Source: Author

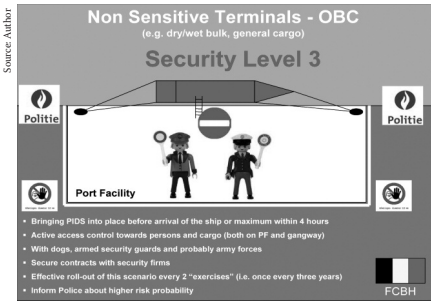


Figure 12: Non sensitive terminals - OBC - SL3.

Source: Author

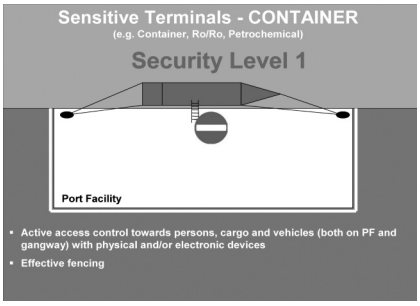


Figure 13: Sensitive terminals - containers - SL1.

Source: Author

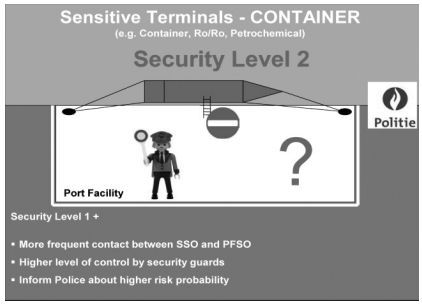


Figure 14: Sensitive terminals - container - SL2.

Source: Author

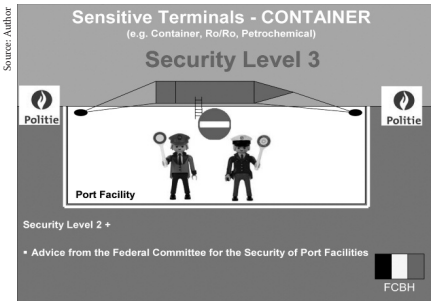


Figure 15: Sensitive terminals - container - SL3.

Source: Author

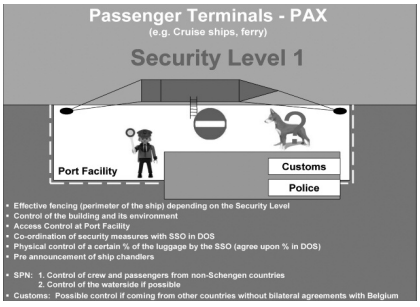


Figure 16: Passenger terminal - SL1.

Source: Author

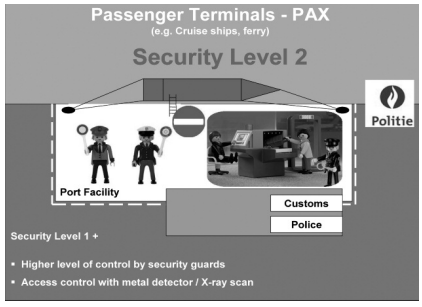


Figure 17: Passenger terminal - SL2.

Source: Author

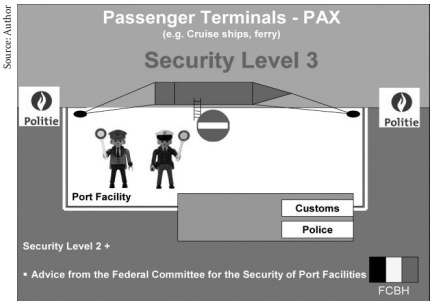
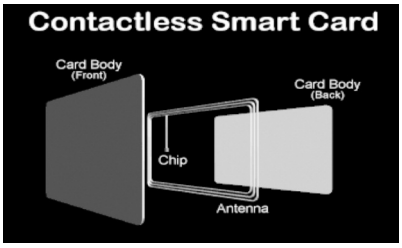


Figure 18: Passenger terminal - SL3.

Conclusions



Source: PISO

Figure 19: Alfapass RFID-card port.

The Saudi government should have taken implementation various security measures, the government's Maritim e Transportation Security Act of 2002 (MTSA) provides additional security to Saudi ports. The International Convention for the Safety of Life At Sea (SOLAS) and the International Ship and Port Facility Security Code (ISPS) provide further security. and should concern with the following aspects:

A ship security plan must outline measures to prevent weapons and other items that could be used to harm passengers and crew from being brought aboard the ship, unless carried by authorized personnel.

A ship security plan has to list restricted areas on a ship and how access to those areas will be deterred. How unauthorized ship access will be prevented also must be detailed.

The plan should include what response measures will be taken when there is a security breach or threat, including maintaining ship operations. How responses to security commands from government agencies will be handled also must be included, as well as how the ship will be evacuated if necessary.

The plan will list security responsibilities of the crew, including auditing security, training for implementation of security measures, reporting security problems and reviewing and updating the plan periodically.

The plan must indicate when security equipment is tested, where security system activation locations are and procedures and training regarding the security system.

The security plan must designate who the security officer is on the ship. The security officer is responsible for ensuring the ship's security and that the plan is carried out. The security officer also oversees security maintenance and training. A second security officer from the company owning the ship also is mandated, with that person working to develop the plan and having it approved by the company before implementation. The company security officer acts as a liaison with the ship security officer.

ISPS or International Ship and Port Facility Security, code implemented a ship security plan and provided preparation for action in the event of a terrorist attack on a ship. The Act requires commercial yachts heavier than 500 GT to be certified. ISPS security training also enacted mandatory training against piracy attacks and includes both ship and port personnel.

Several categories of job types are required to receive training in order to comply with safety requirements. This include the company security officer, the vessel security officer, the head company/vessel/ship security officer, the facility security officer, facility or vessel personnel with specific security duties, port facility security officer and other ship or port facility personnel with specific security duties.

A wide variety of specific training subjects prepare personnel to address safety issues. Classes include general maritime security, port awareness, tactical operations, tactical boat operations, safe boarding techniques and procedures, incident response, tactical underwater operations, emergency medical procedures, basic and advanced fire fighting, crowd control, crisis management, advanced sea survival, basic first aid, first aid care at sea, personal survival techniques, personal safety and liability and medical refresher.

The MTSA requires SOLAS-certified vessels that are over 300 gross tonnage (GT), to carry an automated identification system. This rule also applies to small passenger vehicles that are certified to carry more than 150 passengers. The original version of the rule also applied to specified commercial vessels on international voyages, as well as certain other commercial vessels, but the government rethought this revision after the vessel operators complained about the costs of installing such systems.

Owners of foreign SOLAS vessels do not have to submit security plans to the Saudi Roles for approval. However, under MTSA regulations, non-SOLAS foreign vessels still have to submit security plans accordance Saudi Roles for approval. They may also comply with an alternative security plan, or with measures suggested in another bilateral or multilateral agreement. The Saudi Authority should have to examine and enforces a vessel's compliance with international security regulations and may deny non-compliant vessels entry to Saudi ports.

The Saudi Authority maritime security requirements allow some flexibility for non-SOLAS vessels and port facilities to participate in alternative security programs if they wish to. This allows them to tailor security measures to the requirements of their industries. However, all vessels must follow security plans.

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International Code for the Security of Ships and of Port Facilities (ISPS) Code Overview.

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Floating Oil Storage: A Means to Increase Oil Profits or Evidence of the Effectiveness of the Embargo on Iran?

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ABSTRACT

This article begins by introducing the nature of the tanker market in recent years and the main reasons for deflecting tankers from their normal usage of transporting oil and converting them into floating storage devices due to changes in the market structure. The research then defines the reasons for using tankers for floating storage and concludes with a depiction of the use Iran makes of floating storage in its attempt to contend with the volatile situation of the oil market.

The oil tanker market has considerable influence on the modern economy. The increasing importance of oil as one of the main elements in energy consumption caused the tanker market to become a significant and influential factor in the oil industry. In 2009, for example, half of the 88 million barrels of oil consumed worldwide was transported by various types of tankers, with the rest being transported overland. However, changing consumption patterns, government maritime laws, dependence on tanker building companies and the need to scrap some of the tankers due to superannuation or surplus have made the market very volatile and been detrimental to tanker industry profits. Generally speaking, factors such as world demand for oil products, the distance between oil producing countries and oil consuming countries, the laying of transatlantic pipelines, the number of tankers converted to floating storage devices, and tanker availability as well as the number of tankers designated for scrapping have influenced the industry and its cost effectiveness.

1. Introduction

From time to time, oil companies convert oil tankers into "floating oil storage". Floating Oil Storage is a system that makes use of tankers, normally used to transport crude oil, for temporary storage. Tankers converted for storage anchor in various ports for short periods of between 4 to 6 weeks, and sometimes for longer periods of 3 to 6 months. In most cases, VLCC tankers are used for floating oil storage because they have the capacity to hold about 2 million barrels of oil. Since 2006, floating oil storage has increased due to European environmental laws, trader machinations to increase their profits, tightened sanctions on Iran and the marked changes in oil production and oil consumption patterns. In recent years, Iran has become the main player on the floating oil storage market. Between 2008 and 2009, Iran used floating oil storage both to raise profits and to adhere to its budget. In 2010 and 2011, however, the increase in floating oil storage proved the effectiveness of sanctions on Iran and emphasized Iran's difficulties in selling its products to oil companies and to Western states (Lee Taseoo, 2004; EIA, 2011).

The economic crisis that erupted in August 2008 caused the tanker industry to collapse and to revert to the difficult situation it had been in during the 1980s. Unlike with other industries, however, the crisis in the shipping industry was already predictable at the end of 2006 when, although there was a sharp increase in oil consumption, a larger than necessary number of tankers were put to use. Indeed, there were 2,098 tankers in 2001, and that number had risen to 4,177, with only 85% in use, by 2006. Despite the warning signals, the shipping companies only began to realize the depth of the crisis when the economic crisis in the United States worsened. As a result of a lack of activity and a sharp decrease in profits, the number of tankers sent for scrap rose significantly. For example, 826 tankers were sent for scrap in the 2 years period between 2005 and 2007, while a similar number was sent for scrap within the very short period between the end of 2008 and April 2009. The economic crisis also caused oil companies with big tanker fleets to increase their floating storage in order to reduce the number of vessels at hand, thereby enabling them to raise daily freight rates. In November 2009, for example, 141 oil tankers, about one tenth of world tankers, were reported to have been converted for floating storage, which proves the extent of the crisis (OPEC, 2009).

The shipping and tanker industry continued to lick its wounds in the years that ensued the crisis. Indeed, despite the

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revival the industry underwent in 2010 when freight prices temporarily increased, the tanker market reverted to its lack of stability in 2011, mainly because orders for new tankers had been made before the crisis and could not be cancelled. Between July and October 2011, for example, the average cost for leasing a VLCC (Very Large Crude Carrier) was $12,000 per day, the lowest it had been since the mid-1980s. For that reason, the shipping companies were forced to scrap tankers that had been in use for less than 15 years while they had, heretofore, only scrapped tankers that were at least 22 years old. Furthermore, there has been a significant decrease in orders for new tankers: according to the Gibson ship broking company, the 5.6% increase in 2010 decreased to 2.1% in 2011. As a result of the slowdown in orders and failed attempts to be more efficacious, many companies went bankrupt and others slowed down shipping speeds in order to minimize operating costs. Despite the drastic steps taken, however, there were 64 new VLCC tankers at the end of 2009 and, according to estimates, there will be an additional 80 such tankers by the end of 2012, which will bring about unprecedented excess in tankers and cause freight rates to be low. Moreover, the crisis in the industry was further deepened by the tsunami that hit Japan in March 2011 and caused a decrease in demand for oil products, as well as the sharp decrease in Libyan oil production, all of which also resulted in lessened need for tankers. The state of the tanker market in recent years has caused freight rates for VLCC tankers on the Japan – Persian Gulf route to go down to a mere $5,000 per day, in contrast with the average freights rate of $160,000 per day in May 2008 (Wiese Bockmann, 2008; Tankers 2011; McCarth, 2011 ; VLCC opportunities, 2011).

2. The Use of Tankers for Floating Storage

Oil companies sometimes convert oil tankers for floating storage use. Floating storage is a way to make use of tankers, which are ordinarily used to transport crude oil, for temporary storage. Tankers that are converted for storage use anchor in various ports for short terms of between 4 and 6 weeks, and sometimes for longer terms of between 3 and 6 months. In most cases, VLCC tankers are used for floating storage because of their capacity to store about 2 million barrels of oil. Usage of tankers for floating storage has grown since 2006 due to European environmental laws, trader machinations to increase profits, tightened sanctions on Iran and the marked changes in oil production and oil consumption patterns. All those factors have had an influence, both short and long term, on oil prices.

The use of oil tankers for floating storage grew in October 2003 when the European Union drafted a resolution to gradually prohibit single hull tankers from anchoring in European ports. That resolution was yet another in a long line of resolutions that aimed at reducing pollution and preserving the environment in EU countries. The resolution even stated that the EU would work towards ensuring that similar laws be adopted by international organizations and by shipping organizations, and indeed, as soon as the resolution was passed, single hull tankers carrying crude oil were prohibited from anchoring in European ports. The resolution also included a plan for the tanker industry to gradually phase out single hull tankers. It was resolved, for example, that single hull tankers carrying 20,000 tons would be prohibited from entering E.U. ports by 2005. The next stage was a resolution that MARPOL tankers, which had less potential to damage the environment, would also be prohibited from entering European ports as of 2010. As a result of the tough European legislation, there was a significant cutback in single hull tanker fleets between 2003 and 2010. In 2011, there were a mere 57 such tankers in the world, mainly in China, Brazil and Indonesia, compared to 628 tankers in 2007. As a result of the limitations against single hull tankers, companies began to take them off the market and many were converted into floating storage vessels in order to avoid scrapping them. Floating storage, which had heretofore been negligible, now began to increase because of the legislation (Wiese Bockmann, 2007; McCarthy, 2011).

The afore-mentioned sub-prime crisis in the United States was unprecedentedly detrimental to the shipping industry in general, and to the tanker industry in particular. The sharp decrease in economic activity and the reduced demand for oil products became a problem for the tanker industry, which absorbed heavy losses. At the beginning of August 2008, the price of a barrel of WTI oil on the New York Mercantile Exchange was $148.31, as compared to $35.59 in December 2008. Despite the economic depression and the steep drop in demand for oil products, however, many traders believed that the price of oil would rise and therefore hastened to store oil in tankers in order to later sell it at higher prices. Oil pumping was now not advantageous for the OPEC states due to the drop in oil prices, and they therefore had to cut production in order to raise prices, and indeed, OPEC's decision to cut production in November 2008 encouraged many traders to store oil in floating storage. Between January and April 2009, an average of 45 to 50 tankers out of a total number of 532 VLCC tankers were used for floating storage in order to take advantage of potential future profits from gradual oil price increases (Wingrove**,** 2009; Joshi**,** 2009).

3. Iran's Role in the Floating Oil Tanker Market

Iran has become more powerful in the tanker market in recent years. The National Iranian Tanker Company (NITC), which was privatized in 2009, turned Iran into the most important player in the oil tanker market in the Middle East and the fifth largest in the world. In 2010, the company had 28 VLCC tankers, 9 Suezmax tankers and 5 Aframax tankers, and according to their acquisition plans, Iran will have 50 VLCC tankers by 2013, thereby becoming the most important player in the market. Iran has increased its tanker fleet because it aspires to freedom of maritime movement and because 70% of VLCC tankers are nowadays en route to Asia - mainly to China and India. Furthermore, an enlarged fleet can provide a quick solution to increasing demand as well as preserve Iran's position as a leader in the energy market in its competition with Russia,

and, more recently, with Saudi Arabia, over the Asian markets. While the Saudis reduced the number of their tankers from 46 to 35 between 2006 and 2011, the Iranian fleet grew from 32 to 47, which amounted to about one third of OPEC's entire tank fleet (Lloyd's 2009**;** Lloyd's 2009**;** OPEC 2011).

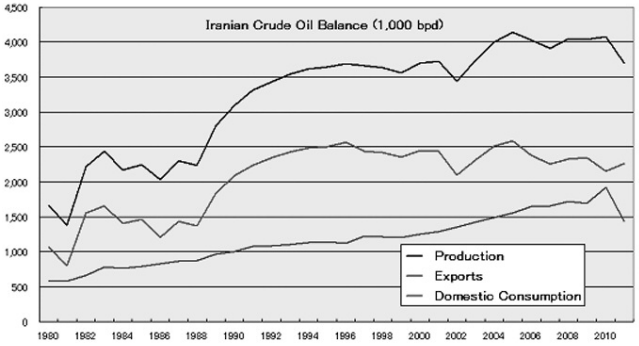
In recent years, other than increasing its influence in the tanker market, Iran has also become the most prominent floating storage user. During 2011, for example, on several occasions, it converted almost its entire tanker fleet - 24 out of its 28 VLCC tankers - into floating storage. Furthermore, about 50% of tankers converted to floating storage worldwide are from the Iranian tanker fleet and, in some cases, the number of Iranian floating storage tankers make up 80% of the market. For example, Iran was using 16 out of the 18 VLCC tankers converted for floating storage worldwide in October 2011, while at the end of March 2011 it was using 24 out of a total of 55 tankers, indicating that there were times in 2011 when Iran had about five billion dollars' worth of goods in floating storage (Lloyd's, 2011).

As a consequence of its power in the tanker market, Iran used floating storage for several purpose up until 2010. In 1991, Iran, Kuwait and Saudi Arabia increased the number of their floating tankers to 91 in order to raise freight costs. In other cases, Iran used tankers to store excess oil because of OPEC resolutions to immediately cut production rates. In 1999, for example, Iran put 39 million barrels of oil into storage after an OPEC resolution to slow down production. In 2006 Iran used the same system to store oil when fields such as Soroush and Nowruz reached peak production due to limited land storage facilities. On the other hand, just before oil prices collapsed in 2008, Iran significantly reduced its floating tanker supply in order to take advantage of the high market prices and to rake in enormous profits. Iran's policy reflects its use of tankers to make big oil profits as well as its central role in shaping the market (Lloyd's, 1999; Lloyd's, 2006).

At the end of December 2008, the price of a barrel of Brent oil was $33.83, about $4 below the profit margin of some of the prominent OPEC states such as Saudi Arabia, Kuwait and the UAE. Iran and some of the leading oil companies, such as Shell and British Petroleum, hastened to convert oil tankers to floating storage in order to sell their goods at higher prices in the future, and indeed, there was an increase in the amount of crude oil in floating storage in the ensuing months - from 55 million barrels in February 2009 to 100 million in April – with Iran using one third of the all worldwide tankers for floating storage. The increase in the number of tankers converted for floating storage became evident as of February 22nd 2009 when the price of a barrel of Brent oil was $41.27 and increased by 25% to $51.84 a month later. Moreover, in September 2009 the price of oil neared $60, the lowest target price set by OPEC. Indeed, at the time there were 45 million barrels of crude oil in floating storage, and one month later, those numbers had risen to 60 million barrels - a third of which were Iranian - one of the causes for the increase of the cost (Lloyd's, 2008; Wingrove, 2009; EIA 2009) of a barrel to $ 74.58.

Iran's use of floating storage is noticeable when oil prices drop below the target price set by OPEC. Iran's policies regarding floating storage are, however, not consistent when oil prices rise above OPEC's official target prices. There have been several cases since 2010 when Iran has not reduced its floating storage although it could make significant future profits by doing so. From October 2011 on there was a worldwide decrease in the number of tankers converted for floating storage due to the aspiration to sell the goods before the year's end. Nonetheless, Iran continued to have the biggest floating storage fleet in the world. In October 2011 there were 46 million barrels of crude oil in floating storage, 34 million of which were in Iranian tankers, compared to 39.7 million in November, 28 million of which were Iranian. In other words, even when traders worldwide were cutting down, Iran still kept its oil in floating Storage (International Energy Agency, 2011; Rogaliano, 2011).

There are several ways to explain Iran's choice to keep its floating storage fleet despite the economic disadvantages. First of all, the increase in the number of floating storage tankers can be explained by the fact that Iran often increases its production rates beyond the target set by OPEC, and because it has limited land storage facilities, it transfers its excess oil to tankers. Iran has intensified its use of floating storage since 2009, however, and the theory that it is due to limited land storage facilities cannot be justified because the extent of Iranian exports has not significantly changed in recent years and Iran is actually exporting less than it was in 2008, before which it did not make marked use of floating storage. Another explanation is that Iran's increased use of floating storage results from OPEC's resolutions to cut oil production in order to raise prices. That does not quite explain it either because Iran used floating storage even at times when there were no decisions to reduce production (Lloyd's, 2009; Lloyd's, 2011; Iran Energy Data Statistics and Analysis-Oil, 2012).



It could also be that Iran is using tankers to transport the oil from maritime areas to land storage facilities. Iran has 13 maritime oil fields which provide 29% of its estimated 4 million barrel daily oil production, but even if one considers that all the oil produced in maritime areas is destined for domestic use, that only amounts to 900.000 barrels per day. In order to transfer that amount monthly, 15 VLCC tankers are required, which is the average number of Iranian tankers that have been converted for storage since 2010. But even that does not provide an explanation because, in most cases, the tankers con-

verted for storage were spotted anchoring in Iranian ports for several weeks, submerged 19 meters deep, which means that they were full of oil and therefore had no reason to remain there if they were meant to transport oil from the maritime fields to land storage facilities. The fact that they remained in place for relatively short terms and were not used for domestic purposes indicates that there was another reason for its use of floating storage (EIA, 2010; Wiese Bockmann, 2011).

The claim that Iran increased its floating storage because of the prohibition against single hull tankers does not explain things either. Indeed, since December 2011, Iran has not allowed the entrance of single hull tankers into its territory. Moreover, Iran has not possessed single hull VLCC tankers since 2005 when it began its purchase of 28 new double hulled VLCC tankers, and by 2010 most of the Iranian fleet abided by the European Union regulations. Although Iran has used single hull tankers for floating storage on several occasions, they were Suezmax tankers, and in most cases (Intertanko, 2011) it uses VLCC.

In the last two years, there has been a correlation between the increase in the number of tankers used for floating storage and the tightening of the embargo on Iran. Until 2008, the sanctions were limited to arms trading and the provision of nuclear products, but in March 2008, new sanctions that included the freezing of Iranian company assets and the surveillance of their bank activities were imposed. In June 2010, the sanctions against Iranian maritime activity were intensified: Iranian ships and tankers were supervised, financial undertakings with Iran were restricted and foreign banking was limited. Japan ceased its financial connections with a number of Iranian establishments, South Korea severed its cooperation agreements with 124 Iranian energy and shipping companies, Switzerland prohibited financial ties with Iranian companies, and the European Union limited its relations with Iran in July 2010 after prohibiting all trade ties, mainly in the energy and financial sectors (MEMRI, 2011).

The embargo on Iran made it very difficult for the Ayatollahs regime to export its oil. The sanctions and in particular the limits put on the Iranian financial sector made it very complicated for traders who wanted to buy Iranian products. As a result, the number of floating storage tankers constantly grew until buyers or financial establishments who were willing to fund the transactions were found, which is why most of the VLCC tankers converted into floating storage were classified as vessels for short term storage of five to six weeks, meaning that the products were ready for export but the banking operatives were taking longer than usual. There was an example of such a delay in May 2011 when India purchased 20 million tons of crude oil from Iran but the Indian Central Bank could not transfer payment due to the sanctions imposed by the West. The Iranians immediately sought ways to minimize the damage and transferred the tankers to Ain Sukhna port near the Suez Canal and from there the oil was transferred via the Sumed oil pipeline to Western tankers in the Mediterranean. Because Iranian oil is mixed with oil that comes from other destinations, it cannot be isolated and it therefore appears to be relatively easy to get around the embargo. That procedure, however, is an extremely slow one because transferring the products to Egypt and then to Western buyers is more complicated and longer than simply loading the products in Iranian ports. As a result, the Iranians preferred to find buyers themselves, and to increase their floating storage facilities until that happened.

The number of Iranian tankers used for floating storage increased even more when Iran's circle of clients dwindled. Between 2010 and 2011 there was a decrease in oil imports from Iran in countries that adopted the sanctions, such as Japan, India and Italy. Countries that adopted the embargo only partially, however, such as South Korea, China and Turkey, increased their imports from Iran, although towards the end of 2011, even those countries that belonged to Iran's circle of important customers, such as China and South Korea, began to show signs of cracking, and soon they too began to reduce their dependence on Iranian oil and to increase their oil imports from Saudi Arabia. Indeed, oil imports from Saudi Arabia to China at Iran's expense increased when the civil war broke out in Libya in 2010: the violent conflict that erupted in that North African country caused a cessation of oil exports, and Saudi Arabia had to increase production in order to make up for its fellow OPEC member's inability to export. As a result, trading between Saudi Arabia and China increased and relations between the two countries became stronger. In October 2011, Saudi Arabia exported 978,000 barrels of oil per day to China, about a ten percent increase in comparison to the 893,000 barrels it had supplied the Asian country one year earlier. China's ability to maneuver between Saudi Arabia and Iran ameliorated its bargaining powers (Lloyd's 2011). Indeed, China was able to asses Iran's low selling power by the amount of its floating storage and thereby to force Iran to be more flexible in its oil prices. It therefore seems that the floating storage market in the Persian Gulf will be an indication of the effect of the embargo on Iran in the coming months, and that Iran will be forced to be flexible in its oil prices, which will be detrimental to its profits in the future (Lloyd's, 2011).

Conclusions

Iran, like the oil companies, converts oil tankers into floating storage in order to increase its profits in the future. In the last two years, however, it seems that the fact that Iran has the largest floating storage fleet in the world is an indication of tightened sanctions and of the Islamic republic's difficulty in finding immediate buyers for its products.

In the near future, there is likely to be an increase in Iranian floating storage tankers until Iran can find buyers for its products, because of the additional sanctions imposed on it and the general agreement amid European Union countries, and lately also on China and South Korea's part, to reduce oil imports from Iran.

On the other hand, those countries will take advantage of Iran's distress and will demand significant discounts in oil prices if Iran, under heavy sanctions, wants them to buy its

products, which in turn will be detrimental to Iran's profits in the future.

In the coming months, the world oil market will be instable and volatile because as long as Iran is unable to find buyers, there will be less supply, and the moment it finds buyers, oil prices will plunge due to increased supply.

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An Applied Case Study Flaws in Spanish National Noise Standard in Maritime Transport

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ABSTRACT

Noise can be considered as one of the strongest health problems for seafarers. In the present paper, we present the major flaws in standards related to maritime transport, which should be resolved, and the precarious state due to its anachronism or its suitability in application at the national level of Spain. Finally, based on a practical case study, we propose as work risk protection procedure for noise work risk prevention for improving the present national standards in accordance with IMO and ground standards and procedures. Results showed values higher than that recommended for standards. In particular, the higher noise levels were reached in between the main engines and the compressors room. At the same time, the lower illumination values were observed in these two zones, which eventually became the principal hazard of the engine room that must be prevented.

1. Introduction

Recent studies showed that noise can be considered as a fundamental parameter, with temperature, that affects the comfort conditions in a ship (Goujard, B. et al., 2005; Orosa and Oliveira, 2009). Furthermore, it is considered as one of the strongest healthy problems for seafarers (Tamura et al., 2002; Tamura et al., 1997). The present noise working law that exists in Spain is the Royal Decree 1316/1989 of 27 October. This decree consists of the indications for protection of workers from noise from the risks of its exposure during the working period. The problem appears when we try to employ it on board due to this article is not of application for maritime and aerospace transport crews.

In the abovementioned situation, only the general regulation (Gestal-Otero et al., 1999) for Occupational Safety and Health (NIOSH), which was passed in March 9, 1971, is applicable. Despite this, we can see that the Royal Decree presents faulty alternatives for the exceptions of its ambiences of application.

The work risk prevention standard in his article 3 states that "The Estate must put all its interest to develop a specific standard as soon as possible". In this sense, we must take the procedure employed to develop the Royal Decree 1316/1989 as reference. This standard establishes the limit admissible value (LAV) for noise contamination at work, and it is based on working periods of 8 hours per day and 40 hours per week. Therefore, it is not adequate to be applied on board and a scientific study, before the development of this standard, must be conducted to consider these specific conditions.

Another typical consideration that must be arranged in accordance with the on board conditions is the hear recuperation. In this sense, standards remember that a hear begins its recuperation from the noise exposition when it is not exposed to this, but we can find that maritime transport crews are always under the working noise during the sea line, which must be about 4, 5 or 6 months. Furthermore, in this particular study of noise on board, we must consider time periods. The first period must consider the working time, considering the noise levels during the entire working period of eight hours for full time working period. The second period must consider the 16 hours of full time working period when the seafarer is on board, but out of the working ambience.

In particular, these time periods present interest in some zones, such as engine room, to be investigated and applied to a corresponding legislation.

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The only Spanish standard that really considers on board conditions is the Decree March 9, 1971, which passes that the General Decree of Safety and Hygiene at Work (GDSHW) is of required compliance in noise ambiences, including ship crews.

In particular, in Title II, the "General conditions of working places and protection procedures" are shown in Chapter 1, Article 31 "Noise, vibrations and rapid changes". In this article, point 1 shows that the noise and vibrations will be avoided or reduced as much as possible in its origin source, trying to reduce its influence in nearer premises. Furthermore, point 8 indicates that the control of aggressive noise sources will not be limited to the isolation source. It must be adapted to the technical requirements to prevent reflection and resonance phenomena that could drastically affect the workers' health.

These conditions are of special interest for engine rooms where the engines are a significant noise source of the ship. Therefore, in its point 2, it is indicated that the hold systems of engines are noise, vibrations or rapid changes sources must be developed to reach the optimal static and dynamic equilibrium. Furthermore, in point 3, it is mentioned that engines will be adequately isolated, and at its point of location, only the maintenance staff will be allowed to work for a short period of time.

Finally, these conditions are translated to the ship design process in point 4, where the standard comments that it is forbidden to install engines or noisy devices near walls or columns. It must be distanced, how to min, 0.70 meters from dividing walls and one meter from outer walls.

In Spain, this is the only information about the noise control on board in merchant ships. As we can observe, there are a lot of good intentions; however, the permissible objective noise values dB (A) are not shown.

Once the need for a specific noise work risk prevention standard arises, it is the time to revise indicators of the principal international organizations such as the International Maritime Organization (IMO) and the International Labour Organization (ILO). The convention 148 of ILO about the "working ambience" (ILO, 1977) was passed by Spain 12/17/80 and in article 1.1, it is stated that it is of application to all the economical activities and, thereby, for merchant ships so.

From this convention, article 4 is notable; it states that the national standards must adopt procedures in the work place to prevent and limit the professional work risks due to air pollution and vibrations. Despite this, procedures to limit the professional work risks are not known thus far.

Another organization that presents objective values is the IMO; the objective values were presented in its Decision of Assembly 468 (XII), passed November 19, 1981, "Code on noise levels on board ships". In point 2, introduction, it is shown that the objective of this code is to advise to administration about the higher noise level and its limits of exposure. Furthermore, in point 5, it shows that this code is not developed to be directly added to the actual national legislation and is only the basis of future standards. Finally, this code give us some noise limit levels for different spaces that can be referred by the work risk prevention staff while developing the noise map on board. These values are showed below.

a) Working place dB (A)
   1. Engine room (with permanent staff): 90.
   2. Engine room (without permanent staff): 110.
   3. Control engine room: 75.
   4. Work room: 85.
   5. Unspecified working places: 90.
b) Government place dB (A)
   1. Bridge and defeat room: 65
   2. Listen position: 70
   3. Radio room: 60
   4. Radar room: 65
c) Service room dB (A)
   1. Kitchen (without equipment working): 75
d) Unoccupied habitual spaces: 90

As a work risk prevention indicator, this Decision of Assembly showed that it is necessary to protect the ears from 85 dB, and in the Spanish case belonging to European Community, the IMO indicates 90 dB (A).

Finally, as a result of this standard, future directives were developed. For example, a future directive passed by the decision Assemble October 29, 2001 in accordance with the Directive 89/391/CEE that not excludes the maritime sector. This future directive shows the Upper exposure limits and three values for prolonged expositions:

a) Exposition limit, 8 hours: 87 dB
b) Upper exposition limits, 8 hours: 85 dB
c) Lower exposition limits, 8 hours: 80 dB

This Decision Assembly considers that the adopted values represent an adequate equilibrium between health protection and workers safety and a not excessively higher cost for companies; therefore, member states must have an adaptation period for crews.

2. Objectives

In present study, we will analyse the main flaws in the standards related to maritime transport at the national level of Spain. After this, a practical case study on board will be carried out with the aim of proposing a sampling procedure for noise work risk prevention of national standards.

3. Materials and methods

3.1. The ship

In this study, the objective that is related to ship is a fast ferry between Spain and France that transport new cars. Hence, this ship is considered as one of the most silent ships that a crew member can find in its working life. In particular, as shown before, the engine room is the zone object of this study.

3.2. Sound and lux units

Decibel is the measurement unit used for calculating the intensity level of sound; it relates the power of the sound source

to study with the power source whose sound is on the threshold of hearing by Eq.1. It is employed to calculate the sensation received by a listener from measurable physical units of a sound source.

$$L = 10 \cdot \log \frac{W_1}{W_0} \quad (1)$$

Where W_1 is the power to examine and W_0 is the reference value in Watts.

The sound waves lead to an increase in pressure in the air, which is another way of measuring the physical sound, which is in pressure units as shown in Eq.2.

$$L = 20 \cdot \log \frac{P_1}{P_0} \quad (2)$$

Where P_1 is the pressure of the sound study and P_0 is the reference value equal to Pa.

While speaking of an electronic device such as a recorder or a mixer, it is useful to talk about the dynamic range known as decibels Fs on "Full Scale". In these cases, the dynamic range of an audio signal matches the highest level of the signal and is referred to as the maximum level of 0 dB, above which the system is saturated, and the noise level is a negative value, e.g., 80 dB. After this modification, the signal is amplified by retaining the shape of the original signal, but by making it wider.

Sound spectrum software has been employed with the aim of analyzing the principal sound on board; that allows the definition of the spectrum on full scale. In our case study, the software, "spectrum analyzer" was employed since it is a free download from the web. Subsequently, sounds were analyzed and the results compared.

3.3. Sampling methods

Standard measures procedures were applied as defined by ISO 140-4, and the equipment was calibrated prior to the measurements with an accuracy of +0.3 dB for sound pressure levels and +0.2 dB for velocity levels.

Samples between enclosures of identical size were made preferably with diffusers in each of the enclosures (e.g., furniture, engines). The area of each diffuser was at least 1.0 m^2.

In accordance with previous studies, the noise sampling process on board must take some considerations:

1. Wind must no exceed de range 4 in Beafort scale, particularly if we are sampling outdoors.
2. Sea condition must be in calm.
3. Rain.
4. Water depth under the keel must not be lower than 3 times the ship draught.
5. Presence of high reflectance surfaces near the microphone.
6. Another sound sources must be considered, for example, noise from workers during their daily tasks.

On the other hand, the sampling position must consider the following:

1. Take various samplings near a sound source, for example, 6 samples per zone.
2. Sampling process will be done at a height between 1.2 and 1.6 meters over deck.
3. Sampling position must not be lower than 0.5 meters near the limits of the room.
4. The distance between two sampling points must not be less than 2 meters. At the same time, in high spaces without any equipment, the maximum distance between the sampling points must not exceed 7 meters. In particular, in the cargo deck, the maximum number of sampling times must not be greater than three.

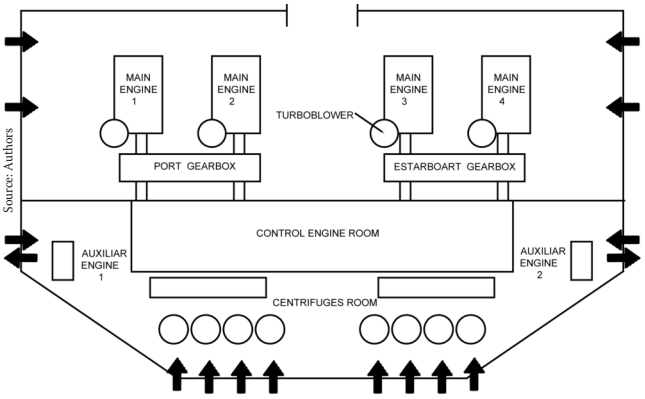

Figure 1: Engine and control engine room.

3.4. Effects of noise over health

Once the sampling process was defined, the noise effect must be analyzed. The comfort zone is located below 45 dB, and over 55 dB, the sound is perceived as nuisance. Over 85 dB, fatigue and dangerous situations are detected. The pre-capillaries undergo contraction and there is an increase in resistance to blood circulation, thus reducing the volume of blood that circulates. Finally, hypertension, digestive diseases, breathing, nervous problems, stress and insomnia can occur. Other consequences are the reduction to sensitivity to colors, reflex and concentration and, in some cases, the fatigue of ears bones can lead to momentary deafness.

The possible solutions to these problems are to stay away from the noise source and to rest. For example, a worker must recover from a noise exposure to 100 dB by resting for10 minutes; 36 hours of outer ear rest should be given if the exposure was for 90 minutes.

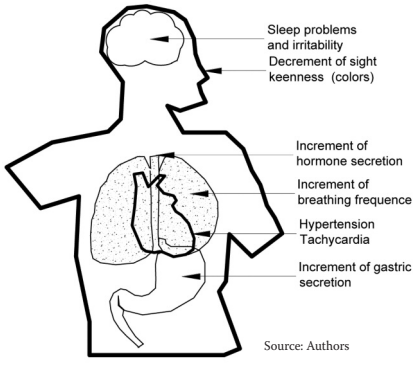

Figure 2: Symptoms that appear when the noise level is over 85 dB (A).

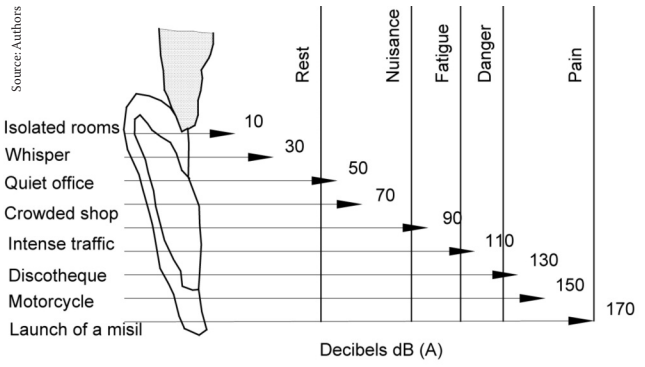

Figure 3: Examples of noise levels.

4. Results

Table 1 shows the noise and illumination levels in different zones of the engine room. Figure 4 shows the sound spectrums of different noises sampled in the engine room, such as noise from the main engine turbine, centrifuge and compressors rooms, and corridors between the main engines (MES).

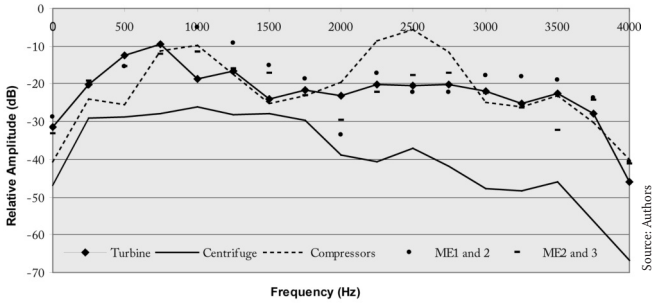

Figure 4: Sound spectra.

Table 1: Noise and illumination levels in different zones of the engine room.

Zone	Control engine room	Corridor ME1-ME2	Corridor ME2-ME3	Centrifuges room	Compressors room
Noise dB (A)	75-80	109.2	116	95	106-112
Illumination (lux)	10-118	2-5	20	10-90	2-100
IMO	75	90-110	90-110	90	90

Source: Authors

5. Discussion

In accordance with the indications in work risk standards, a noise map of the engine room was developed. In the control engine room, the sound sampled was of 75–80 dB when the main engines 1 and 2 are working with a strait of 60%. When the four main engines are working with a strait of 83%, the noise reached values of 80.5%. This value is higher than that showed by IMO for engine rooms with permanent staff, which is limited to 75 dB.

In corridors with a width of 1.5 meters between the engines 1 and 2 and the main engines 2 and 3, the noise level reached a range of 109.2 and 116 dB, respectively, with the four main engines working and a strait of 83%. If we observe the IMO indications, we can confirm that it exceeds clearly the limit value fixed of the engine room of 90 dB for permanent staff and the 110 dB for engine room without permanent staff. In particular, this value is high between the main engines.

In the compressors room, which is located under the control room, the sound reached a value of 106 to 112 dB during navigation without any compressor working. In the centrifuges room, the sound level was about 95 dB. Generally, in these two places, the compressors room and the centrifuges room, the noise level is higher than 90 dB fixed by the IMO.

In this same place, the lux value shows significant changes between different zones from 10 to 118 luxes. The maximum values were reached when sample near a reluctant screen and a near null value in corners and shadow zones.

The illumination was about 20 lux between main engines 2 and 3 and varied from 2 to 5 lux between the main engines 1 and 2. The temperature and relative humidity were about 35°C and 39.1°C and 33.5% and 30%, respectively, for main engines 1 and 2.

In the compressors room, the illumination value was from 2 to 100 lux. In particular, it is very interesting to note that in corners, where it is interesting to do some management task, the illumination values are significantly reduced. The temperature reached 34.5°C and the relative humidity reached 42.3 %during this sailing period.

In the centrifuges room, the illumination varies between 10 to 90 lux. Temperature reached between 32.7°C and 46.6°C and the relative humidity was 40.1% when the ventilation system was working.

Once we have analysed the principal sound levels in the main engine room, in accordance with more developed standards applied on ground, it is important to determine the relative amplitude for each frequency of each different sound that can be detected in the engine room. Figure 4 shows that the turbine of each main engine and compressors room present a higher relative amplitude for a lower frequency and that the centrifuge presents the opposite situation. Finally, the sound spectrum in the corridors between the main engines presents an intermediate value.

In general, from this map of the real sampled data, we can confirm that the values higher than that recommended for standards were reached. In particular, higher noise levels were reached between the main engines and the compressors room. At the same time, illumination values were lower in these two zones; in consequence are the principal hazards of the engine room.

Once it was showed that the principal zones of interest for prevention of work risk in the engine room, it is interesting to see the principal actuation way in ships in accordance with a revision of the royal decree 1316/89.

The first actuation step is carried out by the Shipbuilder. The Green Book of the European Commission, Brussels, 1996, recommends three basic methods for reducing noise exposure:

a) To reduce the noise at its source (engine), b) to limit the sound transmission by using barriers between the noise source and the affected staff, and c) to reduce the noise at the recep-

tion point through acoustic isolation. For example, the principal sounds heard in a real ship and its frequency spectrum were analysed. To determine these sound transmission barriers in an in-depth manner, the standards employed on ground should be considered. For example, ISO 140 specifies the methods for measuring the in situ properties of the airborne sound insulation of partitions between the two enclosures in a position for diffusing the sound field, and for determining the protection given to staff. In this standard, the effect of the frequency to define the perceived sound is considered. To consider the frequency, sampling methods give the values of acoustic insulation to airborne sound in terms of frequency and transform it into a single number which characterizes the acoustic qualities of an environment in accordance with ISO 717-1. Finally, results must be compared with the estimated values from the performance of elements EN 12354. As far as indoor noise is concerned, the standard covers both airborne and impact sound; but this was not analysed in this paper; therefore, future studies are required in this field.

The second actuation step with regard to the businessman. In accordance with the Work Risk Prevention Law, in its articles 14 and 15, the businessman must obtain hygienic samples of noise on board, try to delete and, if it is not possible, to evaluate and reduce its effects. The report from the prevention equipment about the noise must be send to health workers of Social Institute of Marine and Medical Prevention Services.

The third step is the prevention equipment. When this equipment develops its work risk evaluation in a shipping company, they must give a noise map to which crew is exposed to the ship owner, with the ship on port or sailing in different zones of the ship. This step was developed in this case study and helped in defining and characterizing different noise sources. What is more, results showed that only in the control engine room, the engineers could be without ear protections as the sound level is below 90 dB.

The last actuation step with regard to the health workers. The Social Marine Institute develops the health control to crew previous to sign. In particular, hearing medical control in accordance with the requirements of RD 1316/89 must be developed. This standard states the following:

a) Workers in environments that exceed 80 dB (A), medical examination once in 5 years, in accordance with the article 5.
b) Workers in environments that exceed 85 dB (A), medical examinations once in 3 years, in accordance with the article 6.
c) Workers in environments that exceed 90 dB (A), medical examinations each year in accordance with the article 7.

Therefore, we can conclude that a program for conservancy of hearing capacity of the crew is a work risk prevention measure that must be applied by health workers, especially by Public Health workers.

In general, we can conclude that all these steps were an adequate guide to develop this practical case study of formal safety assessment. Despite this, more studies that consider each ship characteristic must be conducted.

6. Conclusions

In present study, it were analyse the main flaws in the standards related to maritime transport at the national level of Spain. After this, a practical case study on board was carried out with the aim of proposing a sampling procedure for noise work risk prevention of national standards. As a general conclusion of this analysis, we can state the following:

1. Nowadays, there are no Spanish standards regarding the sound levels that are bearable by the crews of merchant ships.
2. There are reference values that can be employed at present for developing the standards.
3. From Spanish ratification in 1980 and the IMO convention, hardly any activities were carried out to limit the noise exposure to the staff on board. Therefore, a specific standard should be set with regard to the noise on board in accordance with the Work risk prevention on board and the IMO Assembly A.468 (XII). Furthermore, this new standard must consider the European Directive proposal, despite the fact that it only considers exposition periods of 8 hours. Finally, while this new standard is not developed, article 1 of the Royal Decree 1316/89 must be modified in its scope and show those parts that can/cannot be applied to merchant ships.
4. IMO recommendations were not considered for a program on the protection of the hearing capacity of the crew. In particular, the Social Marine Institute must obey considerations of IMO for developing this program for conserving the hearing capacity of the crew. Furthermore, this program cannot be developed to within the time of investigation on board by means of practical case studies and hence, more studies have to be conducted on formal safety assessment (Lois et al., 2004).
5. In accordance with the previous point, in the actual risk assessments, there is no noise map on sailing; hence, the equivalent values of 8 working hours and 24 hours of the day of each crew member are not known. It is a fundamental tool to prevent the noise problem during the ship design process taking as reference the Resolution A.468 (XII) of the IMO, in particular the Chapter 6.
6. This practical case study showed values higher than that recommended for standards. In particular, the highest noise levels were reached in the zones between the main engines and the compressors room. At the same time, these two zones had the lowest illumination values and hence were the principal work risk sources of the engine room. Finally, it is interesting to analyse the sound spectrum for differentiating various sound sources and to determine their actual effect on health. Mainly, the compressors room and the corridor between main engines are the zones with a higher sound level and higher relative amplitude for a lower frequency. Therefore, these are the principal hazards that must be prevented.
7. Solution to eliminate these work risk sources are based on the actual and future standards recommendations such as those for shipbuilders and health workers.

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Maritime Safety in the Strait of Gibraltar: Taxonomy and Evolution of Emergencies Rate in 2000-2004 period

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ABSTRACT

Both SAR'79 and UNCLOS'82 Conventions are specific tools that establish the juridical and technical foundations for the development of reactive aspects related to maritime safety response. These conventions set up the search and rescue regions in which coastal states should assume the responsibility to dedicate resources, to cover the needs of the SAR responsibilities. 2006 amendments to IAMSAR manual volume I, in force since 2007, June the 1st, established the identification and assessment of risks related to maritime safety as one of the practical principles in maritime risk management. The Strait of Gibraltar is a narrow navi-gational channel connecting the Atlantic Ocean and the Mediterranean Sea between Spain and Morocco. The Strait supports a huge volume of maritime traffic increasing steadily every year. This paper presents the pre-liminary results obtained in relation with the taxonomy and temporal distribution of maritime emergencies re-ported and documented by the Spanish Maritime Administration throughout 2000-2004 period.

1. Introduction.

1.1 Background

The active involvement of the coastal states in safeguarding and promoting the safety of human life, environment and property related to maritime navigation in the waters in which they exercise jurisdiction, sovereignty or sovereign rights, is shown in a number of international legal texts.

The International Convention on Maritime Search and Rescue, Hamburg, 1979 (Convention SAR'79) and the United Nations Convention for the Law of the Sea, Montego Bay, Jamaica, 1982 are included among those juridical tools.

These two fundamental legal instruments lay down both regulatory and technical aspects of the development of reactive response to maritime emergencies.

Both texts establish the principle of division of the entire maritime waters, defining areas of responsibility for maritime search and rescue associated with every coastal nation. These nations should assign specific resources - human, technical and legal - to meet the requirements that arise as a result of the liabilities undertaken by the parties.

Although both conventions regulate the commitments related to maritime search and rescue matters undertaken by the parties, the International Convention on Maritime Search and Rescue, Hamburg 1979, known as SAR'79 Convention, which Spain joined in 1993, lays down the basic guidelines to be followed by the Authorities of the coastal states in the process of design and implementation of maritime search and rescue services.

Over the years, this agreement has been amended a number of times. Among the amendments which are due to be highlighted, we find those adopted in 1998. According to these, it is essential to provide the centres responsible for carrying out maritime search and rescue operation with detailed operational plans appropriate and adapted to the particularities of each specific search and rescue region. These plans will allow carry out these actions effectively.

These plans should also establish not only the procedures to be followed during mobilization of rescue units, but also provide the methodology to be used in developing search and rescue operations. The plans require the establishment of coordination instruments between adjacent rescue centres and procedures and criteria to be used not only during the gathering and evaluation of relevant information related to the emergency but also alerting ships and aircraft transiting the

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area of the incident and requesting their cooperation in operations.

A rigorous approach to the formulation and development of plans and protocols to cope with maritime emergency situations requires the application of specific methodological tools that would make possible the identification, classification and categorization of those risks that must be controlled or the mitigation of their consequences.

On the other hand, at the request of the interested countries, and with the aim of facilitating the adoption of the necessary measures for the adaptation of the standard and promoting harmonization in a global environment, the International Maritime Organization (IMO) and International Civil Aviation Organization (ICAO) published in 1999, the International Aeronautical and Maritime Search and Rescue Manual (IAMSAR), a dynamic document that over the years has undergone several modifications which enabled it to improve and adapt to changing reality.

Among these changes we can find the 2006 amendments, in force since June 1, 2007, which set out the practical principles to be followed in the implementation of aeronautical and maritime search and rescue services and addresses the need to identify and asset the risks related to maritime safety. In such a way that these amendments state that the effectiveness of the response to maritime emergencies depends, among others, upon the knowledge of type and frequency of those marine incidents that may result in a risk for human life at sea, safety of navigation and protection of marine and coastal environment.

This paper presents the preliminary results of the study carried out over the emergency rates in the Strait of Gibraltar, approaching the taxonomy and distribution of incidents and accidents documented by the Spanish Maritime Administration from 2000 to 2004 in the geographical area of the Strait of Gibraltar.

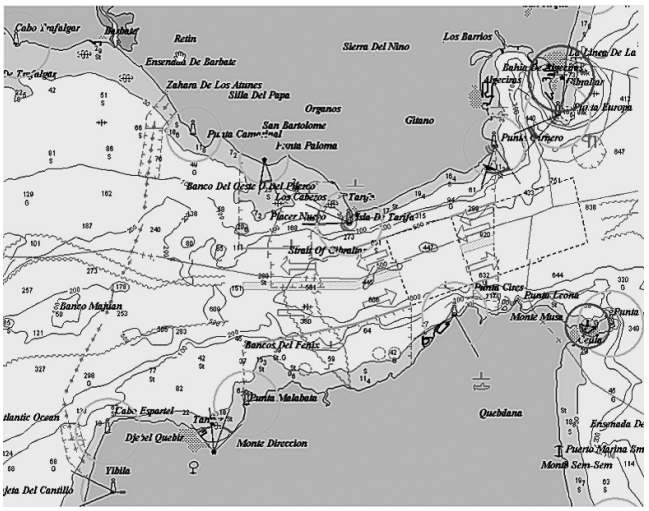
1.2. Environment

1.2.1. Geographical environment

The Strait of Gibraltar (Figure 1) is the natural passage which links the Mediterranean Sea with the Atlantic Ocean. Although its boundaries have never been formally established, for the present research study the western boundary has been defined by the line connecting Cape Trafalgar with Cape Spartel while the eastern one has been considered by the opposition Europe Point - Punta Almina.

The European coast, limited by Cape Trafalgar and Europe Point, is 55 nautical miles long, whereas the African coast from Cape Spartel to Punta Almina is 42 nautical miles long.

Its longitudinal axis is divided into two sections. The Western section, some 18 nautical miles in length and oriented approximately east - west, runs from the line connecting the Island of Tarifa, located on the Spanish coast, with Cala Grande, on the African coast,towards the Atlantic Ocean. The Eastern section runs from west by southwest to east by northeast, along some 15 nautical miles to reach the eastern Strait boundary.



Source: Instituto Hidrografico de la Marina. Spanish Navy.

Figure 1: General overview of the Strait of Gibraltar.

The channel presents its maximum width, 24.2 nautical miles, on its western limit, between Cape Trafalgar and Cape Spartel, while the narrowest section is defined by the line connecting median point between Tarifa and Punta Guadalmesi River, on the northern coast, and Punta Cires, on the southern coast. At this point, the channel is 7.45 nautical miles wide. The eastern embouchure has a maximum width of 12.5 nautical miles.

On the northern coast there are significant shoals and reef areas alternating with broad bays and sandy beaches. On this coast are located the ports of Algeciras- La Línea, Tarifa and Gibraltar.

The southern coast, geologically very similar to the northern one, has, however, a much more rugged and inaccessible coastline. On this coast we find the ports of Tangier, located east of Punta Malabata, Tangiers – Mediterranean, close to Punta Cires, and Ceuta, located by Punta Almina, on the eastern end of the African coast.

1.2.2. Traffic patterns

The maritime traffic through the Strait of Gibraltar follows a clearly defined pattern which is conditioned by four basic parameters: the last port of call of the ship, destination port, the routeing measures established and prevailing weather conditions.

In general the flow of maritime traffic follows two fundamental axes (Figure 2). The most important in terms of traffic density, is the longitudinal axis defined by the tracks of the ships passing from the Mediterranean Sea towards the Atlantic Ocean and vice versa.

The second axis is defined by the tracks of the vessels, mainly ferry ships and High Speed Crafts, connecting the ports located on both sides of the Strait.

The combination of a very high traffic density area (94,157 transits identified through year 2005) (Figure 3), the existence of high concentration of crossing tracks and occasionally very unfavourable weather conditions within a narrow channel, have

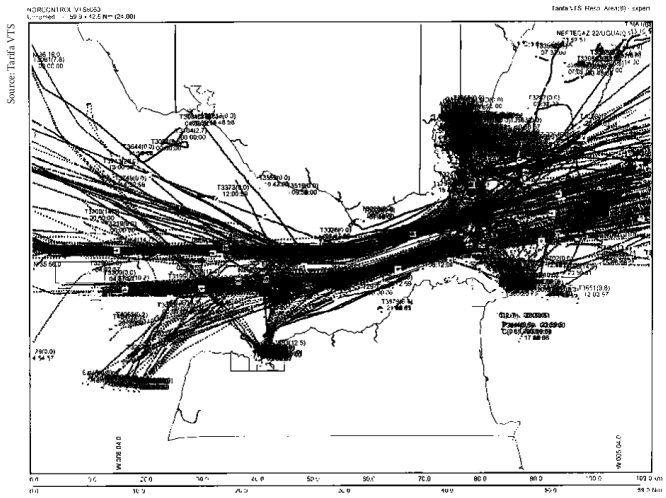


Figure 2: Cumulative maritime traffic radar surveillance picture.

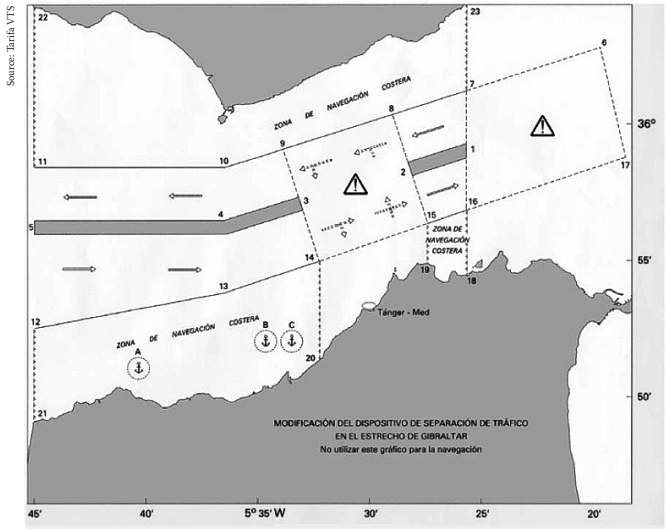


Figure 3: Traffic evolution. Years 2005-2008.

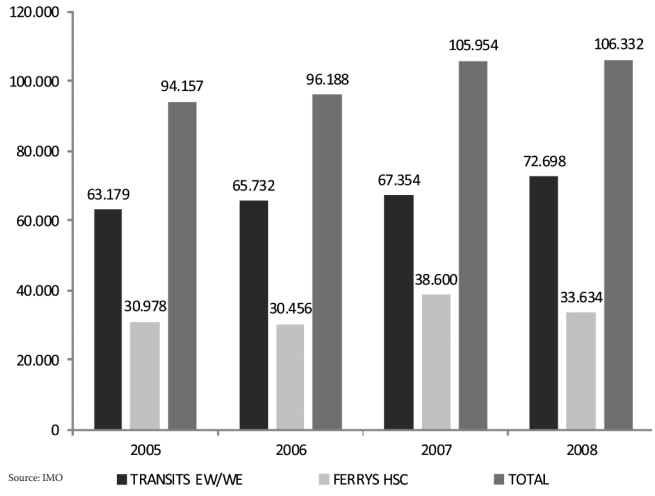


Figure 4: Traffic separation scheme and precautionary areas in the Strait of Gibraltar.

forced the Spanish and Moroccan governments to promote, through the International Maritime Organization, the establishment of several marine traffic organization and monitoring measures (Figure 4) – traffic separation scheme, mandatory reporting system, precautionary areas, vessel traffic services – all of them complemented by an extensive network of maritime signals covering both, northern and southern coasts.

2. Methods

The historical analysis of emergencies in the Straits has been developed on the basis of the information provided by three historical data sets:

1. The database of the General Directorate of Merchant Marine.
2. Annual reports of the Maritime Rescue Coordination Centre of Tarifa, and
3. Annual reports of the Maritime Rescue Coordination Centre of Algeciras.

The analysis of the three data sets reveals a lack of harmonization that, although the big similarities in their basic structure, leads to significant differences in the criteria followed while classifying the information related to each event. It it should be highlighted the lack of information concerning the initiating events or causes of accidents and the extent of damage to property.

Nevertheless, despite the lack of some important information, the geographical location of each event and a detailed description of the units deployed during the response operations are always available.

Due to the high level of dispersion of information regarding maritime emergencies occurred in the Strait of Gibraltar and the lack of clearly defined relationships among the historical records, it becomes necessary a previous compilation of the information, and the unification of criteria for the classification and its subsequent analysis. This all led to the creation of a special data base called GIBSAR, which is the basic tool for the development of this historical analysis of maritime accidents in the Strait of Gibraltar.

This database does not only compile information provided by the marine rescue coordination centres of Algeciras and Tarifa and the statistical series of data produce by the General Directorate of Merchant Marine, but it also establishes a scale for the assessment of effect, both for individuals an vessels, caused by the consequences of these events.

3. Results and discussion

The analysis of the data (Table 1) shows that the total maritime emergencies documented by the Spanish Maritime Administration in the period 2000-2004 within the Strait of Gibraltar area comes to a total amount of 1,216 cases. Only 23.5% of this these figures, 284 cases, are due to false alarms while the remaining 76.5%, 922 cases, are due to real alerts. Notice that the annual distribution of the data presents a great homogeneity.

Table 1: Distribution of real and false alerts related to maritime emergencies in the Strait of Gibraltar. Years 2000-2004.

Emergencies	Year					
	2000	2001	2002	2003	2004	Total
Real	181	187	181	189	184	922
False	61	66	51	58	48	284
Total	242	253	232	247	232	1206

Source: Authors

Table 2 shows that 90.8% of total number of real cases are related to incidents, that means there is neither major structural damages to ships nor losses of human lives nor missing persons nor pollution episodes involved in the event.

On other hand, only 9.2% of the real emergencies are related to marine accidents, considering such events as those involving total loss of the ship or major structural damages, or losses human lives or missing persons or a pollution episode.

In this case, the distribution is also very homogeneous, with values ranging from a minimum of 181 emergencies documented in 2000 and 2002 to a maximum of 189 emergencies in 2003.

Table 2: Distribution of accidents and incidents related to real maritime emergencies in the Strait of Gibraltar. Years 2000-2004.

Emergencies	Year					
	2000	2001	2002	2003	2004	Total
Accidents	20	19	14	12	20	85
Incidents	161	168	167	177	164	837
Total	181	187	181	189	184	922

Source: Authors

Table 3 shows the distribution of all real emergencies attended in the period 2000 to 2004 according to subtype.

There is a clear predominance with 24.1% of the total amount of performed search and rescue operations due to mechanical failure of ships systems and/or services. Pollution episodes amounts 15.6% of the total number of cases.

We should also focus the attention on the number of search and rescue operations related to illegal immigration, whether in the preventive stage, escorting the crafts used in the passage through the Strait as well as in the phase of assistance to the occupants or, where appropriate, during search, location and recovery of corpses. These cases come to represent 12.8% of search and rescue operations.

Operations related to drifting objects varies from 5% to 10%, assistance to users of recreational crafts and devices amount 8.4% and 7.2% respectively, rescue operations on coast and cliffs 5.6%, and drifting boats, which comes to be 5% of the total.

We should also consider the medical transfers between Spanish hospitals located on both sides of the Strait (Ceuta to Seville or Cadiz), which means 4.6% of total operations, nearly twice the rate of medical evacuations from ships which rates 2.6% of the total.

Regarding the severity of the consequences on persons, crafts or vessels and on the environment, it should be notice that minor and negligible severity cases range nearly 30%, while moderate severity cases range 30.4% and major severity 28.5%. Severe cases involving total losses of ships, losses of human lives, missing persons or severe pollution events range 6.5% (Table 4).

Table 3: Distribution of real emergencies according to subtype. Strait of Gibraltar. Years 2000-2004.

Subtype	Year					
	2000	2001	2002	2003	2004	Total
Leisure crafts	12	11	8	22	13	66
Assistance to navigation	2	5	3	3	6	19
Overdue	0	3	0	1	1	5
Allision/Collision	2	3	3	0	2	10
Pollution	29	35	35	23	22	144
Drifting crafts	12	7	7	11	9	46
List / Stability	0	0	1	0	0	1
Medical Evacuation	5	9	5	4	1	24
Medical Transfer	4	3	11	7	17	42
Mechanical Failure	37	38	40	50	57	222
Man Overboard	5	4	3	3	4	19
Sinking	2	3	4	3	4	16
Fire/ Explosion	2	4	2		2	10
Illegal Immigration	23	23	19	38	15	118
Drifting Objects	18	18	24	8	9	77
SOS Message	1	0	0	2	0	3
Castaway Rescue	0	0	0	1	1	2
Coastal Rescue	17	13	8	4	10	52
Grounding	3	3	3	4	6	19
Leaking	4	2		2	2	10
Other	3	3	5	3	3	17
Total	181	187	181	189	184	922

Source: Authors

Table 4: Distribution of real emergencies according to severity rate. Strait of Gibraltar. Years 2000-2004.

Severity	Year					
	2000	2001	2002	2003	2004	Total
Severe	15	13	12	9	11	60
Major	50	61	54	58	40	263
Moderate	57	49	47	77	84	314
Minor	14	17	8	8	9	56
Negligible	45	47	60	37	40	229
Severe	15	13	12	9	11	60
Major	50	61	54	58	40	263
Total	181	187	181	189	184	922

Source: Authors

Table 5: Distribution of real emergencies according to casualty condition. Strait of Gibraltar. Years 2000-2004.

Casualty Condition	Year					
	2000	2001	2002	2003	2004	Total
"Shelf rescued"	328	34	6	12	2	382
Rescued	431	825	474	2156	542	4428
Assisted	9	398	373	303	198	1281
Evacuated	65	11	16	12	17	121
Died before arrival	10	27	17	2	1	57
Died after arrival	22	4	12	12	9	59
Missing	5	3	7	9	1	25
Total	181	187	181	189	184	922

Source: Authors

According to table 5 and regarding casualty condition, almost 90% of the persons involved were assisted or rescued, while 6% of the total amount of persons involved in emergencies got safe by their own means and the number of persons who lost their lives or were missing rates 2.2%.

4. Conclusions

Annual distribution of emergencies, considering the whole period, presents a very stable trend, ranging from a minimum value of 181 to a maximum of 189 cases.

In terms of geographical distribution, two main areas support the highest rate of emergencies both quantitatively and qualitatively. Those areas are the central zone of the Strait of Gibraltar and Algeciras Bay (Figures 5 and 6).

The results of the study highlighted the large number events, such as medical transfers, pollution incidents in port service waters, operations related to the use of recreational crafts and devices, swimmers, diving and other natures related events which, although not considered as maritime emergencies, required the deployment of specific marine search and rescue resources.

It should be noticed the low rate of emergencies directly related to any maritime search and rescue service responsibilities such as leakage, collision or allision, fire or explosion, heel or stranding, which all together rate 7.2% of the SAR operations performed. This rate would increase up to 9.8% if medical evacuations conducted from ships or boats are included.

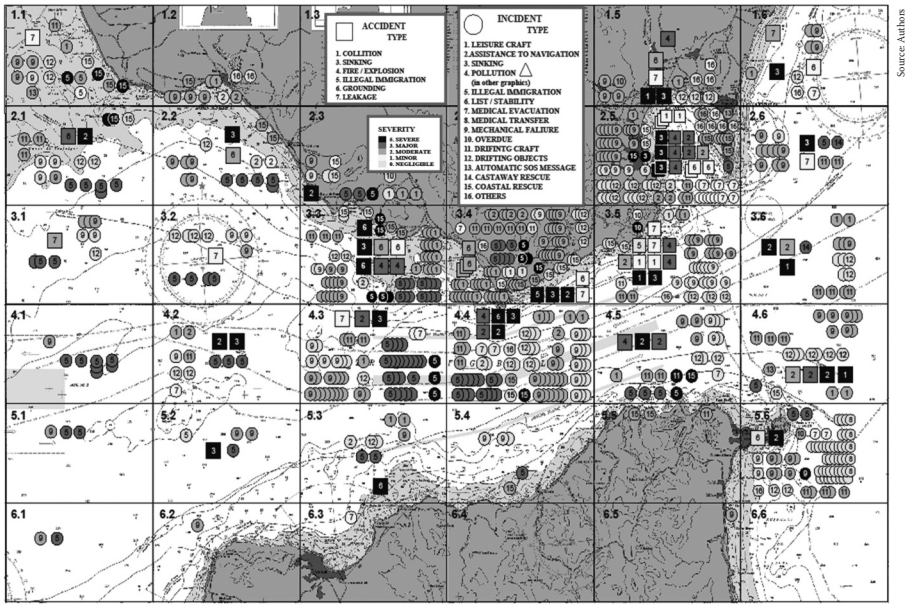


Figure 5: Geographical distribution real emergencies according to subtype. Strait of Gibraltar. Years 2000-2004.

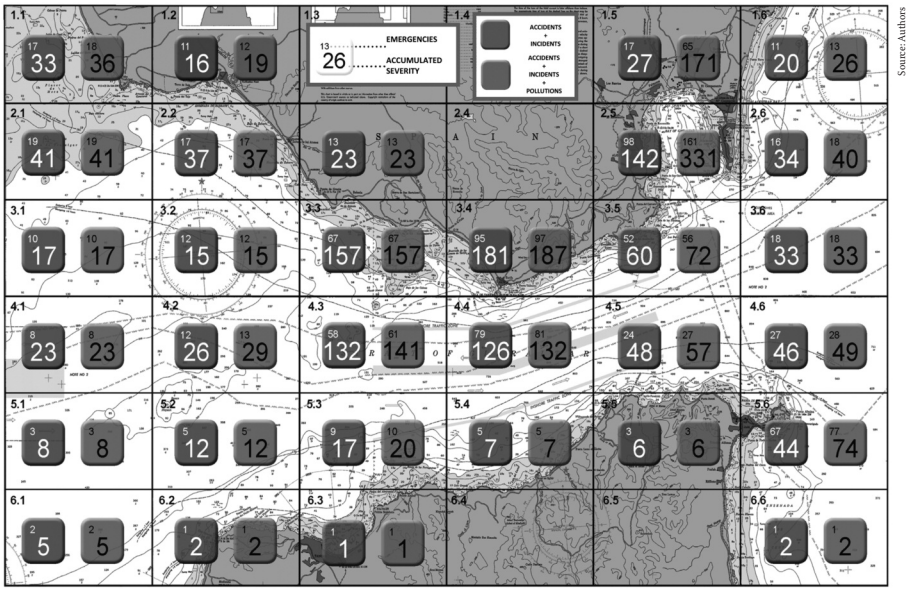


Figure 6: Geographical distribution real emergencies according to severity. Strait of Gibraltar. Years 2000-2004

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Cost Assessment Simulator for Transport Between Mediterranean Spanish Ports and the Black Sea

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ABSTRACT

There is a strong imbalance in EU transport mode shares. In addition, issues like road traffic, noise, accident rates, and especially polluting emissions result not only in external costs to society, but also in high logistical costs to transport service customers. The present paper proposes an assessment model to evaluate final internal and external costs of transport chains served by trucks and short sea shipping (SSS). An efficient and fast tool is presented to help customers decide on the most convenient mode of transportation for a specific trade link. The trade links in this paper connect 19 Spanish provinces to the main ports in the Black Sea region (Bulgaria, Georgia, Romania, Russia, Turkey, and Ukraine) through the ports of Barcelona and Valencia.

1. Introduction

The main objective of this paper is to obtain a calculation method of all costs and times associated with freight distribution. Overall costs (in €) are calculated based on the operational cost of a single truck and the variable Gross Tonnage *(GT)* for the marine transport mode. The time (in hours) required to move freight between a point of origin and a destination strongly depends upon the operational speed of the modes employed. The formulation is subsequently validated with actual data on freight transport by SSS between Spain and Italy (since prices for these links are known). Calculation errors exceeding 10% are not accepted. Validation is performed with other simulators currently in operation. All required data is calculated by an engine generated by an Excel spreadsheet and a *Visual Basic* program, and then presented in tables and graphs. Users of the proposed cost and time simulator will simply need to introduce an origin (*i*) and a destination (*j*), as well as other transport-related parameters.

1.1. State of the art

After analyzing all available cost and time simulators, we found that they are divided into two groups. The first group includes simulators of a practical nature, based on companies or private institutions maintaining a website where only a few variables must be introduced (typically origin and destination) to determine cost or time, without specifying the calculation formula or method used. In these cases, the software is a closed source. Two clear examples are the Shortsea Promotion Centre-Spain, and the Rete Autostrade di Mare. On the other hand, several attempts have been made to estimate external costs based on theoretical

studies conducted in the transport sector. Some have been obtained through research projects, especially within EU-framework programs and EU initiatives like CAFE (2001). Other programs have had an impact on transport sectors, such as RECORDIT (2001), ENTEC (Whall, 2002), UNITE (2003), INFRAS (IWW, 2004), REALISE (2005), MOPSEA (Vito, 2006), EMMOSS (T&M Leuven, 2007), and iTREN-2030 (EU, 2009). For air pollution damages, studies have relied on the ECOSENSE model (often cited as the "ExternE model") developed by IER (2005) within the ExternE project series. Our aim here is to present a simulator of internal and external costs, which will also allow for the updating of cost data and the incorporation of new and different ships for the marine

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mode.The empirical estimation of port cost functions started in the 60's with the work of Wanhill (1974), which aimed to design a model to determine the optimal number of berths in order to minimize total costs derived from port dues, that is, berth and port time. The works by De Monie (1989), Dowd and Lechines (1990), Talley (1994), and Conforti (1992) proposed a cost analysis to appraise port performance and output by calculating several indicators. Cost analysis also allows comparison of productive efficiency over time in a company and between companies. Two techniques are useful here, i.e. data envelopment analysis (DEA) (Roll and Hayuth, 1993), (Martínez Budría *et al*, 1999; and Tongzon, 2001) and econometric estimation of frontier and distance functions (Liu, 1995; and Baños-Pino *et al*, 1999). The doctoral thesis of Ametller Malfaz (2007) describes the development of cost and time evaluations under the hypothesis of freight distribution based on population density.

The behavior of freight distribution systems must be known in order to design a simulation model. As is usually the case, actual systems are complex; therefore, a simple, straightforward mathematical representation requires the simplification of such systems. Road haulage, port operations, and maritime transport must be modeled in order to assign costs derived from each part or component of the logistics chain. The possibility of a shift from strict road transport to a multimodal chain like SSS will depend on route characteristics and conditions. The case under study here assumes a SSS logistics chain where the truck driver does not travel on the ship during the sea leg. This case is likely more competitive than strict road transport since the truck driver can perform parallel activities while freight is being transported by sea, resulting in increased productivity of transport companies and reduced operational costs. Note that an SSS chain can only be guaranteed if a trade agreement with the destination country covers the last stage of the transport chain.

1.2. The commercial scenario

The analysis below shows an upward trend in the volumes traded between Spain and the Black Sea region. Basic data obtained from the Spanish Institute for External Trade (ICEX) analyzes values (in Euro) and volumes (in metric tons) exchanged between Spain and the Black Sea region in 2009. Figures on import and export operations between Spain and Bulgaria, Georgia, Romania, Russia, Turkey, and Ukraine have been evaluated in previous works (Mihailovici, 2011; Rodríguez Nuevo, 2008). The largest number of exchanges occurred with Greece (not located on the Black Sea but included due to the amount of trade), Turkey, Russia, and Ukraine (in the case of the last two countries, as a result of Spanish crude oil imports). It is worth noting that trade operations with all these countries open the door to two large markets, i.e. Central Asia and the Middle East. Data from the Agencia Tributaria (Department of Revenue) and ICEX (Table 1) were used to create a framework to test the feasibility of selecting a transport mode according to physical and environmental costs. Data on (internal) truck costs were obtained from the yearly publication *Observatorio de costes del transporte de mercancías* (Observatory of freight transport costs, 2011), in which a set of model trucks is specified by the Spanish Ministry of Transport. As for vessels, Short Sea Shipping Ro/Pax ships were employed in Mediterranean routes (Martínez de Osés and Castells, 2009).

External costs arise when the social or economic activities of one group of persons have an impact on another group, and when this impact is not fully accounted or compensated for by the first group (ExternE, 2003). The environmental impact and external costs of each mode of transport are compared with the external cost pricing proposed by REALISE (Regional Action for Logistical Integration of Shipping Across Europe) thematic network carried out within the 5th EU Framework Program. The volume of exports and imports between Spain and the Black Sea region is approximately 3,941,806 and 24,898,406 tons, respectively. Thus, the total volume of freight moved from an origin in Spain (*i*) to a destination in the Black Sea (*j*) is about 28,840,212 tons per year, a value that justifies the interest in analyzing the viability of a trade route between both regions.

Table 1: Volumes in metric tons exchanged between Spain and the Black Sea.

2009	Exports		Imports	
	Value	Weight	Value	Weight
Bulgaria	355,232.53	211,267.70	341,875.66	1,200,411.60
Georgia	16,146.92	14,516.40	69,249.74	178,798.10
Greece	1,764,529.42	1,093,081.50	331,898.97	410,281.50
Romania	670,701.01	350,416.30	788,653.51	1,659,126.70
Russia	1,477,423.57	703,394.60	4,587,218.95	15,805,139.00
Turkey	2,597,335.18	1,457,645.50	2,632,495.76	2,144,425.60
Ukraine	188,606.24	111,484.00	582,248.73	3,500,273.60

Source: Authors

2. Methodological considerations

The simulator uses calculations whose results provide a basis for the computer program and the engine for the computation, in terms of costs and travelling times, that determines the internal and external costs, based on the previously mentioned projects. Substantial mathematical and programming work is required, but field work is also essential to obtain real data on regular shipping lines (limiting the study to Ro-Ro ships), port facilities, and vessels. In order to implement the simulator, the following methodological sequence is proposed:

1. Development of a formula and a mathematical model for determining costs and times for internal costs, and costs and amount of emissions for external costs associated with each mode of transport. We have used the REALISE (2005) project which provides statistics and a methodology to calculate environmental impacts and thus the external costs from both sea and road transport. The REALISE project used data sets, based on the COPERT III (EEA, 2002) calculation module. COPERT III was designed to evaluate polluting emissions from road

transport and was part of the EMEP CORINAIR (EEA, 2009) project. The EMEP CORINAIR (nowadays identified as the EMEP/EEA air pollutant emission inventory guidebook) provides guidance on estimating emissions for different modes of transport. The emissions factors of vessels, in g/kg fuel, were calculated taking fuel consumption into account. To evaluate the impact of transport emissions, the scenario considered here is a hypothetical improved future condition, resulting in a 10% decrease in the current emissions, except for SO_2 and NOx. The main engine fuel consumption rate is strongly affected by the propulsion systems installed, such as engine, gear, shaft, and propulsion arrangements. External costs evaluated in this simulator are SO_2, NOx, CO, nm-VOC (local contamination), and CO_2, CH_4 and S (global contamination). As regards haulage, road transport is the first and last stage of freight transport and distribution. It is evident that SSS always requires this component since origins and destinations are generally within port jurisdiction. The terminal may even be located outside the seaport facilities.

2. Create a database with information and characteristics of actual Short Sea Shipping vessels.
3. Analysis of the value of variables and determination of possible reasons for an inefficient freight transport mode to eventually establish its level of competitiveness.
4. Design of the program in *Visual Basic* to create an internal and external cost simulator.
5. Gathering and final analysis of obtained data.
6. Design of a mask to introduce inputs and receive the necessary outputs to serve a route and estimate internal and external costs of a freight transport mode.

When the program is running, freight transport costs and times, as well as costs and amounts of pollutant gases emitted during transport, are printed on the mask.

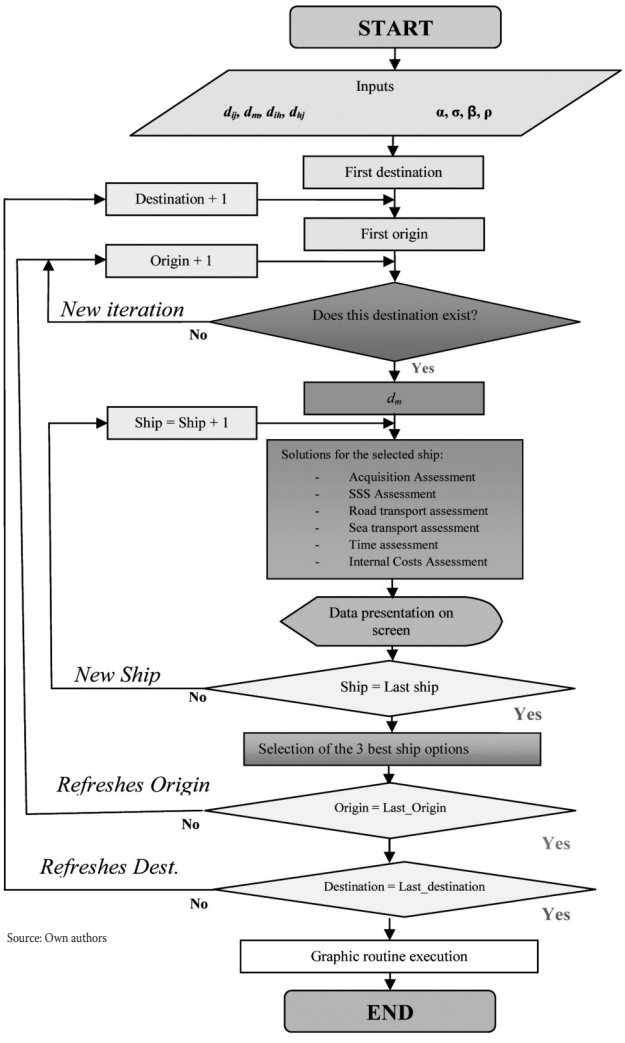
The calculation engine, which performs and works with formula and matrix data in Visual Basic, was designed on the basis on previously obtained formulations (Ametller, 2010), compared with previous existing calculation methodologies (COPERT for road transport or CORINAIR for marine mode). The steps involved in the simulator design are described in the following subsections.

2.1. Description of the data acquisition methodology

After an origin (*i)* and a destination (*j)* are proposed, the work methodology of the simulator is as follows:

1. Choose data from the "destination matrix" and find out whether there is a destination for the selected route (Bulgaria, Georgia, Greece, Romania, Russia, Turkey, and Ukraine).
2. Choose data from the "origin matrix" and find out whether there is an origin for the selected route (La Coruña, Almería, Asturias, Barcelona, Burgos, Cádiz, Cantabria, Castellón, Ciudad Real, Guipúzcoa, Huelva, Lugo, Madrid, Murcia, Tarragona, Valencia, Valladolid, Vizcaya, and Zaragoza).
3. Choose data from the "maritime distance matrix" Barcelona, Valencia and Bulgaria, Georgia, Greece, Rumania, Russia, Turkey, and Ukraine. Maritime distances were obtained from MAP24 and Via Michelin sources.

   At this point the executable program allows entry of variables like ship occupancy -as this is used to spread the total ship costs over the actual number of cargo units loaded-; type of freight, number of calls made and company profits only in the case the consignor would like to consider it, otherwise this value can be zero. These parameters are described below.
4. Print and display all solutions for the best ship (calculation of SSS and road transport costs, time, and pollutant emission costs).
5. Choose the best three ships for the selected route from the simulator's database which has been included in the simulator by selecting a number of Ro Pax ships used in SSS Mediterranean trade and provide their details (ship's name, year of build, length, beam, carrying capacity, lane meters, power, speed, and number of carried trailers.
6. Perform routines under the established formulation (for all destinations, origins, and ships).



Source: Own authors

Figure 1: Work methodology diagram of the simulator.

2.2. Description of functionality

Because the land distance matrix coordinates are annexed to the program code that calculates costs and times for the ships and selects routes, road transport calculations are the least complex. This simplifies the relationship between formulas and distances since only road chain data and road leg (in multimodal chains) data are obtained using the same land matrix. The compiler proposes one ship from the database created in the simulator, which contains vessels currently (2010) serving SSS routes, as has been mentioned before. The ship is studied and initial calculations are made based on its details. The program then selects a destination and finds out whether there is an origin for it. If this is not the case, the compiler goes back to the previous step and starts again.

After identifying a ship, a destination and an origin, the program with a database with the existing shipping lines, confirms whether there is a shipping company on the established route. A port –Barcelona or Valencia in the case of Spain– where the consigner will ship the freight is selected. If no route is found, the simulator goes back to the previous step and makes calculations starting from the new origin. It is important to keep in mind that choosing shorter distances results in lower costs and shorter transport time.

When the program selects the most efficient ship in terms of costs, a destination, an origin and a route, it calculates the costs and times for that route.

Once data for the first selected ship is generated, the program goes back to "selection of ship" and makes and records the calculations for all the available vessels in the "ship list". The program allows the user to choose and save the three best ships to serve the selected route. This is important because the shipper can thus charter the ship, which implies optimal costs and transport times, as indicated by the simulator.

The penultimate level consists of choosing a new origin for the destination initially selected. This functionality is shown in order to provide an alternative origin, but the calculation process starts all over again while keeping the previous destination (in the opposite case, the program goes back and selects another origin).

The last step is to use up all the origin possibilities for the above destination and to start a new search for all possible origins for every selected destination. Finally, there will be as many results as pairs of destinations/origins. This way, data for every ship for all destination/origin pairs are obtained individually. The simulator can then describe costs and times for each ship and possible route, providing the user with the best choice. All data is interpreted by means of tables, charts, and the mask designed for the presentation of simulator data (Fig. 1).

Source: Own authors

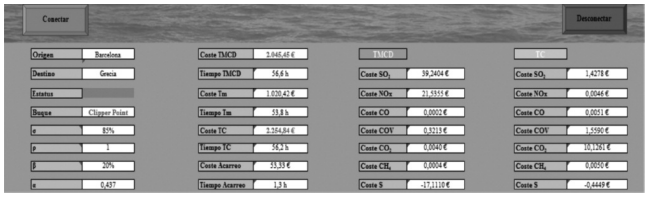


Figure 2: Example of the simulator mask, showing all the variables to be selected before the calculation process.

Table 2: List of ships inserted in the simulator database and regressions done with them.

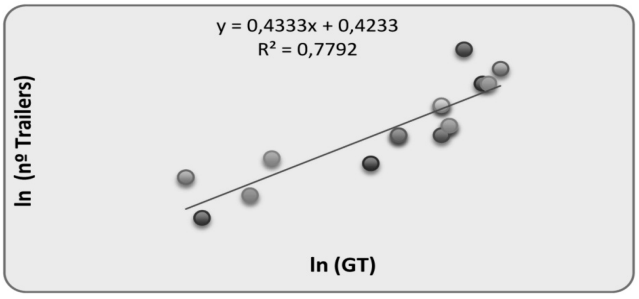
Name·of·ship¤	Year·of·building¤	Lehgth·(m)¤	Breadth·(m)¤	Draft·(m)¤	GT¤	Lineal·metres·(m)¤	Power·(KW)¤	Speed·(Knots)¤	N°·of·trailers¤	ln·de·GT¤	ln·Trailer¤
Bouzas¤	2003¤	151,8¤	21¤	6,2¤	15.224¤	1.680¤	12.960¤	21¤	96¤	9,63062841¤	4,564348191¤
Catania¤	2003¤	179,5¤	25,6¤	6,8¤	25.995¤	2.230¤	18.900¤	23,5¤	127,4285714¤	10,16565595¤	4,847555984¤
Pilar·del·Mar¤	2008¤	187,4¤	25,6¤	6,85¤	26.904¤	2.300¤	21.600¤	23,5¤	131,4285714¤	10,20000303¤	4,878463521¤
Schieborg¤	2000¤	173,4¤	25,2¤	7,5¤	21.005¤	1.884¤	11.000¤	22,5¤	107,6571429¤	9,95251578¤	4,678951574¤
Ave·Liepaja¤	1999¤	179,93¤	25,24¤	6,5¤	22.152¤	2.000¤	23.762¤	23,5¤	114,2857143¤	10,00563831¤	4,738701579¤
Ave·Luebeck¤	1999¤	179,93¤	25,24¤	6,5¤	22.152¤	2.000¤	23.762¤	23,5¤	114,2857143¤	10,00563831¤	4,738701579¤
Zurbaran¤	2000¤	180¤	25¤	6,5¤	24.046¤	2.000¤	32.300¤	23,5¤	114,2857143¤	10,08772239¤	4,738701579¤
European·Endeavour¤	2000¤	179,95¤	25¤	6,5¤	24.046¤	2.130¤	23.762¤	23,5¤	121,7142857¤	10,08772239¤	4,801676378¤
Midnight·Merchant¤	2000¤	179,95¤	25¤	6,5¤	24.046¤	2.130¤	23.760¤	23¤	121,7142857¤	10,08772239¤	4,801676378¤
Murillo¤	2002¤	180¤	25¤	6,5¤	25.098¤	2.396¤	32.300¤	23¤	136,9142857¤	10,13054434¤	4,919355078¤
Clipper·Point¤	2008¤	152¤	23,03¤	5,7¤	14.759¤	1.830¤	18.480¤	21,5¤	104,5714286¤	9,59960835¤	4,649870365¤
Superfast·Galicia¤	2003¤	160¤	23,2¤	6,8¤	16.686¤	1.762¤	34.300¤	22,5¤	100,6857143¤	9,72232532¤	4,612003926¤
Superfast·Levante¤	2001¤	158¤	25,2¤	7,2¤	17.391¤	1.905¤	34.300¤	22¤	108,8571429¤	9,76370811¤	4,690036407¤
Maria·Grazia·On¤	2004¤	179,8¤	25,6¤	6,5¤	26.302¤	2.230¤	21.600¤	24¤	127,4285714¤	10,17744003¤	4,847555984¤
Hoa·Sen¤	2001¤	179,8¤	25,6¤	6,5¤	24.418¤	2.040¤	34.000¤	24¤	116,5714286¤	10,10307758¤	4,758504206¤
Trinacria¤	2002¤	179,8¤	25,6¤	6,5¤	24.409¤	2.040¤	34.000¤	24¤	116,5714286¤	10,10270072¤	4,758504206¤
Sorolla¤	2001¤	172¤	26,2¤	6,21¤	26.916¤	1.809¤	28.960¤	23,5¤	103,3714286¤	10,20047762¤	4,638328604¤

Source: Own authors

3. Preliminary results

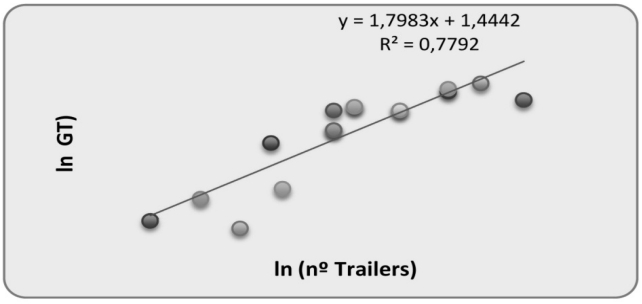
We have designed a simulator of internal and external costs that provides marine stakeholders interested in the Spanish and Black Sea markets with very close estimates of the costs of using maritime or road transport.

The simulator considers European road transport regulations on driving times (2002/15/EC Directive) and costs of road freight transport (Spanish "Observatorio de costes del transporte por carretera", 2010). For marine transport, similarities in cost structures among the groups of ships selected, mainly Ro-Ro ships, make it possible to use linear regression in order to get formulae for marine internal costs, in which the variable to consider is gross tonnage.



Source: Own authors

Figure 3: Example of regression of number of trailers/ GT.



Source: Own authors

Figure 4: Example of regression of GT/ number of trailers. Source own.

In order to validate the simulator results, these were compared with real costs and sailing times of SSS lines linking Spain and Italy. Finally, agents of import/export trade between Spain and the Black Sea region were consulted for getting a qualitative information to gether with the quantitative data coming from Spanish statistics (ICEX).

3.1. Design of cost and time simulator

The simulator was designed to compare freight transportation by road chains and by multimodal (with SSS leg) chains only.

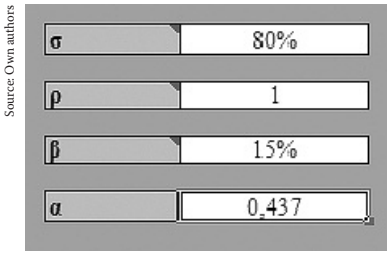
Both internal and external costs can be calculated. Prime or internal costs are those derived from fixed and variable costs related to transport activities. External costs are environmental costs associated with estimated emissions considered in previously mentioned projects.

The simulator makes some assumptions regarding the time required for activities within the transportation chain, such as loading and unloading operations. The loading and unloading time varies according to the type of ship used and port handling operations. Considering 0.5 hours plus lading and discharging times.

3.2. Simulator technical specifications.

The simulator includes the following set of options, which can be optimized by the executable program:

- Names of the best three ships. In any case, if the first ship is already chartered, there are second and third best options.
- Ship's cargo-carrying capacity (σ), that is, the actual load volume that a ship can carry in her holds. This is an important factor for shipowners, given the fact that profits strongly depend on the percentage of the total loading capacity actually used. The ship's profit depends on the ship's occupancy rate. If the ship occupancy rate parameter is not introduced in our program, the ship will have an occupancy rate of 100% and this is an unrealistic value, as an average the occupancy rate ranges around of 60-70%, thus affecting the real share of the ships' costs.
- Number of ports visited by a model Ro/Ro ship in each trip (ρ). Obviously, a higher number stops at ports leads to increased port costs for the shipowner.
- Specific profit margin of the shipping company (*β*), established as desired by the simulator user.
- Freight cost parameter (α) for determining inventory costs, id est the cost for the manufacturer of maintaining the freight in a warehouse waiting for it to be sold; for example, perishable or refrigerated goods require transport under more demanding conditions than other types of goods, resulting in higher costs.



Source: Own authors

Figure 5: Example of variables that can be optimized by the executable program.

The value of the previous variables can be modified by the user of the simulator, as the only independent variables. This is of great importance for shipowners because costs and service times can be adjusted by promoting certain variables. The value of the internal costs depends on the type of ship, thus on her tonnage or GT.

3.3. Reliability of the Simulator

The program's reliability was assessed during the design phase by comparing the obtained figures with real prices. The results, which were based on a sailing route served by a Western

Mediterranean company, were conclusive and satisfactory as the error or difference between the model data and real data did not exceed 10% (see Table 2).

Table 3: Summary of existing deviations between actual and estimated costs.

Route	Freight Cost (€) Tractor Trailer (17.5 meters)	Analysis Value (€)	Standard Deviation
Barcelona-Livorno	805	832	–3.4 %
Barcelona-Civitavecchia	787	861	–9.4 %
Valencia-Livorno	1.001	900	–10 %
Valencia-Salerno	989	1.017	–2.8 %

Source: Shipping companies (2010)

3.4. Display of Cost and Time Competitiveness Indexes

The simulator calculations can be displayed graphically. The costs and time required for freight transport from one province (origin) to another (destination) are determined by the simulator. Additionally, the external costs produced by the transport modes were calculated using the REALISE project formulae. Using the criterion of moved volume per province, a province table is used to find out which provinces are most likely to move more freight to the Black Sea region. For comparison purposes, the authors used the cost of embarking a trailer in Spanish-Italian trade. There are several options to be considered as an unaccompanied trailer, a complete truck (tractor plus trailer), and a complete accompanied truck. A volume ranking is established and reflected by the so-called Cost Competitiveness Index (CCI). This index determines the competitiveness of boarding the trailer throughout the journey against the road option with a single-driver truck. The mentioned index uses the following formula (Rodriguez Nuevo, 2011):

$$CCI = \frac{1.012 \cdot d_r + 96}{0.332 \cdot d_m + 1.012 \cdot d_h + 805}$$

d_r: Road distance, means the total distance covered by a road transport only
d_m: Maritime distance
d_h: Haulage distance, stands for the distance of road legs before and after a marine transport chain, within a multimodal transport chain.

If the value is more than 1, then the SSS alternative is more competitive with regard to costs than the road-only alter native.

The Time Competitiveness Index (TCI) determines the competitiveness in regard to time of boarding the trailer throughout the journey instead of the road option and the following formula is applied (Rodríguez Nuevo, 2011):

$$TCI = \frac{d_r - 108}{d_m + d_h - 56}$$

If this value is greater than 1, the SSS alternative is more competitive with regard to time than the road-only one.

A competitiveness ratio, which is different for each Spanish province, determines whether a route is competitive in terms of time and cost. As an example, the following figures show the trailer-only option.

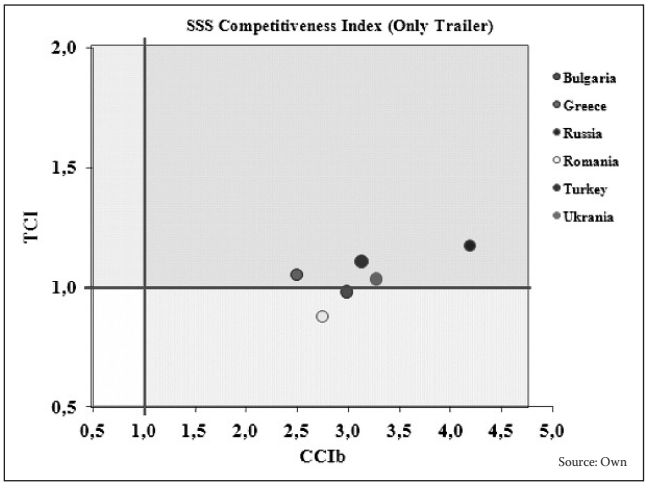


Figure 6: Cost Competitiveness Index of SSS versus road-only transport between Madrid and the Black Sea.

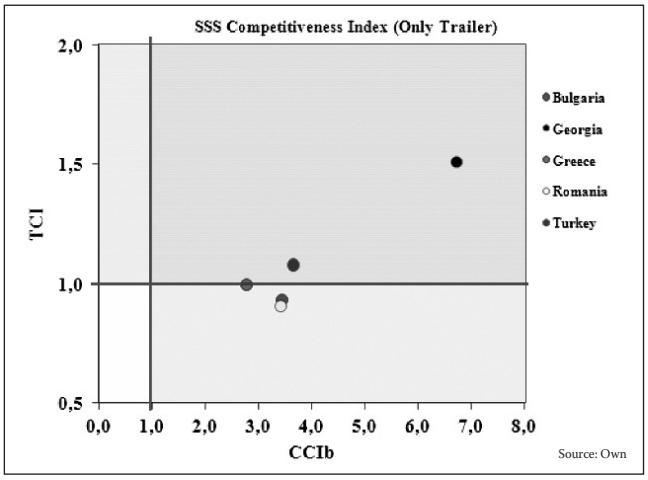


Figure 7: Cost Competitiveness Index of SSS versus road-only transport between Barcelona and the Black Sea.

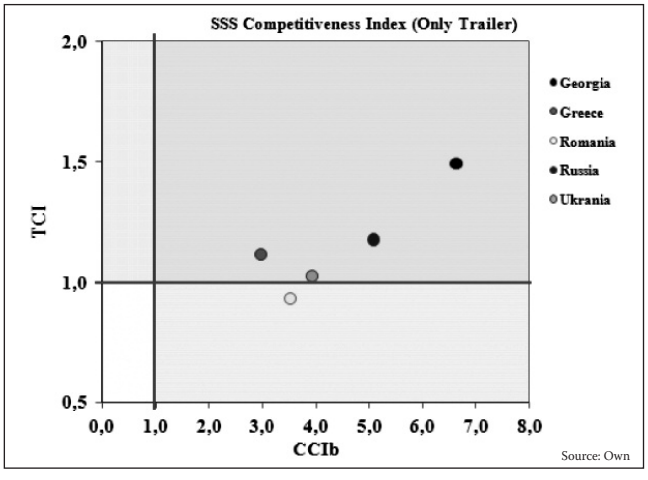


Figure 8: Cost Competitiveness Index of SSS versus road-only transport between Castellón and the Black Sea.

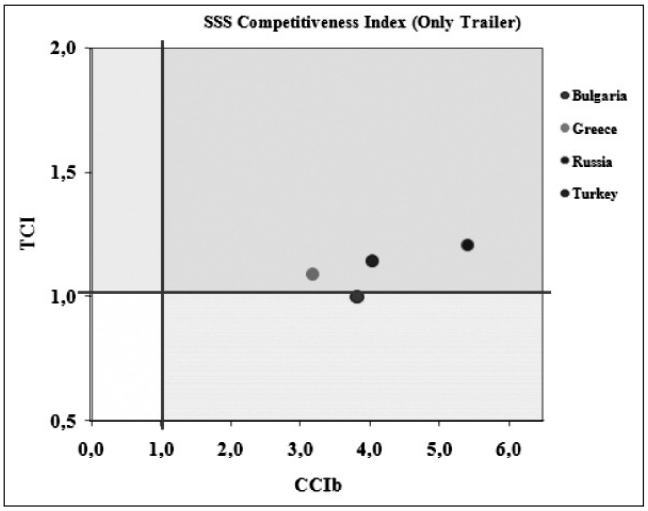


Figure 9: Cost Competitiveness Index of SSS versus road-only transport between Cádiz and the Black Sea.

4. Discussion of results

Regarding cost calculations, in all routes, road transport was found to be more expensive. The farthest destination (Ciudad Real in Spain to Poti in Georgia), reaches the cost of 7,299.98 €. This is the most expensive route between Spain and Georgia. The least expensive route costs 2,254.84 €, and reaches the Piraeus port from Spain.

The marine option is always more economical, the most expensive one being the one going from Spain to Russia (Rostov-na-donu) at 2,556.82 €, and the cheapest one to Piraeus costing 1,123.82 €.

Costs differ less for the route between Spain and Piraeus (less than 1,131.02 €). This last case is justified because of the similarities in distances travelled both by road and by sea. The biggest difference is in the route between Ciudad Real (Spain) and Poti (Georgia) at 4,987.82 €.

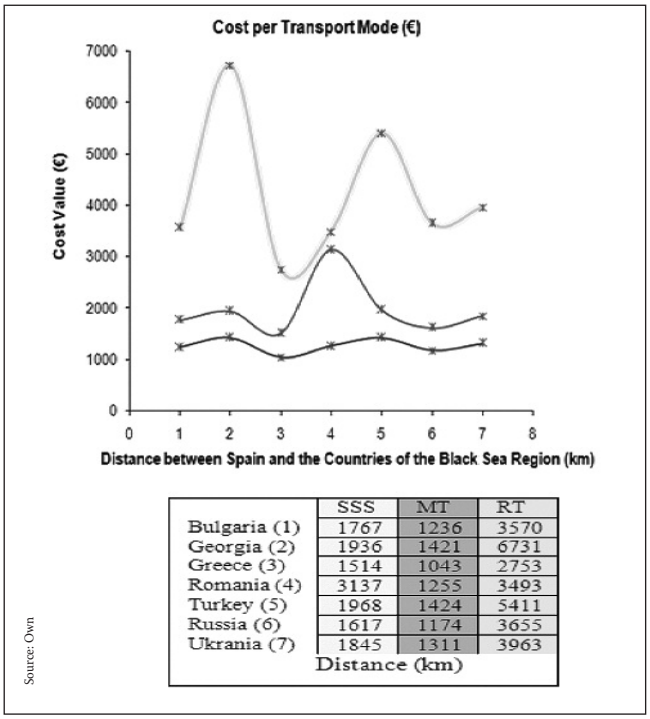
Table 4: Table showing the costs (in €) and time (in hours) between different origins in Spain and Poti (Georgia).

ORIGIN	SSS Cost	Road Cost	SSS Time	Road Time	TMCD/TC Costs	TMCD/TC Time
Barcelona	1,484.53	6,117.09	101.2047115	152.5510	**24%**	**34%**
Burgos	2,113.49	6,782.66	116.8899335	169.1494	**31%**	**31%**
Cádiz	2,338.17	7,299.98	126.4108305	182.0504	**32%**	**31%**
Castellón	1,572.82	6,401.88	107.3242665	159.6532	**25%**	**33%**
C. Real	1,870.57	6,858.39	114.7496565	171.0380	**27%**	**33%**
Lugo	2,419.71	7,198.65	128.4444005	179.5234	**34%**	**28%**
Murcia	1,753.66	6,761.33	111.8340305	168.6174	**26%**	**34%**

Table 5: Table showing the costs (in €) and time (in hours) between different origins in Spain and Piraeus (Greece).

ORIGIN	SSS Cost	Road Cost	SSS Time	Road Time	TMCD/TC Costs	TMCD/TC Time
Barcelona	2,148.78	3,282.00	85.18854600	81.8482	**65%**	**-4%**
Burgos	1,646.50	3,147.61	72.66260600	78.4966	**52%**	**7%**
Cádiz	1,123.82	2,254.84	56.60322692	56.2324	**50%**	**-1%**
Castellón	1,202.79	2,553.50	61.59700600	63.6804	**47%**	**3%**
C. Real	1,691.71	2,514.03	70.76559892	62.6962	**67%**	**-13%**
Lugo	1,504.15	2,900.15	69.11257000	72.3254	**52%**	**4%**
Murcia	1,155.37	2,617.50	60.41437000	65.2764	**44%**	**7%**

The assessed costs and time are shown in figure10.



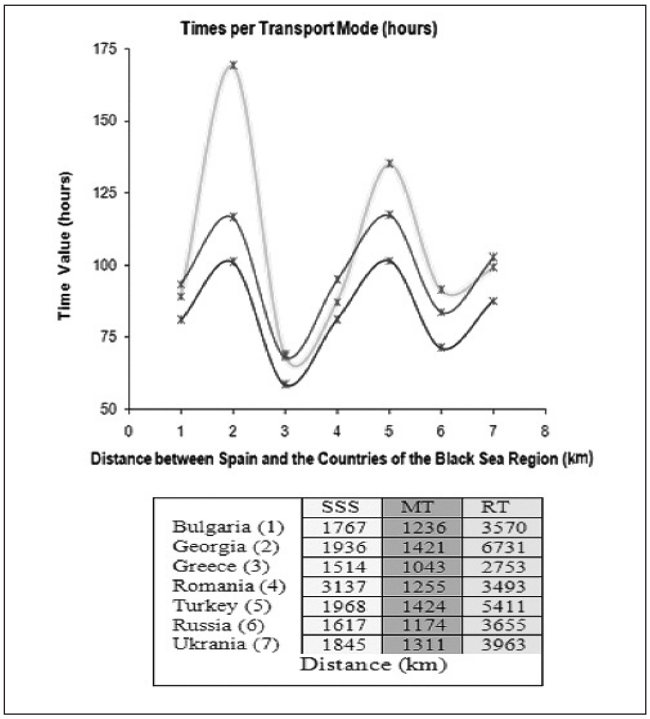


Figure 10: Graphical representation of costs and time required between Spain and the Black Sea.

6. Conclusions

A simulator for the evaluation and reporting of data to assess internal and external costs for a freight transport chain has been created. The calculation scenario is the route between Spain and the Black Sea region because of its potential in the near future.

In general terms, we found that SSS is more economical for all routes between Spain and the Black Sea region.

The "road only" option was found to account for 60% of the most favorable cases in terms of time. Routes between Spain and Bulgaria, Greece, Romania, and Ukraine take less time when using the road-only alternative.

The following results were obtained regarding the cost and time competitiveness indexes:

— The Time Competitiveness Index (TCI) determined that SSS routes between Spain and Georgia and Spain and Ukraine are the most efficient in terms of time.

— The Cost Competitiveness Index (CCIa) determined that SSS routes with the driver, truck, and trailer onboard the ship are more competitive in terms of cost than the above case.

— The Cost Competitiveness Index (CCIb) determined that SSS routes with only the trailer onboard the ship are the most competitive in terms of cost.

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Logistics Centres Assessed as a Port City Decongesting Strategy: Case Study of a Nigerian Port City

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ABSTRACT

The work assessed the role of logistics center concept as a port city decongestion strategy. Logistics centers in world's most modern ports were studied and the impacts they make on port efficiency noted. Port back up areas, freight villages as well as their connecting corridors were all evaluated to ascertain their contribution to port city traffic decongestion. The approach applied in the study involved the assessment of traffic situations in the Nigerian port city of Lagos. The paper suggested two solutions to the handling of port city congestion problems. The first is the formation of a rail linked logistics village positioned outside the city peripheries. The second is the formation of a waterfront port system logistics center linked by feeder vessels and hinterland rail connectivity. Pipeline linkages were also suggested for tank farms.

1. Introduction

The position of port cities in the logistics chain of import and export cargoes cannot be over-emphasized in the distribution of inward goods into the hinterland as well as the preparation of goods destined for export. Ports play the middleman position in the distribution of inward goods into the hinterland as well as in the preparation of goods destined for exports. They serve as centers for consolidation and deconsolidation of cargo. They play the role of the warehouseman for these cargoes pending the time they are collected by their consignees.

Over the years, the role of ports as part of the logistics supply chain of countries has made port development a government and public sector concern. Government investment in port is supported by the growth pole principle which infers that growth achieved in the sector will be transferred to the rest of the economy. However, the inefficiencies abounding in government organizations have made the inclusion of the private sectors absolutely necessary, thus giving rise to four different generations in port development.

Rapid development of ports in recent times has led to the transfer of congestion to port cities thus requiring the development of the transport logistics drivers in most port cities. The relationship between ports and cities has been age long. The port of Amsterdam and Rotterdam for instance are said to have developed within cities. However, the development in ship sizes and other factors forced them to relocate towards the sea.

Today, many port cities are laden with the problem of traffic congestion thus necessitating the development of dedicated truck corridors, rail links and other aspects of the transport logistics driver in a bid to avoid congestion. To avert the problem of congestion, logistics centers also known as freight villages have now been incorporated into the logistics supply chain of a port city. However, the adaptation of most port cities to this new design has been slow. This has resulted in the manifestation of inefficiencies in most port city supply chain.

2. Objectives

The objective of this paper is to assess the role of the logistics center concept as a port city decongestion strategy, generally. The specific objective is to assess how the Nigerian port city of Lagos has utilized the logistics center concept as a port city decongestion strategy.

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2.1. Literature review

The need for collaboration between port authorities and port cities in the area of planning has been the subject of so many literatures in port reform.(World Bank (2007). Logistics center development serves as a means for improving the efficiency of highly congested ports. This has been applied together with other parameters in the port of Hong Kong (Yang et al 2008).

The inadequacy of space both within and outside port districts in world major ports like Hong Kong has also been observed by many writers. (Wing 1998), (Low, 2002). To make provision for inadequate space certain ports like Taiwanese port of Kaohsiung and some others have created offshore logistics centers for cargo processing and consolidation. (Yang et al 2008).

The utility of logistics centers or freight villages as a port city urban freight solution has been greatly emphasized in literature. Allen and Eichorn (2007). The work analyzed solutions strategies applied by the cities of Bologna and Bremen in optimizing logistics issues in the port cities.

The concept of port city logistics centre has also been emphasized using the term port back-up areas. This refers to a logistics park, a distribution park or even a freight centre where facilities are made available for cargo processing, consolidation and deconsolidation along the port hinterland supply chain. (KMI 2005). A port is in existence to ensure sufficient continuity in the transport chain. It is more than an intermodal hub also consisting of a back up area (such as logistics centre and distribution centre), with an active role in the value added chain. KMI (2005). IAPH and Spanish Ports Agency (2003).

2.2. Methodology

The method applied in this research was drawn from the lean logistics theory applied to ports The method is based on the development of agile ports where best principles are adopted by other operators in the system thus inducing efficiency in other members of the logistics supply chain. In this regards, the logistics centre practice together with the best transportation link option available in the system were used to produce a best operations handling plan for the port city congestion problem.

3. Report of findings

The location of logistics centers inside ports in Lagos state has been found in this work as the ultimate solution to the continued congestion problems in the hinterland area of both Lagos and neighboring Nigerian states. Two aspects of the port system existing in the Lagos state can be compounded to constitute of the water front port systems complex and the hinterland dry port complex.The waterfront port systems complex constitutes of the ports of Lagos, Tin can Island port, Ikorodu port, Snake Island and adjacent oil terminal facilities in the area. Whereas the port systems in Nigeria operate the landlord model with concessions being operated by global port giants like AP Mocller and others, the hinterland dryport complex constitutes of inland container depots operated by private firms basically located within Lagos metropolis. Movement of oil from tank farms and oil terminals located at the water front complex for hinterland transportation are by freight tank cars. With over 70 percent of Nigerian goods passing through the Lagos port complex most of which are inward cargoes, a congested road transport logistics system is thus built on a daily basis within the Lagos metropolis. The need for effective cargo diversion from the road mode to other modes steered from an effective logistics centre within the waterfront port systems complex is thus apparent.

3.1. Proposal for a logistics village

Given the continued increase in containerization and cargo flow in the Lagos ports, this research makes hold to propose the location of a logistics village along a functional rail line and another logistics centre at the waterfront port sector. Two, logistics centers suggested by this work can thus be referred to as rail linked logistics village and waterfront port system logistics centre. Whereas the hinterland rail linked logistics village is designed to decongest the already congested Lagos city with her ineffective road linked dry port system, the waterfront port systems logistics centre proposed in this work, will do the same along the already congested port networks. For the water fronts of Lagos, Tin can Island and Snake Island port locations, new spaces for possible quayside extension should be made available for future expansion. This required expansion can be realized through the formation of the waterfront port systems logistics center proposed in this work. The waterfront logistics center should be accessible from both land and sea side connected properly located outside the Lagos metropolis.

3.2. New rule for waterfront tank farms

A rule should be passed banning tankers from loading directly from waterfront located tank farms. Transportation of refined products from such tank farms should be partly by pipelines to designated hinterland locations away from the Lagos metropolis. Such rule will automatically decongest the already overloaded road networks linking Apapa with the rest of Lagos state. Underwater pipeline together with special locations away from the city center for the tank farms should be surveyed.

Source: Author.

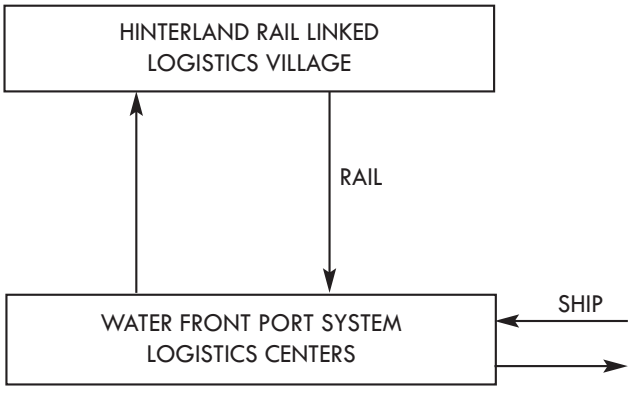

Figure 1: Logistics center solution model for congestion problems in port cities

4. Conclusions

This research proposes a two way logistics center solution to the port city congestion problem existing in maritime cities. The Lagos port system in Nigeria was used as a case study to re-design the port city in a way to reduce ship freight induced congestion from the city roads, thus making the transport logistics aspects of the global freight induced, thus making the transport logistics aspects of the global freight supply chain a sustainable one. Other port cities in the global village having congestion problems may borrow leaf.

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The Influence of Managers and Organisational Profiles in CSR Decision-Making. Ideas for Implementation in the Maritime Sector

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ABSTRACT

The principles that promote corporate social responsibility (CSR) and corporate philosophy should be translated into concrete action and promoted by decision-makers at corporations. After conducting a meta-analysis of research conducted on the performance of socially responsible businesses, Wood and Jones (1995) argued that people in leadership positions are the most important social agents in this area.

Therefore, this article focuses on several variables in the personal characteristics and the organisational contexts in the maritime sector that appear to determine the decision-making processes of managers who are responsible for CSR. We believe that a better understanding of the factors that influence the decision-making process of those who promote, articulate and/or implement CSR may illuminate ways to facilitate the conditions for socially responsible management in effective maritime organisations. The main objective of this paper is to understand how these personal and organisational variables affect decisions about socially responsible actions at the corporate level and to propose ways in which maritime companies can improve their CSR performance.

1. Introduction

Corporate social responsibility is becoming more important and creating competitive advantages for companies. The maritime sector is no exception, and it has displayed a growing interest in the field in recent years. In fact, recent decades have seen a major shift in production, distribution and consumption models in the maritime sector that are the result of a sense of responsibility. Factors such as a concern for natural resources, the growing impact of business activities or repeated scandals in environmental and financial companies have increased the importance of CSR. Furthermore, these factors have led companies in general, and the maritime sector in particular, to have more interest in creating a climate of trust with the public to improve the sector's image in society and among their workers and employees.

The study of the maritime sector is important, given that it is one of the most important economic activities in Spain, both economically (it contributes between 3% and 7% of GDP) and with respect to employment within the industry and in complementary industries (accounting for 2.3% of Spain's total employment) (Spanish Maritime Cluster, 2009a).

Concern about companies' social responsibility and sustainability has grown in the last decade. In October 2007, the Blue Book was published, containing a maritime policy aimed at sustainability with respect to the seas (a suitable human-habitat ecosystem, marine environmental protection and maritime safety and penalties for damage caused, among other central aspects). Two years later, in 2009, the status of the Spanish Maritime Cluster was approved. The objectives of the Strategic Plan of the Spanish Maritime Cluster include wealth creation, social welfare, business excellence, increasing the competitiveness of Spanish companies in the global market, improving the efficiency of companies' industrial and commercial management and boosting the professional development of workers involved in this activity. All of these objectives are related to the search for socially responsible behaviour at the corporate level (Spanish Maritime Cluster, 2009a).

The aim of this study is thus to contribute to this area of analysis by reflecting on companies' implementation of CSR practices. This study also seeks to identify new ways to incorporate these practices to help the maritime industry to im-

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prove its socially responsible activities and to gain influence and competitiveness.

2. The leadership role in CSR

The role of managers in the decision-making process has been extensively studied in the literature on strategic management and may be useful for implementing CSR activities in the maritime sector. As recognised by the members of the Spanish Maritime Cluster, the "implementation of social responsibility within any organisation depends on strong leadership from management. Knowledge and awareness of social responsibility and value are the starting point to get the highest address of the party as the strategic value" (Spanish Maritime Cluster, 2009b, p.32).

Several studies agree that there is much to be learned about this subject by analysing individual decision-makers to gain a better understanding of their motivations and their effects on a company's management strategy (McGuire et al., 2003; Swanson, 1999, Hitt and Tyler, 1991, Hambrick and Mason, 1984). In the middle of the last century, Davis (1960) predicted that during the second half of that century, managers would be able to decide how to act on their sense of social responsibility. In that context, Greening and Gray (1994) highlight the importance of the senior managements' commitment to address the political and social issues that affect the organisation and to integrate these issues into corporate strategic planning. As stated by Clarkson (1995), when key leaders in organisations incorporate accountability for their behaviour, they are in a better position to meet their goals of wealth creation, not only for themselves but also for their stakeholders.

Wood (1991) considers managers to be moral actors who must always choose among alternatives. This task has been explicitly included in the model of the social action officer at a company and is one of the fundamental principles of CSR: managers must exercise discretion in targeting socially responsible corporate action. However, certain obstacles that isolate the effects of individual decisions by leaders have been found. According to Agle et al. (1999), the results of corporate actions are influenced by several other factors, such as laws and regulations, environmental institutions and the culture of the organisation. However, other scholars, such as Jones and Wicks (1999) and Donaldson (2002), have argued that the social action officer in a company is subject to the direction of the company's leaders.

According to Hitt and Tyler (1991), managers' involvement in the process of organisational decision-making has been analysed from deterministic approaches (where the environment or control of resources define the decision-making process) and from approaches that place a greater emphasis on the strategic choices made by leaders, which are influenced by their values, experiences, expectations and cognition. Geletkanycz and Hambrick (1997) add that leaders' strategic decisions are also affected by external ties, the influence of the social environment and the information they collect. According to Key (1997), several studies have addressed the discretion of management and its relationship to personal and organisational factors, such as the managers' age, education level, gender, role, the size of the organisation, the type of organisation and the industry in which the firm operates (Finkelstein and Hambrick, 1990; Haleblian and Finkelstein, 1993, Hambrick and Abrahamson, 1995).

3. Companies' areas of CSR activities

Possible areas of social action for the company are classified in various ways in the literature. According to the Commission of the European Communities, there is no single list; however, there is some consensus that these areas of corporate action can be defined according to the social and environmental concerns that arise from a company's business and commercial activity and their relationship with various stakeholders (IPES, 2002). Fernandez (2001) highlights the need for a classification method to analyse the performance of socially responsible activity from the perspective of company leaders.

In 2009, the Spanish Maritime Cluster published the Manual of Best Practices that identifies opportunities and benefits for companies in Spain that integrate CSR into their operations. In this manual, CSR practices for the maritime industry are identified as human capital (the work environment), collaboration with society in general (social responsibility), environmental sustainability (the environment), the respect of human rights (ethics), the relationship with customers (commercial) and the relationship with suppliers (managing the supply chain) (Spanish Maritime Cluster, 2009b). These general areas of socially responsible action coincide with those presented in the analytical model proposed in this study. It should be noted that the manual does not develop the issue of corporate governance relevant to all companies seeking to act responsibly in the market.

Considering the extent of the economic activities included in the framework of the Spanish maritime sector and to allow broader use of the instrument proposed in this study, the definitions of the various fields of socially responsible activity were established after a review of many directives, guidelines, diagnostic tools, and management evaluations and reports on CSR used internationally. Subsequently, within each of the fields, those actions were identified to be representative of the company.

The first area of corporate performance analysed was the workplace, which included actions that the company took for the welfare and professional and personal development of its staff and to improve the quality of life for their families. The second area, the social field, included what the company contributed to the welfare of society and the quality of life in the communities in which it operated. The third area, the environment, included the actions the company took to minimise the potential impact of its operations on the environment, to develop environmental awareness and to preserve natural resources. The fourth area of responsible action was referred to as transparency, values and corporate governance, which in-

cluded actions related to how the company integrated a set of ethical principles and good governance goals in its strategic objectives while also considering the rights of various interest groups with whom it interacted. The fifth area, the scope of the supply of products and services to the market, encompassed the actions that the company developed in the design, distribution and supply of its products and/or services and in managing its relationships with consumers. Finally, the scope of the management of the supply chain was defined as the way in which the company interacted with its trading partners (suppliers, intermediaries, dealers and strategic partners). Table 1 details the topics for the analysis of a company's socially responsible activities.

4. Personal and organisational variables that influence a company's social action priorities

Waldam et al. (2006) have suggested that approaches that focus on maximising business benefits and socially responsible activity do not consider the attributes and qualities of leaders. These approaches assume that there is an overlap between the characteristics of managers and the organisation's strategic vision for CSR. However, according to Gardner (1998), individuals develop different senses of responsibility according to the various groups with whom they interact. It is therefore important to consider the various factors that may affect the individual's particular approach to CSR. Some scholars, such as Hambrick and Mason (1984), Hitt and Tyler (1991) and Wally and Baum (1994), have synthesised empirical studies on the importance of structural and personal factors in the decision-making process.

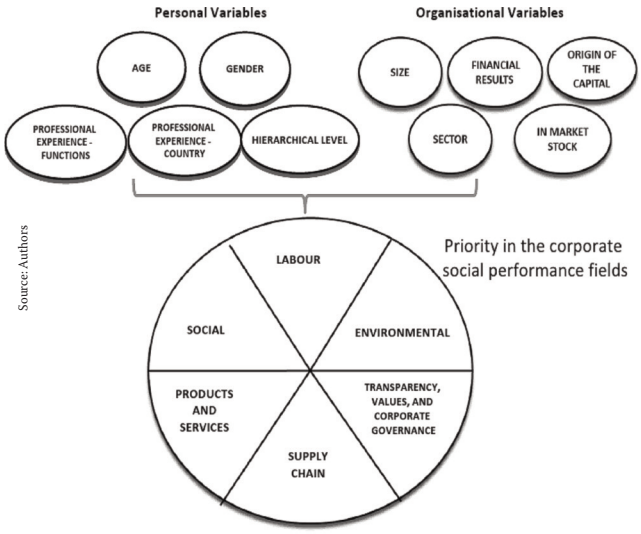

Figure 1: Personal and organizational variables.

In this sense, Browne (2003) suggests that demographic variables affect how managers perceive CSR because, according to cognitive theory, the environment determines how information is processed and how decisions are made. Thomas and Simerly (1995) had argued that because the commitment of the company is generated from the commitment of its members, the characteristics of leaders play an important role in understanding how a company demonstrates CSR. The personal characteristics of managers most often cited in the literature review were age, gender, the position of senior staff in the hierarchical structure of the company and the managers' experience. As shown in Figure 1, ten independent variables were used to examine how managers prioritise a company's CSR activities.

Table 1: Topics addressed by the field of corporate social perfonmance.

COMMON ISSUES	LABOUR FIELD	SOCIAL FIELD	ENVIRONMENTAL FIELD
• Issue goals included in the strategic plan of the firm. • Resource allocation for management. • Establishment of management standards or management quality systems • Training programmes for the different levels and units of the company	*Worker rights *Hiring modalities *Health, safety and worker's welfare *Worker's retention *Quality of life * Labour satisfaction *Training and development	*Citizens rights defence *Philanthropic actions * Social investment projects *Cooperation with social actors for development *Participation of commercial partners and customers in social action *Community impact assessment *Meeting state obligations	* Environmental impact assessment * Saving and use of resources * Environmental issue defence * Environmental criteria in the purchase conditions for the customer * Environmental criteria in the selection of commercial partners * Environmental competency training in commercial partners * Environmental management systems
	TRANSPARENCY, VALUES AND CORPORATE GOVERNANCE FIELD	**SUPPLY OF PRODUCTS AND SERVICES TO THE MARKET FIELD**	**SUPPLY CHAIN MANAGEMENT FIELD**
•Development of management assessment and control systems * Management accountability	* Dialogue channels * Stakeholders in the decision-making process *Board of directors' and managers' performance assessments * Policies and incentives for responsible behaviour * Information transparency and respect for the investor's rights * Business risk management * Ethical codes	* Customer safety and privacy policies * Guarantees and conditions * Improvement of industry/sector performance * Supply of products and services to minorities * Fair competition * Truth in promotion and advertising * Information systems for the product or service	* Improvement of the competencies of commercial partners * Fair treatment * Transparent information on contractual conditions * Meeting commitments * Selection under social support criteria * CSR implementation support for commercial partners * Feedback mechanisms on satisfaction

Source: Authors

5. Variables related to the profile of people in leadership positions

Leaders' ages have been analysed in previous studies. The literature regarding age includes these factors: the probability that individuals of the same age may have similar values and beliefs (Hitt and Tyler, 1991); the relationship between increasing age and factors such as a decreased ability to integrate information; less confidence in the decisions made by others; the amount of information required to make a decision; the amount of time required to make that decision; an increased capacity to assess

information and risk and institute risk aversion (Hambrick and Mason, 1984); less flexibility in value judgments (Fikelstein and Hambrick, 1990); less confidence in their own assessments (Browne, 2003); and a preference for the status quo (Hambrick and Mason, 1984; Key, 1997; Browne, 2003). It should be noted that in the studies reviewed by these authors, the empirical evidence has shown mixed results (Quazi, 2003).

Regarding gender, Key (1997) states that previous studies have not shown consistent results with respect to the impact of gender on decisions about ethical issues (Galbraith and Stephenson, 1993; Khazanchi, 1995; Sikula and Costa, 1994; Tsalikis Buonafina and Ortiz, 1990). However, other studies and meta-analyses conducted on leadership and gender have shown that female leaders are more likely than male leaders to show an interest in the ethical consequences of their actions and in the individual needs of the different people and groups affected by the decisions (Eagly and Johnson, 1990; Eagly, Gartzia and Carli, 2012; Gartzia, 2010, 2011; Gartzia, Ryan, Balluerka and Aritzeta, 2012). Therefore, it is necessary to further investigate the variable of gender to draw conclusions regarding CSR in the maritime sector.

Another variable concerns the types of professional experience that can influence the decision-making processes of leaders. This relationship has been discussed in previous academic work from several perspectives: the type of professional experience and its relationship to one's ability to assimilate information (Marcel et al., 2005); the length of service as a factor related to the level of involvement in social issues addressed by a company (Quazi, 2003); the type of functional expertise and view of problems, objectives and tasks (Hambrick and Mason, 1984, Hitt and Tyler, 1991; Simerly, 2003; Browne, 2003); and sensitivity to issues stemming from business experience (Hambrick and Mason, 1984; Changati and Sambharya 1987, Thomas and Simerly, 1995, Brammer and Millington, 2004).

Simerly (2003) proposes the consideration of two types of functional expertise. The first type involves numerous interactions with the environment and therefore is more sensitive to social demands. In that group, the professional experience is focused on the generation of results (commercial and marketing, customer service, product development, image and public relations, general management) and the work community (areas of corporate social responsibility, institutional relations, community relations, corporate foundations). The second type is considered less sensitive to performance management, social responsibility, and other issues related to internal processes. This group includes liabilities assumed in operations, such as finance, legal, accounting, and human resources.

To complement the latter type, according to Egri et al. (2004), another relevant variable is the managers' work experience in multinational companies, where the organisational culture of the parent company can influence how decisions are made about CSR. The author suggests the importance of studying the influence of culture in countries with developed economies and in countries with emerging economies.

Finally, several studies have analysed the influence of the company's management hierarchy and its relationship to the process of strategic decision-making. Ireland et al. (1987) and Petrick et al. (1993) suggest that the hierarchical levels occupied by managers in the company affect their strategic decision-making because those in higher positions may have a greater proximity to and more interactions with various stakeholders. However, authors such as Ostlund (1977), Aupperle (1984), Barnett and Karson (1989), Hemingway and McLagan (2004) cite these studies' lack of evidence.

From the above analysis, we proposed five exploratory hypotheses for future studies in the field that focus on the analysis of the personal characteristics of managers or for further discussion of the literature. Such assumptions relate to the possible behaviours of subgroups of respondents compared with the overall prioritisation of socially responsible activity for the company. The hypotheses that directed this study were the following:

- H1: Younger leaders assign greater importance to socially responsible action than older leaders.
- H2: Women in leadership positions tend to place a higher priority on socially responsible action than men in leadership positions.
- H3: There is a positive relationship between the number of years of professional experience a manager has in areas with extensive interaction with the environment and the priority s/he attaches to socially responsible actions.
- H4: There is a positive relationship between the number of years of professional experience a manager has at a company headquartered in a developed economy and the priority s/he attaches to socially responsible action.
- H5: There is no relationship between the hierarchical level of people in leadership positions and the importance they attach to socially responsible action.

6. Variables relating to company profile

Several authors have highlighted the influence of exogenous factors that may influence company managers' decision-making. Although the literature review revealed a wide range of factors identified through empirical research in recent years, not all cases found empirical evidence to support the influence of these factors in the decision-making process for CSR. The variables that are considered structural features of the company have more empirical support in the literature. These variables include the size of the company, its financial earnings, the origin of capital, the firm's economic activities and its presence or absence in the stock market.

According to McGuire et al. (1988) and Wally and Baum (1994), a significant number of studies related to the analysis of corporate social performance consider the size and financial performance of the company to be important variables in the decision-making process. In addition, the studies have found a relationship between the firm's size and the effectiveness of CSR (Waldam et al., 2006); between firm size and the criteria for the allocation of management resources to CSR (Brammer and Millington, 2004); and between the firm's size and the type of management tools used to manage CSR (Graafland and Van de

Ven, 2006). Haleblian and Finkelstein (1993) and Hambrick and Abrahamson (1995) argue that the size of the company, among other factors, predicts the range of discretion of employees in leadership positions. On this issue, Steiner (1974: 81; in Keim, 1978) suggests that "while the company gets bigger, [it] develops a potential influence on more people. The company then takes more interest in what [the manager] does and, in turn, the company plans more carefully about [the manager's] responsibilities. In this sense, [managers] tend to be more affected by the public interest." Indeed, Keim (1978) argues that the discretion of management and the effectiveness of corporate social action may be affected by the size of the organisation. Keim claims that larger firms expect that managers have a greater capacity to act beyond the logic of profit maximisation, which could improve the conditions that affect CSR decision-making.

Some studies on companies' investment in CSR have suggested that the financial performance of the organisation can be a factor. Due to the abundance of studies on financial performance, Margolis and Walsh (2003) and Orlitzky et al. (2003) have conducted "meta-studies" to understand this factor. Margolis and Walsh (2003) state that after 30 years of research, it cannot be said with certainty that there is a positive relationship between corporate social action and the company's financial performance. They also maintain that it is possible that investment in socially responsible actions destroys the value of the company or damages its ability to create wealth. However, some studies make specific contributions regarding the various factors mentioned above. Carrroll and Buchholtz (2000, in Coldwell, 2001) suggest a relationship between a company's socially responsible action, its financial performance and its corporate reputation. Meanwhile, Hay and Gray (1974) argue that the most profitable companies are better able to act socially than less profitable companies. Buchholtz et al. (1999) argue that while many researchers have focused on analysing a company's profit levels to understand its socially responsible corporate action, these studies have found inconsistent results. Bourgeois and Singh (1983) highlight several theories related to a lack of resources and leaders' political behaviour and decision-making. These authors claim that the availability of financial resources does not promote internal negotiations among company leaders in the short term because these resources usually have a predetermined use; unexpected surpluses generate unexpected internal discussions because there may be little consensus on their use in the long term. According to Hambrick and Snow (1977, in Bourgeois and Singh, 1983), a greater availability of resources gives a company greater flexibility to experiment with different competitive strategies. This assertion is consistent with the view of Cyert and March (1963, in Bourgeois and Singh, 1983), who argue that there is less internal conflict when there are enough resources to attempt new uses without controversy. In the same vein, Campbell (2007) suggests that when resources are scarce or the company experiences financial difficulty, the firm will perform only a minimally acceptable level of socially responsible activity.

Regarding the cultural variable's effect on CSR, Egri et al. (2004) postulate that the influence of foreign capital could impact a company's organisational culture. According to McWilliams et al. (2006), CSR in corporate strategy is affected by the cultural framework of each country and the institutions that regulate the market. However, in the case of multinational companies, SEKN Austin (2004) argues that while subsidiaries are influenced by the policies of the parent company, they try to adopt the activity patterns of the countries where they operate and seek to create alliances with others to strengthen their local acceptance.

Regarding the company's business, some authors argue that this variable may influence corporate strategies (Finkelstein and Hambrick, 1990, Hitt and Tyler, 1991; Haleblian and Finkelstein, 1993, Wood and Jones, 1995; Hambrick and Abrahamson, 1995 and Campbell, 2007). Factors that affect how decisions are made include the sector, consumer tastes, competitive behaviours, the role of technology, the supply chain configuration (Wally and Baum, 1994), the regulatory landscape (Campbell, 2007) and the level of stability or turbulence in the sector (Haleblian and Finkelstein, 1993). According to McWilliams et al. (2006), one expects higher levels of investment in CSR from more mature companies in a particular sector because these companies have a wider range of products on offer, and consumers consumers of their products are presumably more sophisticated in their tastes and more knowledgeable about the available supply.

A final important variable that affects a company's actions is whether it is listed on a stock market. Being listed on a stock market may invite influence from regulators and the market (Instituto Ethos, 2006, Goodwell, 1996, McWilliams et al., 2006, etc.).

Given moderating factors for which greater empirical evidence has been found, we proposed the five exploratory hypotheses presented below for exploration in the maritime sector. Such an analysis may promote public health interventions within that sector. This study's aim is to analyse the specific subgroups of people and the organisational characteristics that influence companies' decisions regarding CSR.

H6: There is a positive relationship between the firm's size and the priority that senior staff give to the development of socially responsible activities within the company.

H7: There is a positive relationship between a company's financial performance and the priority that senior staff give to the development of socially responsible activities within the company.

H8: Leaders who work at companies with a predominance of foreign capital in their ownership structure place a higher priority on the development of socially responsible action than leaders who work at companies with no foreign capital in their ownership structure.

H9: Leaders who work at commercial and service companies place a lower priority on the development of socially responsible action than leaders who work at companies that belong to all other sectors (industrial, extractive and construction).

H10: Leaders who work at companies listed on the national or international stock exchange place a higher

priority on the development of socially responsible action than leaders who work at companies not listed on the stock market.

The lines of research listed above can guide the analysis of the decision-making process for CSR managers in the maritime sector. Senior managers become promoters and coordinators of initiatives in various areas of socially responsible activity for the company. Given the strong role of big business in the progress of emerging economies, one can conclude that the role of managers is key to establish a culture of social responsibility efforts at all levels (state, business, civil society and individuals).

These ideas are reflected in the work of Del Castillo (2010), which analyses these relationships and concludes that in certain sectors of business activity in emerging economies, a performance-oriented corporate development of basic activities is still prevalent, and there is minimal activity in the field of CSR. In addition, there is limited interaction between the management of a company and other actors in the environment. Del Castillo's study finds that managers' previous exposure to and interaction with the corporate cultures of international companies in developed countries influences their greater concern with social ills. In particular, the size of the company, its financial health, the presence of majority foreign capital in the ownership structure and its presence on the stock market were mitigating elements in the prioritisation of CSR actions. In the same vein, the companies' industrial sector was a factor in the prioritisation of environmental actions and in the supply of products and services to market, two areas in which maritime companies have a significant presence.

Ultimately, therefore, the research highlights the need to reflect on the type of company profile that promotes and facilitates a company's practice of CSR principles. The research has contributed to a better understanding of the business factors that may favour or limit the integration and implementation of CSR throughout a company and among its stakeholders.

From this approach, the need to generate the necessary space in the company for staff to lead the work of promoting and managing CSR becomes evident, and managers require additional experience in achieving this goal. The research stresses the need for these leaders to have opportunities for career development with greater exposure to the various stakeholders, i.e., a strong interaction with the environment. It would also be beneficial for leaders to have opportunities to become familiar with current thinking and best practices from regions of greater economic and social development. Moreover, the study also highlights the influence of cultures and mature, socially responsible management, which can serve as an inspiration and a guide for companies that are in earlier stages of the adoption of CSR. In this context, larger companies' public exposure and the influence of promoters and regulatory mechanisms such as the stock market encourage the companies to take a proactive stance as corporate citizens.

7. Future research

Overall, the studies reviewed indicate that it is important to go beyond a utilitarian view of CSR. This approach would establish performance-oriented corporate actions in a more inclusive model. Thus, the importance of considering the characteristics of the decision-makers and the contexts in which they operate is clear. In addition, understanding leaders and their companies will help develop innovative approaches to CSR, which is still in its infancy. The creation of forums for sharing experiences and sensitising decision-makers is also important for advancing CSR.

The action model developed should not be restricted to the analysis of the personal and organisational factors that influence the prioritisation of courses of action. Rather, future research should include other variables related to the values and motives of decision-makers and the organisational environments in which they work. The phenomenon of CSR through the lenses of the specific areas of responsible corporate social performance should be studied, as well, without losing a holistic perspective of the concept. Deepening the understanding of each area of CSR and the various factors that influence CSR is a central goal.

The importance of this reference model for engaging in socially responsible action and innovative CSR is particularly important given the close relationship between the areas included in CSR and the actions of the maritime sector. For example, as shown in the manual regarding the seas, which is related to the campaign to promote maritime social responsibility in Spain and financed by the Ministry of Labour and Immigration, social responsibility should aim to increase the awareness of CSR. Socially responsible actors should also emphasise the need to improve the sustainability of the Spanish maritime sector's various economic activities and promote a healthy society, economy and environment. In this way, CSR can be integrated into any company related to shipping, shipbuilding, engineering and maritime auxiliary industries, extractive fishing, recreational boating, marinas and yacht clubs, marine facilities and renewable energy production.

A significant challenge is to find ways to improve the commitment of the organisations to the development of society and the preservation of the environment. The goal is not only to generate responsible behaviours toward people and groups who interact with these companies but also to create a working environment that is sustainable in the long term. Among the challenges in the maritime sector are actions related to managing people and diversity (such as the reconciliation of work and personal life, the enhancement of work environments, and improved working or training conditions), which may directly benefit the company through service improvements, customer satisfaction, customer loyalty and improvements in the company's reputation.

Other important areas to address relate to environmental sustainability. Actions such as complying with legislation regulating waste, managing the company's impact on the environment and the protection of oceans and biodiversity in the sea can help the company to both improve its image and rep-

utation and to gain other company's recognition as a leader in CSR. Such actions can also prompt cooperation in implementing environmental conservation measures or even increase the possibility of receiving institutional and government aid for the preservation of the environment. Ultimately, it is necessary for leaders in the maritime sector to change their approach to CSR, viewing it as an opportunity rather than a threat, and to integrate CSR into the sector's development. In this way, it will be possible for companies to meet society's needs in the twenty-first century.

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The Influence of a Keel Bulb on the Hydrodynamic Performance of a Sailing Yacht Model

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ABSTRACT

The scope of this work has been to investigate the overall performance of a sailing yacht with a keel-bulb configuration. Experiments were carried out at the Laboratory of Ship and Matrine Hydrodynamics (LSMH) of the National Technical University of Athens (NTUA). A ¼ scaled model of a 50-ft modern sailing yacht has been tested. Experimental results referring to the drag, the side force, the dynamic C.G. rise and the dynamic trim, are presented. The performance of the model in calm water was evaluated, both with and without the bulb attached to the keel for a grid of leeway angles and three model speeds. In addition, the free surface elevation has been measured at various distances from the hull and characteristic wave cuts are presented.

1. Introduction

The investigation of the flow around racing yachts is an important issue, especially in the final design stage, where optimization of the hull form results in a competitive design. Nowadays, although the role of the numerical methods in the design of sailing yachts has significantly increased, the experimental methods have also been considerably refined since Davidson's memorable towing tank investigation (Davinson, 1936). Kirkman (Kirkman, 1979) discussed the evolving role of the towing tank in providing assistance to the designers and the appropriate means of using model tests in light of the contemporary understanding of scale effects. Especially for sailing yachts, balancing under the combined effect of aerodynamic and hydrodynamic forces and sailing in most of the cases in an inclined and yawed condition, the contribution of the experimental evidence to the prediction of their behaviour is invaluable. It is important to minimise the yaw angle in order to optimise the velocity against the wind (VMG). Furthermore, racing yachts compete in races where the winner is only a few seconds faster than the other participants. In such cases the incorporation of high technology and the adoption of innovative solutions can make the difference.

In towing tank measurements on sailing yachts, the keel is acting as lifting surface at yaw angles 3.5° – 7° which affect considerable all resistance parameters as well as the free surface. The yacht keel features a relatively large laminar region and requires special transition devices which must control both lift and drag components. Besides, modern sailing yacht designs consist of a keel-bulb configuration which has beneficial results to the overall stability of the yacht. However, the bulb tends to increases the resistance components. In addition, in some cases, the lift increases, which results to a better windward sailing.

The aim of the present work has been the experimental investigation of the hydrodynamic influence of a bulb attached to the keel of a particular yacht design. To study its performance three model speeds have been selected and various yaw (or leeway) angles were tested. Results for the side force and the drag are presented and compared for different cases. Moreover, since for a competitive sailing yacht design the free surface effect is important, measurements of wave cuts have been also taken which can be used for comparisons with various numerical approaches.

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2. The experimental setup

2.1. The tested model

A 1:4 scaled wooden model of a 50-ft modern sailing yacht, designed by Mortain and Mavrikios according to the British Oxygen Corporation (BOC) regulations has been extensively tested in the towing tank of the Laboratory for Ship and Marine Hydrodynamics (LSMH) of the National Technical University of Athens (NTUA). Both, the canoe body and the keel are made of wood to ensure precise representation of the hull form (Figure 1). In order to achieve a light model construction to enable testing at light displacements, water-resistant plywood was used to shape the transverse frames and wooden strip planks which formed the shell. The main particulars of the yacht, the keel and the tested bulb are given in Table 1.

Table 1: Main particulars of the tested yacht

Main Particulars	BOC 50-ft yacht
Length at waterline	14.87 m
Breadth at waterline	2.66 m
Design draft (canoe body)	0.415 m
Design draft (maximum)	4.065 m
Design displacement	7.175 mt
Appendage displacement	0.569 mt
Trim	Even keel
Sectional foils of Keel	NACA 64A015
Span of keel	0.8m
Rigging	Ketch
Sailing area	130 m^2
Bulb length	2.4 m
Bulb diameter	0.5 m

Source: Authors

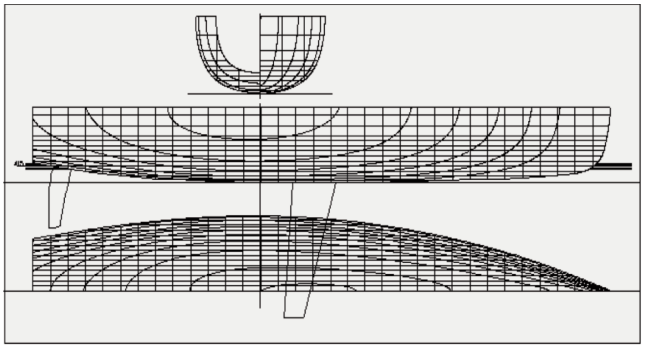

Figure 1: The lines plan of the model.

2.2. Selection of turbulence stimulators

Ship model tests use turbulence stimulators to compensate for the violation of Reynolds similarity and enforce laminar-turbulent transition in models roughly at the same location as in full scale. Joubert and Matheson (Joubert & Matheson, 1970) studied the effect of stimulators on the boundary layer characteristics past a model in a wind tunnel. It is common to use empirical rules to correlate the size of the stimulator with its position from the forward end of the body as well as with the model speed. In conventional resistance towing tank tests, the results from this procedure can be assumed reliable, as the size of the stimulator affects only a small area near the bow. The forced transition leads to the recovery of the desired turbulent flow and influences mainly the total skin friction component.

There are cases, however, where this standard procedure is not applicable because the turbulence stimulators disturb drastically the flow-field. For instance, in towing tank measurements on sailing yachts, where the keel, acting as lifting surface at yaw angles 3.5° - 7° , affects considerable all resistance parameters.

There are two conditions that must be satisfied by the turbulence stimulation devices in order to have the desired effects. Firstly, their geometrical properties should be selected in such a way that steady turbulence is stimulated leading ideally to equivalent velocity profiles to those of the fully turbulent flow. Secondly, their height should be not present high parasitic drag, leading to overestimation of the resistance force. Combination of these two conditions results in a range of geometrical values that can be selected for the stimulation, when a speed range is considered for testing.

Trip wires, which are commonly used in Laboratory for Ship and Marine Hydrodynamic (LSMH) of NTUA, have low parasitic drag and work sufficiently for a wide range of ship model types. However, they are unreliable in cases where lifting surfaces exist, such as the keel of a sailing yacht. In fact, the rapid change of the pressure about the trip wire affects the local pressure and changes drastically the lift and drag characteristics. Sand strips on the other hand, are expected to trigger turbulence without causing significant local picks of the pressure and, therefore, they exhibit a rather smooth behaviour. Since it is generally difficult to estimate their parasitic drag, it is desirable for keep it near to a minimum value (Mishkevich, 1995). Based on previous experimental and numerical investigations with regard to the effect of turbulence stimulators on a sailing yacht model, we concluded to use sand strips (Figure 1, 2) on the keel and trip wire on the canoe hull of the model (Liarokapis, Sfakianaki, Perissakis and Tzabiras, 2010; Tzabiras, 2008).

The significant influence of turbulent stimulators placed at the same location near the leading edge of the keel with and without the bulb is shown in Figures 2 and 3. In Figure 2, the drag force is plotted with respect to the yaw angle for the carriage speed of 2m/sec corresponding to a Froude number equal to 0.32. As expected, the cases without stimulators present the lower drag values. The label "tape" corresponding to a 6 mm tape has almost the same influence with the used wire of 0.5 mm. Evidently, the higher drag is observed when turbulence stimulators are applied on both the keel and the bulb. However, the most important differences appear when the side force is compared, Figure 3. In general, the absence of turbulence stimulators on the keel is associated with a noticeable increase of the side force. The use of wires seems to cause higher lift and lower drag with respect to the tapes due to the different level of the caused disturbance on the flow field. When the bulb is included, the side force becomes higher for the same actual length of the keel, owing to the annihilation of the tip vortex.

Source: Authors

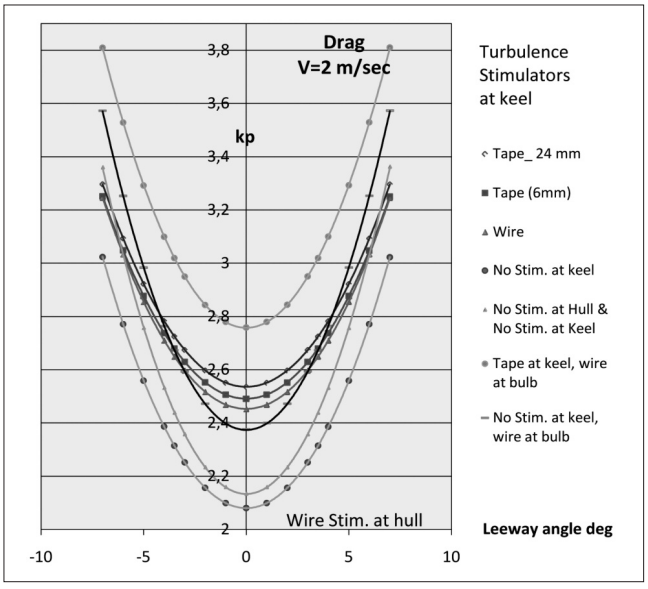

Figure 2: Resistance (Kp) against leeway angle Vm= 2 m/s.

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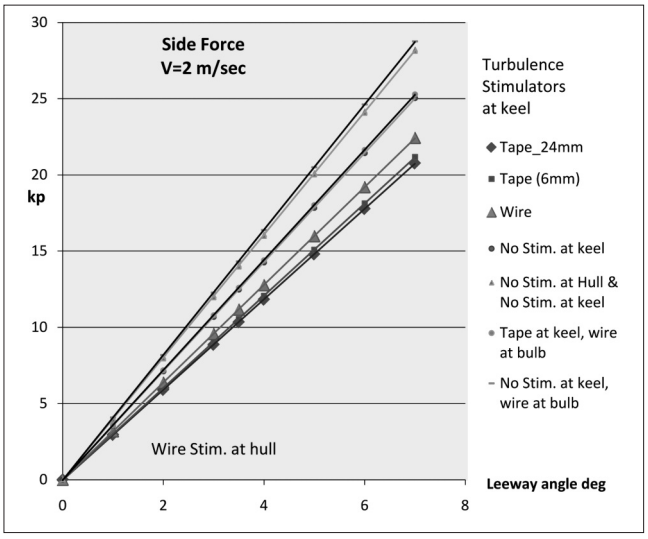

Figure 3: Side Force (Kp) against leeway angle Vm= 2 m/s.

In order to compare the results for the total forces as presented in the sequel, it was decided to apply a standard configuration of turbulence stimulators, as follows. A trip wire (with a mean diameter of 1.8mm) was fitted on the canoe body at a distance of 23 cm from the bow, a sand strip of 6mm was fitted on the keel (tape) and a trip wire of 0.5 mm on the bulb, The keel stimulator was placed at a distance of 2 cm from the leading edge, while the diameters of trip wire diameter were calculated through the standard software used at the LSMH for ship models, according to the Reynolds number and the position of the installation.

2.3. Experimental apparatus

The LSMH of NTUA possesses a four-component balance yacht dynamometer specially designed for its towing tank (Figure 4) by Wolfson Unit. The dynamometer is capable of measuring drag, side-force, yaw moment, roll moment, heel, trim and heave.

The model was attached to the dynamometer at the LCG, via a pivot, which allowed the vertical motion (heaving) and the rotation around the lateral axis through the attaching point (pitching). The model was restrained in surge, sway, yaw and heel. The drag along the yacht's track down the tank, the side force, vertical to the drag, the yaw moment and the roll moment were recorded. At the same time the vertical motion of the centre of gravity and the trimming angle of the model were measured from the attitude of the model relative to the dynamometer. Although these data have no direct use for any performance estimate, as explained by Campbell and Claughton (Campbell and Claughton, 1987), they can provide some qualitative insight into the hydrodynamic behaviour of the yacht. Furthermore, the model was restrained at preset angles of heel and leeway, selected for performance prediction.

Sailing yacht measurements resolve two critical issues on the experimental procedure. The first issue is the accuracy of the dynamometer positioning relatively to the water surface. The yacht dynamometer is attached to the tank carriage through two parallel rails. A fully adjustable rig connecting the dynamometer with the towing tank carriage was devised. The constructed rig allows for 6-degrees of freedom adjustments and by using modern measuring techniques e.g. (laser, etc) the experimentalist can accurately align the dynamometer parallel to the water surface.

The second issue is associated with the position of yacht model relatively to the longitudinal axis of the towing tank. A possible misalignment affects the measurement of resistance and side forces. The alignment procedure proposed by the manufacturer suggested rotating the model till both the side force and drag is minimized (resistance versus side force squared diagram). Following this procedure, it was noticed that a fairly small misalignment (less than 0.5 degree) with respect to the tank longitudinal axis leads to substantial side forces, which results in a considerable misrepresentation of the lifting phenomenon. Another source of misalignment is inherent to the model as a result of the construction asymmetries mainly of the keel and its installation to the hull but also of the hull itself. To overcome the problem, special software was developed to calculate the exact upright position of the model by involving the measurements in both positive and negative yaw angles. The main objec2tive is to calculate

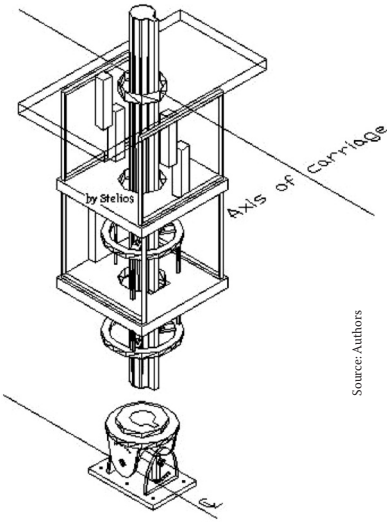

Figure 4: The yacht dynamometer of LSMH/NTUA.

the yaw (or leeway) angle at which the side force vanishes and the drag presents its minimum value employing a least square fitting among the measured data. According to the measured values at low yaw angles, a second degree polynomial was adopted for the drag force with respect to the yaw angle at a given speed, while the side force was represented by a straight line.

To evaluate the data from the sailing yacht dynamometer several tests we carried out using also the classical (one component) dynamometer of LSMH. All experiments were performed at the upstream position, both with and without the keel and with the keel-bulb configuration. The results confirmed that both dynamometers produce the same output. In the following graph the drag is plotted against the velocity both with and without the keel for the two dynamometers. Evidently the data obtained by the classical dynamometer are lying on the curves of the sailing yacht dynamometer (Figure 5).

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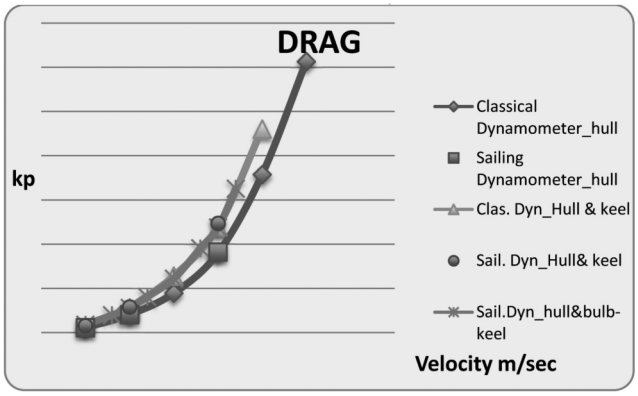

Figure 5: Comparison of the Dynamometers.

The wave pattern was measured by the well established wave probes which are the commonly used instruments for this kind of measurements. The time history of the free surface elevation at specific transverse locations was recorded at various distances and the corresponding wave cuts were represented. For our measurements we used two kinds of wave probes, the resistance and the acoustic type.

- The resistance wave probe, which although is a low cost, reliable and relatively accurate instrument, has considerable limitations mainly due to the fact that it is an intrusive method. Thus, it is not feasible to position these wave probes on the path of the model.
- The acoustic wave probe, which measures the distance to the wave surface by sound propagation. Steep and very fast moving waves can be measured with a relative velocity of 15 m/s, and frequency response of 100Hz. The acoustic probes, due to their non intrusive nature, where used for measuring wave elevation near the hull.

3. Analysis and presentation of the results

The performance of the model in calm water was evaluated, both with and without the keel and with the keel-bulb configuration for upright position in a variety of leeway angles. During the experiments, the draught of the hull was decided to be kept constant, in order to study the hydrodynamics changes when the bulb was fitted on the keel. Moreover, the model was tested at three speeds (0.5, 1 and 2 m/s) and at four leeway angles (0, 3.5, 6, 7 degrees) on both tacks.

3.1. Resistance tests

When installing the dynamometer and the model in the towing carriage, there are some unavoidable sources of misalignment. Special software has been developed which finds the "zero-angle" position of the model by involving the measurements in both tracks since, even a small fraction of a degree in the alignment of the dynamometer may induce reasonable errors in the measured forces. The main objective is to calculate the yaw (or leeway) angle at which the side force vanishes and the drag presents its minimum value employing a least square fitting among the measured data. According to the measured values at low yaw angles, a second degree polynomial was adopted for the drag force with respect to the yaw angle at a given speed, while the side force was represented by a straight line.

The measured values for the drag and side forces are presented in Figures 6 and 7, respectively. The forces are given in Kp, while all configurations are included, i.e. the bare hull, the hull with the keel and the hull with keel and bulb. For each combination, the results are drawn for two model speeds, i.e. 1 and 2 m/s, with respect to the leeway angle. As expected, the drag increases drastically as the speed becomes higher. The corresponding drag values are given in Table 2, while the percentage differences between configurations are presented in Table 3, which also includes results for the low speed of 0.5 m/s. In the last column of this Table, the standard deviation represents the uncertainty between the adopted least square curve for the mean values and the measured data. It is evident that, for a constant speed, the percentage difference of the drag between the hull-keel and the bare hull cases increases substantially with the leeway angle. This behaviour is due to the drag of the lifting surface of the keel, which is essentially more sensitive to yaw. Since the corresponding non-dimensional coefficient becomes higher at low speeds, the effect of the keel explains also the reduction in the percentage difference when the speed increases at constant yaw. It is also noticeable that at low speeds the drag of the bare hull is almost constant with respect to the leeway angle, while it is more drastically affected at the high speed of 2 m/s. In this speed the wave making resistance component is considerable and the wave formation is influenced by the yaw angle. The addition of the bulb leads to an almost constant increase of the resistance of about 11% at the speed of 1 m/s where the wave resistance is negligible. Therefore the non-dimensional drag coefficient of the bulb appears practically constant at all yaw angles. This is also true for the speed of 2 m/s up to the leeway angle of 5 deg. In this case, the slight percentage increase at higher angles may be associated with the influence of the bulb on the wave formation as discussed in the next section. At the speed of 0.5 m/s the yaw angle influences apparently the total resistance changes. However, it should be noted that the corre-

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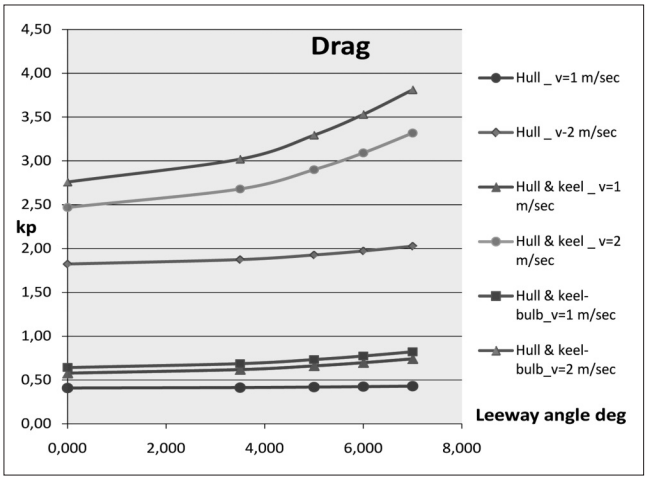

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Figure 6: Resistance against Leeway angle.

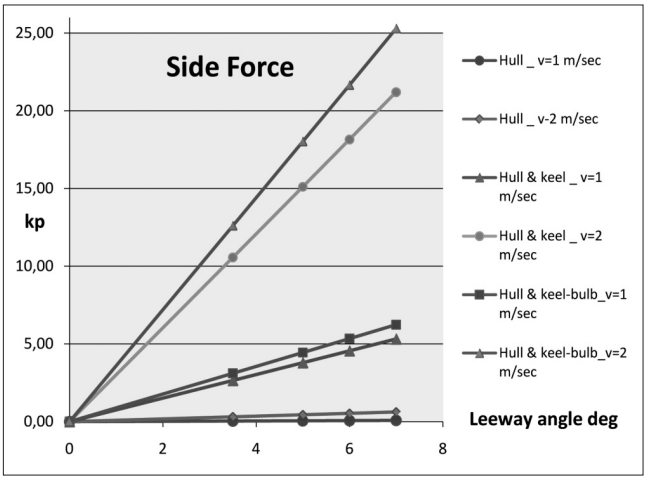

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Figure 7: Side Force against Leeway angle.

sponding Reynolds number is reduced while the turbulence stimulators have been selected for the speed range between 1 and 2 m/s. Therefore, extended laminar flow areas may appear affecting decisively the measured forces.

The side force, Figure 7, exhibits different behaviour than the drag. Actually it is generated by the keel and becomes significantly higher than the drag as the leeway angle increases. The bare hull is essentially a non-lifting body and presents very low side forces for both speeds at all tested angles. Therefore, the comparison with the keel configurations is rather meaningless. This is clearly shown in Tables 4 and 5 where the values and the percentage differences of the side forces are depicted. The presence of the bulb increases considerably the side force at all speeds and yaw angles when compared to the hull-keel case, Table 5. Although the bulb behaves also as anon-lifting body, its presence removes the tip vortex formation which is responsible for a local lift reduction. Besides, the percentage difference between the hull-keel-bulb and hull-keel configurations is substantially higher than the corresponding differences of drag (almost doubled) at all speeds. This performance improves the efficient route of the yacht.

In conclusion, the drag and the side force increases when the bulb is fitted on the keel. This is apparent in Figure 8, where the non-dimensional drag coefficient *CD* is plotted versus the side (lift) coefficient *CL*. These coefficients are defined as

$$CL = \frac{F_S}{1/2\rho S v^2} \qquad CD = \frac{F_D}{1/2\rho S v^2}$$

where F_s, F_D stand for the side and drag force respectively, S is the totally effected surface and *v* the model speed. As observed in Figure 6, the keel-bulb configuration produces higher *CD*

Table 3: Percentage differences of Drag.

Hull&Keel vs Bare Hull						
Speed (m/s)	0	3.5	5	6	7	Standard deviation (SEE) (Kp)
0.5	39.28%	54.95%	71.81%	85.45%	103.7%	0.002
1	41.66%	49.63%	57.75%	64.62%	72.32%	0.003
2	35.45%	43.03%	50.57%	56.74%	63.74%	0.007
Hull&Keel&Bulb vs Hull&KeeL						
Speed (m/s)	0	3.5	5	6	7	Standard deviation (SEE) (Kp)
0.5	5.12%	7.55%	9.52%	11.27%	12.61%	0.002
1	11.07%	11.16%	11.04%	10.88%	10.93%	0.003
2	11.79%	12.72%	13.55%	14.17%	14.79%	0.015

Source: Authors

Table 2 : Measured Drag vs speed and leeway angle.

DRAG (Kp)					
Hull	Leeway angle (deg.)				
Speed (m/s)	0	3.5	5	6	7
0.5	0.112	0.111	0.110	0.110	0.109
1	0.408	0.413	0.419	0.424	0.430
2	1.822	1.873	1.926	1.972	2.027
Hull & Keel	Leeway angle				
Speed	0	3.5	5	6	7
0.5	0.156	0.172	0.189	0.204	0.222
1	0.578	0.618	0.661	0.698	0.741
2	2.468	2.679	2.900	3.091	3.319
Hull & Keel-Bulb	Leeway angle				
Speed	0	3.5	5	6	7
0.5	0.164	0.185	0.207	0.227	0.250
1	0.642	0.687	0.734	0.774	0.822
2	2.759	3.020	3.293	3.529	3.810

Source: Authors

Table 4: Measured Side force vs speed and leeway angle.

SIDE FORCE (Kp)					
Hull	Leeway angle (deg.)				
Speed (m/s)	0	3.5	5	6	7
0.5	0	0.013	0.019	0.023	0.027
1	0	0.038	0.054	0.065	0.076
2	0	0.312	0.446	0.536	0.626
Hull & Keel	Leeway angle				
Speed	0	3.5	5	6	7
0.5	0	0.785	1.122	1.348	1.575
1	0	2.647	3.786	4.548	5.313
2	0	10.563	15.108	18.150	21.202
Hull & Keel-Bulb	Leeway angle				
Speed	0	3.5	5	6	7
0.5	0	0.975	1.394	1.675	1.957
1	0	3.107	4.444	5.339	6.237
2	0	12.601	18.023	21.651	25.293

Source: Authors

Table 5: Percentage differences of Side force.

Hull & Keel vs Bare Hull		
Speed (m/s)	Difference %	Standard deviation (SEE) (kp)
0.5	5733	0.025
1	6890	0.059
2	3286	0.097
Hull & Keel & Bulb vs Hull & Keel		
Speed	Difference%	Standard deviation (SEE)
0.5	24.25	0.014
1	17.39	0.058
2	19.30	0.184

Source: Authors

coefficient for the same *CL* (Tinoco, 1993).

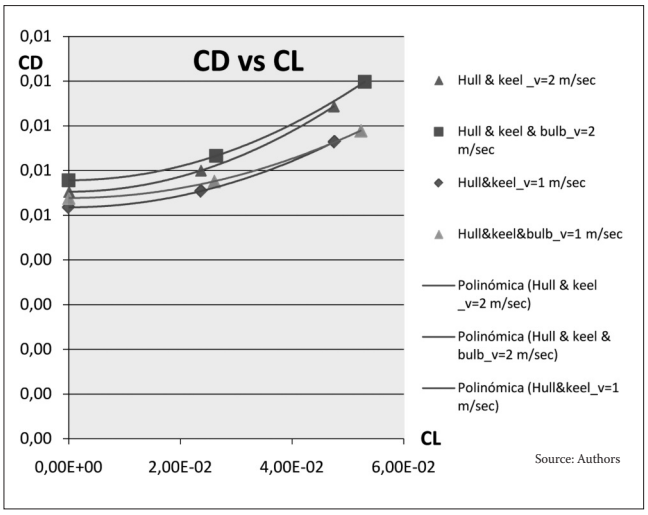

Figure 8: CD against CL.

The side force plotted versus drag in Figure 9, shows the advantage of the addition of the bulb on the original keel. Between two yachts sailing at the same speed and presenting equal side and drag forces, the more competative is the one with the ability to sail at a lower leeway angle. This is particularly important when the yacht sails windward. It is apparent from Figure 9 that for equal side force and drag the comparison of the two cases demonstrates that the yacht with the bulb, sails at a lower leeway angle. Therefore, the presence of the bulb not only lowers the centre of gravity of the yacht (improving stability), but also increases its ability to sail windward. This effect is more intense at low Reynolds numbers and at small yaw angles.

In order to study the effect of the bulb on sinkage at various speeds, the CG rise is plotted against speed in Figure10 at zero yaw. As observed, the difference among the three curves (hull, hull-keel, hull-keel-bulb) is practically negligible, showing that the main contribution to sinkage is due to the hull wetted surface.

Finally, the effect of the trim on the resistance at zero yaw was investigated. In Figure 11, it is observed that a small trim by bow or stern increases resistance. The higher values were noticed for one degree trim and when the transom is partially submerged. The minimum values of Drag both with and without the keel were observed at even keel.

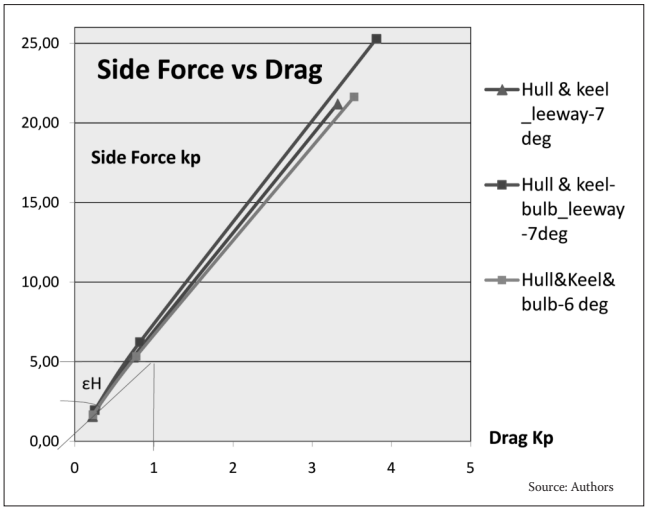

Figure 9: Side Force versus Drag.

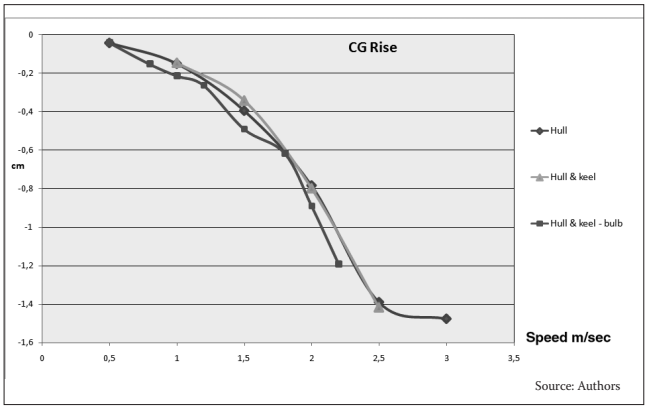

Figure 10: Heave against model speed.

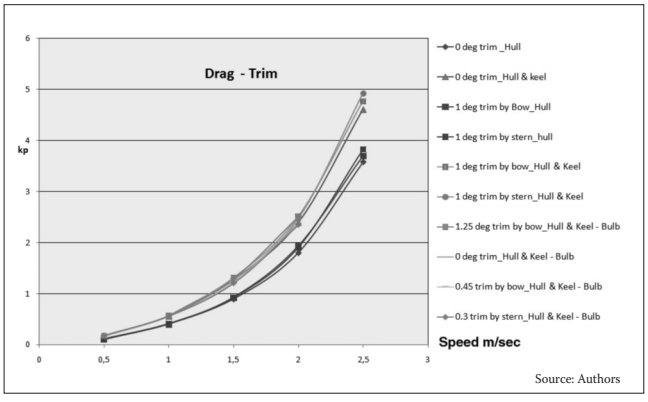

Figure 11: Drag against Trim.

3.2. Wave patterns

Measurements of wave profiles at various distances from the longitudinal axis of the tank were taken at the one side of the tank using both resistance wave probes. Again, the model was tested at three speeds (0.5, 1 and 2 m/s) and at three leeway angles (0, 3.5, 7 degrees) on both tacks. The main purpose of

these set of measurements was to explore the influence of the keel and keel-bulb configurations on the wave formation as well as to provide data for comparison with CFD methods. Experimental free-surface data are particularly useful for wave resistance calculations (Dumez & Cordier, 1997) and for validation of numerical prediction codes (Brizzolara, Bruzzone, Cassela, Scamardella and Zotti, 1999).

Representative plots are shown in Figs. 12 to 13 where the wave cut along the tank at a distance of 0.64m from the longitudinal axis of the tank is plotted for the leeway angles of 0 and 7 degrees and a model speed of 2 m/s. The positions of the bow, keel and stern are also marked on the horizontal axis. Figure 12 shows that the differences of the three model cases appear at the area of the keel but they are rather small since the keel produces zero lift and the bulb is located well beneath the free surface. The same picture is observed in the windward side of the yacht. On the contrary, noticeable changes on the wave formation are apparent at the leeward side. The negative pressures generated on the suction side of the keel cause a deeper trough after the keel which is followed by a significant increase of the wave crest about the stern of the yacht. Since the bulb increases lift, the differences between the hull and the hull-keel-bulb cases are larger. These changes imply that at high speeds and yaw angles the phenomena are more intense and affect accordingly the side and drag forces.

4. Conclusions

The scope of this work was to investigate the overall performance of a sailing yacht with a keel-bulb configuration advancing in calm water. The experimental results referring to the drag, the side force, the GS rise, the dynamic trim and the wave pattern for three model speeds were presented. It was found that the kind of turbulence stimulators affects significantly both the drag and side and a careful selection is necessary in this respect. All experiments were performed using a trip wire on the hull and the bulb and sand strip on the keel of the model.

In general, the experimental results derived in the towing tank of LSMH of NTUA are in satisfactory agreement with other published data. In leeway angles 3.5°-7° the keel significantly affects the hydrodynamic performance as it is apparent from the comparisons of side and drag forces. Besides it affects the wave formation about the yacht especially at high speeds implying also a considerable influence on these forces. The addition of a bulb to the keel seems to have beneficial results in some cases.

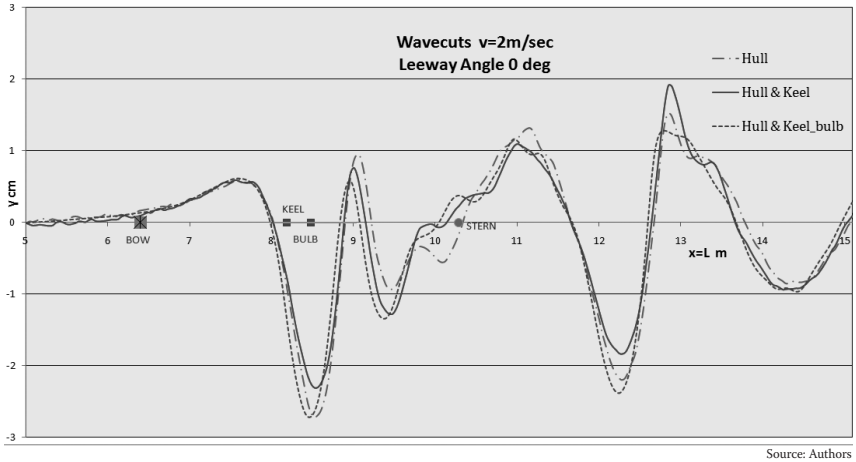

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Figure 12: Wavecut at V= 2m/s, Upright condition.

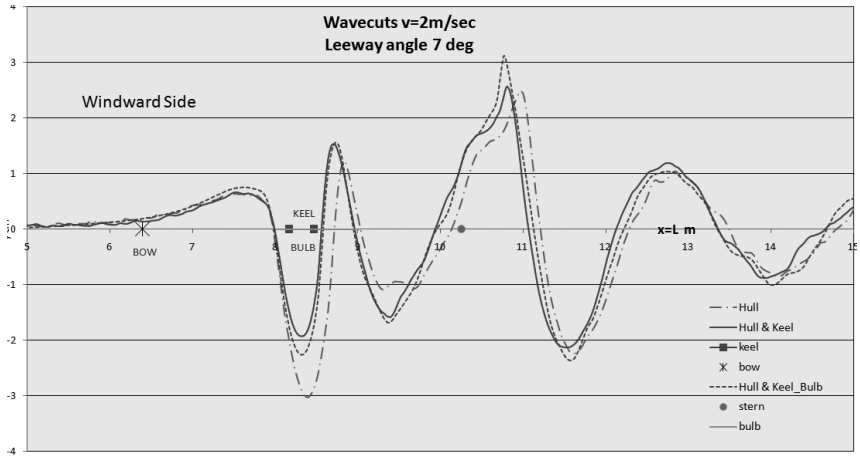

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Figure 13: Wavecut at Windward side, V=2m/s.

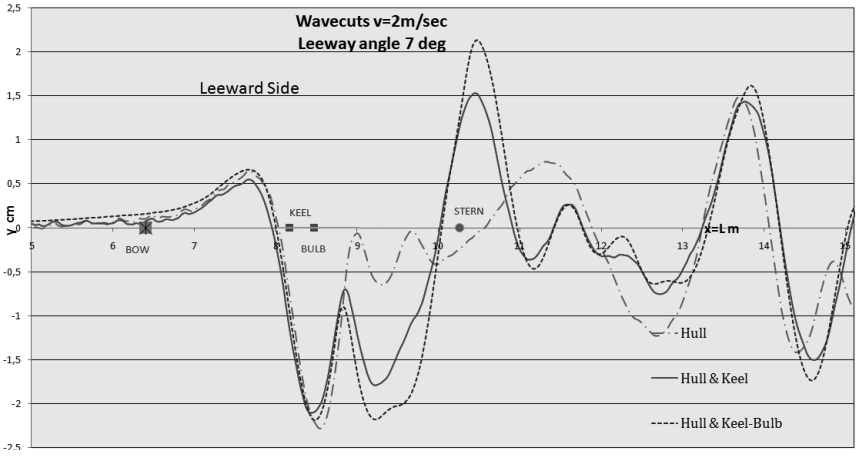

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Figure 14: Wavecut at Leeward Side, V=2 m/s.

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Re-Enactments of Historical Seafaring Between Experimental Archaeology and Constructions of Identity

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ABSTRACT

The paper discusses re-enactments of historical sea-journeys as connecting history of seafaring to the discussion of collective memory. Also, the role of lay-persons and experts on history and the role of re-enactments for communicating history are negotiated.

The paper looks on various re-enactments and their focus in execution and in presentation, and how these try to bind in to current discussions of history and its meaning for society.

For the discussion re-enactments are differentiated into re-building ships (and boats), retraveling historical journeys, experimenting with historical forms and ways of navigation, handling the vessel or even liven on board. The paper concludes that as long as the participants understand about the unbridgeable gap between the past and the present, they can learn and tell a lot about how things most likely worked in the past and how this relates to the present, as one can understand, how people connect to the past, how sense is made of practices and artefacts from the past. The references in each choice of events to be re-enacted inform us on the construction of continuities and dis-continuities. The same is given in each choice of ship to be re-built. It is crucial to analyse the underlying canon of references: specific periods appeal more than others, they are attributed with importance in re-telling the past. The choices and amissions help to understand the current construction of historic developments that shaped the present.

1. Introduction

The past is a foreign country, they do things differently there (Hartley 2004,5). And they do indeed. Their reports are of varying quality and depth: depending on the cultural and other knowledge of authors and recipients, they can be filled with meaning. The way things were done, machines worked, artefacts were constructed, occurences and incidents were interpreted, and how general and particular working and living conditions were – all this can be deducted from the records. But a lot is left open. It has to. And it is human to try to fill the gaps in the understanding of things past and present. For all past is focussed by the present.

Memory is a method by which historical data can be brought to life and fruitfully contextualised with depth, detail and alternative perspective, while historical enquiry can help make sense of the changing role of memory over historical time (Keightley 2008, 191).

And so does re-enactment as a method. While history might be considered an object of academic disciplines, heritage can be described as communication of history. But every simplification like this immediately leads to the question of authority in reading and interpreting, in presenting and teaching history. There are very different forms of aquainting oneself with historical issues like specific sea-journeys, which are at the focus of this paper. But they, like other forms of re-enactments, are experiments in documenting and reflecting on historic conditions of life. Beyond that, re-enactments generate memories and connect historic topics to the present, or as Jorge González expressed it: They "re-tell the past to re-negotiate the presence and open-up for alternative developments" (González 2012).

There are many ways to gain more understanding of sources and their messages. Re-enactments are one method to fill the gaps in the reports and knowledge we have of past events (and non-events) that combines hands-on experiences and assessment of possible truth in historical reports or reconstructions of the past. But there are different kinds of re-enactments, not all can be considered as re-constructing aspects of the past to re-evaluate them in exchange and interrelation to scientific progress. The opposite extremes might be described as experimental archaeology on the one hand and commemorative events on the other, in between there are var-

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ious combinations of elements of both sides. Even though there is a growing lay-interest in results of history as a science, the interests behind re-enactments remain quite diverse. There is a poignant difference between re-enactments that try to establish a more precise understanding of specific historic constructions, maintenance, or usages and those that focus on emotional understanding of past events and their meaning for today's culture.

Re-enactments allow for practical participation – by those who are ignorant of detailed historical backgrounds and by those who have detailed knowledge of historical reports and constructions of the past, which they want to scrutinise. Participants can be experts on crafts that are linked to the object of the re-enactment. To reduce the opposition to stereotypes: participants are academics and non-academics, skilled or non-skilled, i.e. they are highly trained in things theoretical, in things practical, they come with a firm methodological catalogue and canon of background-knowledge, with a perspective trained in exchange with their peers, or they take in all kinds of sources and have any exclusive perspective in interpreting these and other information. And some are only in for entertainment. Especially for this last group, participation may lead to mayor changes in their understanding of the re-enacted issue and of their self-understanding. But especially in re-enactments, academics are met by non-professionals, who are experts on their specific field of interest, know academic and other sources on the issue, but deal with these in a different way than the academics, who have been tought specific traditions of dealing with sources, how to read and how to interpret them. The first encounters like this usually are highly irritating for the academic participants, for their knowledge is appreciated, while their exclusive views and methods are not. They are no longer the custodians of information, but meet people that have worked themselves into the same topic, but not following academic traditions or reading-lists. It often is a clash of cultures, first. And then both sides learn from each other and the differences between academic-expert and lay-expert are no longer a hindrance, but allow for both sides to learn about their subject and about themselves and their topical limitations.

Most re-enactments of historical sea-journeys are depending heavily on the non-professionals who are in for entertainment, as only a minority of the people on board are experts on the issues to be researched. It is mainy these lay-people that give colour and emotion to the experiment. They do the manual labour and experience the re-enactment with mind and body. This leads to stronger ties than most other ways of dealing with issues: Practical experience always has consequences for the assessment of related actions past or present, no matter if it is set in the frame of a historically or heritage-oriented re-enactment.

Re-enactments consist of different elements: The preparation and it's cultural context, the working context aimed at, sequence of actions to be performed itself, the artefacts and the infrastructure that are used, the assessment of the whole and its parts afterwards. Some re-enactments use todays infrastructure, eat food that is not prepared and stored like it might have been done in the relevant period of the past, and the participants wear modern and functional clothing, especially raingear. Others re-construct a vessel from sources and archaeological findings, filling gaps from imagination or deduct solutions from comparable settings that exist in documents or boat-building traditions. The building of a vessel can be part of re-emactments, and depending on the focus of interest, the building is as important as its actual use. In the last 50 years, a movement comparable to the oral-history movement, has started to document regional and even local forms. By now, their archives have become the main (often: the only) sources for research in regional traditions in ship and boat-forms and in aspects and past practices of their building[1]. A much smaller movement of re-constructors has developed alongside, who build new boats in precise accordance to the old forms and methods.

As ships are quite expensive to built, re-constructions of historic ships only happen rarely and usually in the context of anniversaries that are used to draw attention to a related nautical achievement in the past. These projects often are supported by public money and usually are part of job-creation schemes and of touristic and scientific programmes[2]. But the heritage-factor is close at hand – especially when the re-construction is supposed to draw visitors and earn money, as in the case of the re-construction of Francis Drake's *Golden Hind* at Brixham:

Come aboard and explore the ship that was home to Drake and his crew of 70 for almost 3 years. Experience the sights, sounds and smells of life aboard a Tudor ship. Feel the romance of the seas in the great age of sail. The ship is an excellent resource for students studying the period especially KS2 Tudor history and we also offer a comprehensive education service for school visits[3].

When the focus of a re-construction is on the boat or ship, the style of clothing and choice of food and beverages indicate what the re-enactment is aiming at: Modern clothing worn on an re-constructed prehistoric or historic is as possible as re-constructions of contemporary clothing. The differences show immediately, whether the re-enactment is about testing particular techniques or artefacts or whether it focusses on working conditions. Historic clothing might allow to understand its advantages or disadvantages, the comfort and discomfort it offers in specific working conditions. But usually it is used to get more "authenticity" for the production of documentation in film or photography, to meet the interest of the media and draw a wider audience that is used to costume-dramas and related stereotypical images. Some re-enactments are re-tracing historic journeys for commemorative reasons only. They want to remind of a specific historic event and its meaning communicated with the reporting on the re-enacted journey – a striking example for this is the re-enactment and docu-

[1] E.g. for Sweden, the method of documentations was described in Eskeröd 1970 and Zacke & Hägg 1973. The continuing research and practical work in Scandinavia is shown in Haasum & Kaijser 1998.

[2] E.g. the re-constructions of cogs in Bremen, Bremerhaven, and Kiel; somewhat grander projects are the *Batavia* and *De Seven Provinciën* in Lelystad, Netherlands.

[3] Start page of the *Golden Hind* at Brixham: <http://www.goldenhind.co.uk/> (14.04.2011)

mentation of the Australian "First Fleet[4]". The commemorative re-enactment of the First Fleet that brought convicts and first settlers to Australia 200 years earlier, exemplifies the loose connection between past and present: The ships and their crews are firmly rooted in the presence and its growing mobility and worldwide communication. The living conditions on land and on board, the social background of their predecessors must remain foreign to them – no one is deported or exiled to the end of the world, home is just a phone-call away, the dangers of the journey have become less, safety equipment and seaworthiness of the vessels, the quality of food and beverages are decidedly better. The participants are much better nourished at the outset of the journey. Even though the living conditions in Britain around the turn of the 18. century are described thoroughly and are generally known, the details and their consequences for the individual can not be fathomed any more, neither by researchers nor by amateur re-enactors: Leaving for the unknown was maybe not that scary back then, when hunger, housing, work, harassment or other social issues were dire.

Today, traveling on ships and boats is very different from the past. The clothing and food is very different, and health is directly influenced by these. It continues with the accomodation on board and the way, ships and boats are built, and does not stop with navigational infrastructure – not at last the existence of Coast Guards and other emergency services that can be contacted via todays communication networks gives a feeling of security out at sea that was not to be thought of in the past. Tim Severin points out in this context that all his re-enactments emphasize this difference because he wants the audience to keep this in mind. He is interested in the vessels and their sailing and other stecifications, in the working condition on board, in historic methods and tools of navigation – and checks on all of these constantly by parallel use of modern technology. The highest priority is given to security, not to the production of emotional commitment and dramatic images.

The BBC commissioned "The Ship" in 2001, retracing for six weeks parts of James Cook's first voyage of discovery up the North-East coast of Australia and through the Great Barrier Reef in a replica of the *Endeavour*. After getting used to its peculiarities and the conditions of their work and live on board, the crew quickly and emotionally began refering to it as their "Wooden World" (Baker 2002), seemingly not knowing the book by the same name on the Georgian Navy and its social and other complexities that were not influencing their journey (Rodger 1986).

In the re-enactment, food like at the original journey was used, but no alcohol, there were no naval hardships, no drill and no hierarchies like in the Georgian Navy (Cook 2004, 248). One has to keep in mind that Cook was taking care to have his ships much better supplied with healthier food for all on board than his contemporary collegues in the British Navy and on other ships, but still, for todays palates the food must have been a challenge. Also, all participants knew at all stages of the journey that they would return to their lifes on land, for them life on board was a break from their ordinary lives, it was not a chance to get fed and housed better than on land, like it was back then.

Re-enactment tends to make ordinary events grand and the grand ordinary. And so we grapple with things that would have been second nature to Cook and his men - using the log-line, taking soundings, sleeping cheek by jowl, obeying orders, washing in salt water, eating awful food. Wonder, elation, fear, exhaustion, seasickness. These visceral experiences are not diminished by the contrivance of the theatre. In fact, just the opposite is true. Our inexpert bumbling, our lack of mastery over ropes and rigging, is the very thing that makes this theatre of the past seem authentic[5].

History and Heritage are part and parcel of re-enactments as there is no way of hindering the adaption of a hictorically critical experiement into a heritage-oriented construction. Neither the conducted experiment itself nor its results. The "Invention of Tradition" plays into these interconnections as well as heritage builds on exactly those mechanisms that are crucial for the establishment of invented traditions.

It is the crew of re-enactment-journeys that consists mainly of volunteers who work as deckhands and execute the necessary sail-handling routines, they literally pull the ropes – sailing ships (and boats) with historic rigging and sailcloth is hard work. If those that organise and conduct re-enactments would have to pay these crews, experiments would be very expensive. But due to the image and reputation, the extra-ordinariness of these events, it seems to be no problem to find enough volunteers: Tim Severin points out in his description of the *Argo II*-journeys, that not even the hardship of rowing the replica of an ancient Greek galley of 20 oars upstream (e.g. up the Bosporus) stopped the volunteers from turning up – quite to the contrary, it became a matter of pride for national or local rowing clubs to help out and give the original crew some rest (Severin 1986 and 1987).

The execution of historical reports in re-constructions and re-enactments leans towards the emotionalisation of the experiment, as all labour and thought-intensive projects are. The difference between text and "real" conditions, incidents, and actions is known from all those flaws and liberties of autobiographical writing. The logs and reports of commanding officers always describe and argue from the author's position. Research has shown that historical descriptions of events at specific locations often can not have happened as described. They have to be seen as constructions that depend on specific interests and views onto the world – leaving us in ambiguity and the need to consider various possibilities. Sometimes a re-enacted journey is the best way to scrutinise a historic report or story: Its individual details are tested and put into sequence to check their probability in relation to primarily geographical and/or nautical conditions. For example Tim Severin's "The Ulysses Voyage" does exactly this. He concludes his report on the experiment by discussing the probability of specific locations for the incidents described in Homer's epic (Severin 1987).

[4] E.g.: Iggulden 1988 and: King 1988.

[5] Agnew, Vanessa (04.09.2002): "What can Re-enactment tell us about the past? in: <http://www.bbc.co.uk/history/programmes/programme_archive/the-ship_history_reenactment_04.shtml> (14.04.2011)

The building and use of a replica of a historic boat or ship, the taking part in the experiment itself offers pride and identification to those who took active part in planning, building and using the artefact. Looking at the boat and following its journeys allows for the construction of naval and cultural continuities and may act as a reminder of past events and bygone glories (etc.) of the nation in question (the national heritage). In Polynesia, experiments have been performed on navigation oriented at clouds, wave-patterns etc. as it was professed by mythical ancestors but hardly and only very restricted in the recent past. This way of navigation has been re-established in experiments, expanding on the fractured memories of a few and having become an issue of collective self-understanding of not only those directly involved in conducting the first experimental journeys that started the (re-)discovery of this method (Lewis, Oulton 1994). Building on the remaining bits of knowledge of former generations that had survived for their experiment, the art of navigation had to be learned more or less entirely new again. But the experience and understanding of the conditions at sea enabled the navigators to read more and more of the information given in the old maps, because now they were able to fill the details of the images, of the materials used with meaning: The different ways of knoting and weaving the strands of grass or sticks and applying sea shells on them, the way knowledge about the ocean was translated into images in their narratives (Akerblom 1968). Not surprisingly, those who took part are very proud of their activities, as they gained specialised experience and in consequence, higher social standing, as the re-discovered craft fits so well into the self-description of the Maori – in opposition to those dependent on modern methods of navigation – as being able to communicate with nature.

Greg Dening has argued that journeys in the footsteps of ancestors, oral tradition etc. in Oceania are not only experimental archaeology, but – if continued after the scientific experiment – are essential for the build-up of identities of the concerned groups / collectives as they are re-assessing their historic past and stabilising their understanding of historical meaning and abilities (Dening 2004, 182). This seems to be right not only in Oceania but in general: The taking into possession ("Landnahme") of the ocean by groups and societies is re-established in those re-enactments or re-creations (strictly speaking: creations) of historical journeys. At the same time, this tests different models and possibilities in relation to their probability and hints of historical importance and grandeur are created or stabilised in the memory of the collective. It is not the documents that illustrate past glory or importance and their meaning for the presence, but the re-enactment of the journey itself that might become a cult on its own as a pilgrim's journey or the via crucis in any catholic church. Actions are canonised because of their assumed historic importance, their re-enactment creates a memory of suffering on the way to these achievements against certain odds and dangers, against ignorance and – in the case of the journeys of discovery for example – limitations in the contemporary understanding of the world.

Restrictions have to be considered when dealing with the re-enactment of historical incidents: It is the lack of knowledge or memory that is described by them that usually triggers the re-enactment. Generally, they try to test assumptions on the ways things were done in the past, as one does not know it any more *en detail*, as the historic reports and descriptions are not convincing or fully understandable, or as the practical execution of things is not possible any more as a routine.

These lacks of knowledge, of memory, are resulting from the way human memory is working in todays societies, they are the floating gap of memory that sets in after three generations and the end of their oral history of personal experiences (Assmann 2011, 4). Only exeptionally, with isolated incidents, a fourth generation is reached. After this, the memorial of living and working conditions is gone, if it has not been transfered into written material that is communicated to the following generations who might retrieve it from the sources. It is important to understand that written sources are falling into the floating gap, as well. But due to their material and medial nature they can be re-discovered and re-read.

Re-constructed historical boats and ships are reminders of the past, usually lifted from far beyond the floating gap of memory. They serve as condensed markers of past events and conditions and are filled with meaning by historical and heritage-approaches alike.

They usually are based on mediated sources, usually written material and illustrations, often archaeological discoveries, and are subject to the interpretational width of these sources and findings – not at least because wooden boats survive rarely longer than a limited amount of time.

2. The Bounty

For Britain and other nations that were part or heart of an empire the remembering of voyages of discovery and possession, of invasion or defence, of naval triumphs and disasters is crucial, if the self-understanding still builds on this part of the national history – or is used for arguing for contemporary activities in the wider world (be it naval or other) (e.g. in Regan 2001). But in this context, too, it has to be emphasized that artefacts are open to interpretation. The boat or ship itself is not carrying one obvious meaning but is open to interpretation. The memory of the Empire always comes along with its younger twin, the criticism of the Empire and its consequences for world history etc. Let us take the reconstructions of the *Bounty* as example: They were done at different times for different purposes, usually to be used as a prop for a film on the mutiny. But they are continued to be used after filming, and draw their audiences when they come to sailing events or when anniversaries of fitting historic events are celebrated. And here the problems start: people take them for true replicas, but they are not, necessarily. When their details are compared to the original plans, it is surprising, how far they vary[6]. One was built to accomodate bulky filming equipment and does appear quite

[6] The original drawings still are held in the National Maritime Museum Greenwich. Easier obtainable is: McKay (n.d.).

different from the original and leaves the audience with a wrong impression of the ship. The films have falsified the events around the ship more than even an extreme heritage-minded interpretation would dare to do (Dening 1994, 339-368). So we have a reduced setting in reference to the historical background, as we look on a myth, mainly transported and spun further by several fictional films and there are some ships that vary amongst each other quite a lot, while all of them are claimed to replicate the historic *Bounty*. But even under this circumstances it is quite difficult to say, what the *Bounty* is standing for, considering that the mutiny is only a small but prominent part of her history. Thinking of the *Bounty's* bread-fruit-journey is incomplete without remembering slavery and colonial trade. William Bligh's command is incomplete without his orientation towards James Cook's example. His log and report of the journey show only his point of argument, they represent his priorities, are influenced by his sense of duty, and so on (Bligh 1792). The reception of the events in Britain at the time were highly influenced by interests of other parties, like the supporters of Fletcher Christian, who was socially much better connected than Bligh's (Alexander 2003).

3. Testing theories in the field and in the laboratory

Books only store and communicate lexical knowledge, even when they describe specific steps of action in the construction or assembly of something. The understanding of the meaning of the described actions depends on the practical experience and related imagination of the individual reader. Usually, the described steps of action and their consequences and meaning in context need to be re-created to understand all aspects given in their textual description. To value the information given in the text, it has to be comparable to other ways of doing them and to put them into the historical context – e.g. the quality of historic tools and the level of craftsmanship that was given on average. And here the experimental activation of text-based knowledge becomes extremely tricky: Generally, it is not possible to judge specific methods after having gone through their prescribed steps only once. They have to be trained to gain a thorough routine in doing them. Handling a sextant is not learned from a book, it has to be done again and again to understand the navigation-textbooks. Even for most contemporary sailing-enthusiasts and seamen, establishing a geographical position by sextant, clock, charts, and mathematics is quite demanding and is becoming more and more exotic due to the establishment of global positioning systems.

Scientific and other theories are tested in experiments, in our case in re-creations of journeys across different sections of the seas. These experiments are corresponding to and co-operating with other fields of science or argumentation and allow for the destruction or approval of theses on specific nautical feats. E.g. Thor Heyerdahl tried to prove the possibility of his ideas on the distribution of specific cultures by sea in experimental journeys. He used purpose-built reed-boats, balsa-raft etc. for the different journeys. These provided material for films and engaged books but were proven wrong by archaeology, anthropogogy, and scientific history. Interestingly enough, even though the line of scientifical arguments against his ideas is tight and well based, there are people in his footsteps, who are trying to prove by sailing reed-boats similar to his constructions that his theory describes a realistic possibility[7]. All their sailing does not counter the results of far reaching gene-matches that established other routes of distribution of humans on earth. If nothing else, this is a good example for the stability of ideas that can hardly be corrected by scientific proof but are happily in opposition to "the Other".

Connections are constructed to the pre-decessors in each re-enactment. Re-enactments link the cultures of the past to the present, the amount of reflection on the unbridgeable distance between "then" and "now" allows for division of re-enactments into research or nostalgia-projects. Not always are traditions invented along the way, but the relations established between these aspects of distinctly different cultures are dominating over other possible links. At the same time gaps in the cultural memory are becoming obvious in re-enactments and can be re-filled: E.g. the technique of navigating with a sextant on the Southern hemisphere had to be developed from scratch by the navigators of the BBC-re-enactment of Cook's *Endeavour*-journey in 2001, as they lacked their usual Northern fix-points and curves to follow.

By re-constructing a boat or ship, one can learn how these were built using the existing tools. The construction tests the accuracy of the descriptions and re-establishes knowledge about the historic tools and how hey could be used. By using the re-constructed vessel, one can establish how they can be sailed and what individual movements or strings of operations simply are not possible. And knowing this allows to evaluate the accuracy of reports of specific (historic) achievements made by boat or ship. Everything beyond that, esp. emotional readings of these activities and artefacts are limited by their contemporary context and can inform us on the present, but not the past.

4. Conclusions

All dealing with the past interprets the past and constructs relations to the present. Re-enactments put past events into the presence and allow for their re-entry into oral-history as the re-enactment is filled with personal experiences and stories. This is not closing the floating gap of memory but it can bridge it to some extent: in the form of the re-enacted interpretation it allows for the re-entry of issues from the past into personal memory. The difficulty is to differentiate between the contemporary content and the knowledge about the re-enacted historic event and circumstances. The re-negotiation of the historic event can be true to knowledge about the past, but it also can falsify and e.g. romanticise the past. The difficulty in re-enacting is to safeguard re-enactment and hinder invention of history.

[7] E.g.: The *Abora* project <http://www.abora.eu/2010/index.php/abora2.html> (14.04.2011)

From re-enactments we can learn about how things worked, how tools were used, what actions were possible or not possible with them in the past. We even can get a vague feeling for the difficulties of past actions and appreciate what they ment in their historic context.

First of all, we learn how specific things were done in the past and relate this to the presence and how things are done in our time. Differences, similarities, and continuities and their historical references become more clear in negotiating just this historical information.

And on another level, we learn about contemporary society, about the way, identity is constructed in reference to the past. Because we not only learn about how things were done, but also, how people connect to the past, how sense is made of practices and artefacts from the past. The references in each choice of events to be re-enacted inform us on the construction of continuities and dis-continuities. The same is given in each choice of ship to be re-built. It is crucial to analyse the underlying canon of references: specific periods appeal more than others, they are attributed with importance in re-telling the past. The choices and amissions help to understand the current construction of historic developments that shaped the present. In other words: From understanding how the presence relates to the past, we can learn about how sense is made in this relation to the past. We can learn how identity is built in detail.

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Production of Nautical Literature in Spain, in the Nineteenth Century

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ABSTRACT

Navigation was not immune to the difficult circumstances that Spanish science experienced during the nineteenth century. Since in scientific and technological disciplines the transfer of knowledge occurs primarily through specialized publications, their study can provide significant information about the development of a specific field at a given place and time. Taking as a basis an existent bibliographical index that includes 260 nineteenth-century Spanish nautical works, the chances for the evolution of navigation shall be discussed in this paper, in the light of the vicissitudes of the nautical literature edition in Spain in the Nineteenth century.

1. Introduction

In Spain, the advancement of science and technology in the nineteenth century was hindered by political instability within the country. Very little domestic scientific production took place, and even less was done to keep abreast of the advances taking place abroad[1].

In scientific and technological disciplines, the transfer of information occurs primarily through specialized publications. Their study has proved an effective means of tracking the spread of new ideas[2], hence their importance to the history of science and the unquestionable interest of historical researchers in examining catalogues of these printed sources. The analysis of these indexes can also provide an insight into the evolution of a particular discipline at the place and period considered.

In order to see if the devastating cultural framework of nineteenth-century Spain proved true in the nautical field, an analysis of the Spanish specialized literature production has been conducted. The results shall be discussed in this paper.

2. Methodology

In order to perform the analysis of literature production that comes next[3], an index of Spanish nineteenth-century nautical works has been prepared firstly, taking as starting point the bibliographical index compiled by Llabrés Bernal (1959). Other bibliographical indexes have been consulted, including Fernández de Navarrete (1851) and Palau Claveras and Ponce de León (1943). In the first approach, 260 works on the discipline 'Cosmography and Navigation' were compiled, 21 of which were not listed by the mentioned authors but were found in libraries or archives[4]. Key aspects supporting the preparation of this index are:

— Works (published and manuscripts) on Cosmography and Navigation have been listed, including those of a historical character.

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[1] The cultural scenario of the nineteenth-century Spain has been outlined, *inter alia*, by Vernet (1975), López Piñero (1992) and Sánchez Ron (1999).

[2] See, e.g.: Ibáñez, Llombart and Iglesias (2004).

[3] It is also worth mentioning that our intention was not to perform a complete bibliometric study, although some ideas have been taken from: Price (1973); López Piñero, Terrada and Portela (1984); and Capel, Solé and Urteaga (1988).

[4] Some texts have not even been found but their existence has been somehow corroborated. For instance, reference to the unpublished manuscript: José B. de Goldaracena (1851) *Tratado de navegación*. Bilbao, has been found in the record of the author kept at the archive located in Alcalá de Henares: Archivo General de la Administración. Sección Educación y Ciencia. Legajo 5725.

— Works related to other nautical disciplines such as 'Ship handling' or 'Naval architecture', have not been gathered.
— New editions and reprints have been included.
— Translations into Spanish of foreign texts related to navigation have been included.
— Articles published in journals have not been listed, except those who had offprint.

The histograms and tables included in this paper have been prepared based on this inventory. The total number of works has finally been reduced to 233. The criteria followed for the preparation of the data are:

— Works have been arranged according to their edition year.
— Some works that have been excluded are:
— Historical texts
— Manuscripts
— Booklets that are less than 10 pages in length
— Periodical works like almanacs and yearbooks

Among them, we find 146 works strictly related to navigation. Those are the works that remain from the previous index, after picking off the texts on hydrography and even the cosmographies and other works on astronomy. For works that comprise more than one volume, it has only been taken into account the volume covering the subject navigation.

These data support the interpretation of the vicissitudes of the nautical literature production, in the light of the troubled political unrest which hindered the progress of science and technology in nineteenth-century Spain. To put it in context, the background to the issue shall be provided in the first place.

3. Background

The venture of the discovery, conquest and exploitation of America, were the circumstances that led to the fact that one of the areas of scientific activity more developed in sixteenth-century Spain was the art of navigation, and closely associated to it the naval architecture and the nautical cartography[5]. The numerous losses that occurred, not only due to the imperfection of the art but also because of sailors' ignorance, led the Government to control the mariners' training, through the *Casa de Contratación* of Seville[6], and to protect those who disseminated nautical knowledge, which favored the emergence of more or less notable writers who compiled the rules and precepts of the profession, in order to facilitate their understanding to mariners (Márquez y Roco, 1875).

Books just compiling nautical rules such as *Suma de Geographia* (Sevilla, 1519) by Martín Fernández de Enciso and *Tratado del esphera y del arte de marear* (Sevilla, 1531), by Francisco Faleiro, were followed by more complex texts called *Artes de navegar* and *Regimientos de navegación*[7]. The supremacy of Spanish treatises is widely recognized and reached its algid point with the famous *Arte de navegar* (Valladolid, 1545) by Pedro de Medina and *Breve compendio de la sphera y de la arte de navegar* (Cádiz, 1551) by Martín Cortés, texts that widely surpassed the level of their predecessors, and were spread in Europe in successive editions[8]. With these works, nevertheless, the brief period of Spanish teaching in the nautical field finished, not being observed recovery signs until the end of the seventeenth century, with the presence of authors like Francisco Seijas Llobera[9] -*Teatro naval hidrográfico* (Madrid, 1688)- and Antonio de Gaztañeta[10] -*Norte de la navegación hallado por el quadrante de reducción* (Sevilla, 1692)[11].

The modernization of scientific and technical disciplines began in Spain with the *novator* movement over the last third of the seventeenth century. During the eighteenth century, modernization was sponsored by the governments of the new Bourbon dynasty that were inspired by the Enlightenment, reaching its peak during the reign of Carlos III (1759-1788). The country became permeable to the European scientific development, making possible the gradual incorporation of Spain to the modern science and technology, which had a direct repercussion, among others, in the nautical field.

In fact, the production of nautical works continued in Spain during the eighteenth century, whose level has been described by Vernet (1975, p. 170) as acceptable and optimal. Nevertheless, as shown by Capel (1982, pp. 204-5), it did not have a uniform distribution throughout the century, which confirms, in addition, that the cultivation of science and its governmental promotion were not necessarily contemporary. The common denominator of the large majority of works published in these years was their educational destiny and their essentially practical character. There were some exceptions with a greater mathematical content, indispensable for the improvement of the nautical studies, like: *Compendio del arte de la navegación* (Sevilla, 1717) by Pedro M. Cedillo; *Tratado de navegación teórica y práctica* (Sevilla, 1749) by Juan Sánchez Reciente[12]; *Lecciones náuticas* (Bilbao, 1756) by Miguel Archer; *Compendio de navegación* (Cádiz, 1757) by Jorge Juan[13]; or *Lecciones de navegación* (Isla de León, 1790) by José de Mazarredo[14].

Completely different from these is the treatise that Fernandez de Navarrete (1846, p.415) considers the most skillful and complete work ever written in Spanish language on this matter, the *Tratado de navegación* (Madrid, 1787) by J. Mendoza y Ríos, author who put the perfect end to the century with the

[5] See, e.g.: López Piñero, 1979, pp. 44-46 or Martín-Merás, 1999, p. 11.

[6] See, e.g.: Arroyo, 1989, p. 9, or Pulido Rubio, 1923, p. 9 and pp. 219-222.

[7] The most prominent *Artes* were those by Medina (Valladolid, 1545) and by Cortés (Cádiz, 1551). Among the *Regimientos*, the one written by Medina (Sevilla, 1552), which was published again in 1563, outstands. The latter were treaties less complicated than the former and, therefore, more accessible to the sailors they were addressed to. See: Guillén, 1964, pp. 5-6.

[8] See: Guillén, 1943. On the English translations of these works, in particular, see: Basterrechea, 1997.

[9] On Seijas' works, see: Fernández de Navarrete, 1846, pp. 400-402.

[10] On Gaztañeta´s work, see, e.g.: Fernández de Navarrete, 1851, vol. 1, pp. 134-135; Fernández Duro, 1879, pp. 41, 46; and Apestegui, 1992, pp. 44-45.

[11] The Spanish nautical texts of the Renaissance have been analyzed by Carriazo in an interesting work that combines both, the historical and the linguistic approaches. See: Carriazo, 2003.

[12] Cedillo and Sánchez Reciente taught mathematics and navigation at the Royal School of San Telmo in Seville. See, e.g.: Tikoff, 2008; and García Galarrón, 2009.

[13] Work that has been considered a representative text of the transit from the 'art of navigation' to the 'science of navigation'. See: González de Posada, 2008.

[14] On Spanish nautical textbooks of the eighteenth century, see: Iglesias, 2000.

publication in 1800 of his *Colección de Tablas para varios usos de la navegación*[15].

Thus, Spain occupied an excellent position at the beginning of the nineteenth century, but the encouragement of scientific activity would soon be interrupted. As a consequence, the country remained out of the process of emergence of contemporary science that would shortly take place in Western Europe[16].

4. Politics-shaped science in nineteenth-century Spain

During the nineteenth century, the development of scientific and technical activities in Spain, reflected the political instability that characterized the period. According to Vernet (1975, p. 231), the Spanish War of Succession (1808-1814) caused the collapse of the feverish development of science, which López Piñero (1992, p. 14) extends up until 1833, qualifying the interval between 1808 and 1833 as a catastrophic period. In spite of the brief liberal interlude (1820-1823), the absolutism that presided over the reign of Fernando VII (1814-1820 and 1823-1833) meant persecution or exile for leading scientists, the re-establishment of the Inquisition, and censorship of the press, López Piñero (1992, p. 15) claims that the few uniquely Spanish scientific contributions were made by exiles in contact with the latest European tendencies.

However, the fact that there was no active, organized, scientific community in Spain, during the first third of the nineteenth century, hardly implies that there were no isolated researchers within the different scientific branches. For instance, certain Spanish naval officers studied advanced navigational techniques with the support of the Navy and enjoyed worldwide recognition as scientists, although their contribution to the progress of mathematics or physics was scarce as they were expected to commit themselves to teaching and maritime activities (Peset *et al*., 1978, pp. 39-40). Among those found towards the end of the eighteenth and the start of the nineteenth century, we may mention Jorge Juan (1713-1773), José Mendoza y Ríos (1763-1816), Gabriel Ciscar (1760-1829), and José Sánchez Cerquero (1784-1850)[17].

Broadly speaking, in spite of the above, as Menéndez y Pelayo (1888, p. 130) said, the nineteenth century did not actually start until 1834 for Spanish literature and science. Indeed, the cultural scene only improved during the reign of Isabel II (1833-1868) as a consequence of the end of absolutism. Although this period had its political ups and downs and in consequence its discontinuities in scientific policy, recovery was possible, to a great extent, thanks to fewer controls over the edition and circulation of scientific publications. It should also be mentioned that important educative reforms were undertaken in this period and some scientific institutions were established; factors that undoubtedly helped to smooth the way[18].

Despite the difficult circumstances that Spanish science experienced during the nineteenth century, as from 1833, different scientific and technical disciplines began once again to flourish, but at unequal rates, although they all matured during the second half of the century (Vernet, 1975). The efforts made along the mid-nineteenth century and the period known as *Sexenio Revolucionario* (1868-1874) laid the foundations for the recovery that scientific activity knew in the Restoration, as from 1874. Although, as Tuñón de Lara (1982) points out, the cultural renaissance that occurred with the Bourbon Restoration was not exactly promoted, but rather consented, by the official policy.

5. Spanish works on navigation in the nineteenth century

Following the methodology set out above, this section will chart progress in the production of nautical works in nineteenth-century Spain. As formerly mentioned, the prepared index comprises a total of 233 works, which include 146 texts strictly related to navigation.

In Figure 1 the influence of the national political situation in the production of these works can be observed. In fact, the negative impact of some war periods as the War of Independence (1808-1814) is confirmed, whereas a clear upward trend in the number of works can be seen as from the reign of Isabel II (1833), taking into account, as already indicated, that cause and effect are not necessarily contemporary. Broadly speaking, the same general trend is observed if the only works considered are those on navigation. In this case, there is a notable production increase in the second half of the century, which accounted for 72.6% of the total.

In the following sections, we shall continue with the analysis of the production of the 146 selected works on navigation as they constitute a suitable representative for the nautical literature production along the nineteenth century.

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[15] This work, which gained great prestige, was improved and translated into English and French. Mendoza himself prepared the first English edition (London, 1805), published again in 1809, and, in 1842, appeared a French edition prepared by Richard. In Spain, the second edition was published in 1850 and in several occasions thereafter so that its use was generalized among navigators.

[16] See, e.g.: López Piñero, 1992, p. 13; and Sánchez Ron, 1999, p. 36.

[17] Jorge Juan together with Antonio de Ulloa (1716-1795) were the only Spaniards taking part in the expedition to Peru (1734-1743) organized by the French Academie of Sciences, in order to resolve the question of the Earth's real shape. On this subject see, e.g.: Lafuente and Mazuecos, 1987. The main focus of the literary works by José Mendoza was on navigation. His masterpiece was the celebrated *A complete collection of tables for navigation and nautical astronomy* (London, 1805), first edited in Spain in 1800 (see Note 15). But Mendoza's contribution may be partially considered as originating in exile, since he eventually settled in London, where he was commissioned in 1789 by the Spanish government. See, e.g.: Fernández de Navarrete, 1851, vol. 2, pp. 91-96. The unquestionable excellence of the professional career of Gabriel Ciscar has been stated by his numerous biographers. The most recent and complete biography is by La Parra, 1995. Ciscar developed multifarious activities, one of which outstands because of its international projection: his geodesic and gravimetric research carried out in connection with the International Congress for the unification of weights and measures (Paris, 1798). Finally, a recent work by Ausejo and Medrano (2012) focuses on Ciscar's role as mathematician. José Sánchez Cerquero was the Director of the San Fernando Observatory since 1825 and made important contributions in the fields of mathematics, astronomy and navigation. See, e.g.: Pavía, 1874, vol. 3, pp. 455-459. The works published abroad by these Spanish scientists are listed in Valera, 2006.

[18] On the educational reform process that took place during the first half of the nineteenth century, see: Gil de Zárate, 1855. On the foundation of some scientific institutions, see, e.g.: Gomis, *et al*., 1986.

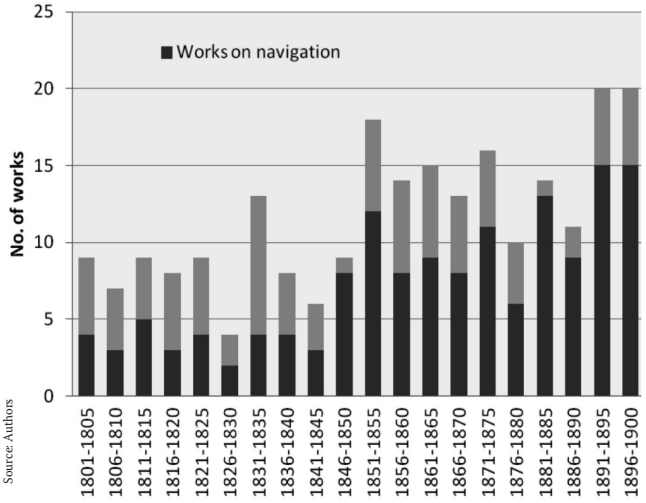

Figure 1: Spanish nautical works, 1801-1900.

5.1. The first decades of the century: the consequences of the War of Independence and the absolutism

At the turn of the century, two fundamental works derived from the Winthuysen syllabus[19] were edited: *Lecciones de navegación* (Madrid, 1801) by Dionisio Macarte and *Curso de estudios elementales de marina* (Madrid, 1803) by Gabriel Ciscar. The new instruction was passed in 1790 but, in principle, no text existed that complied with the established programme.

Table 1: Spanish works on navigation, by subject and edition typology, 1808-1833.

Subject		First Edition	Reprint	Translation	Translation Reprint	Total
General (*)		1	–	–	–	1
Treatise		1	4	–	–	5
Monograph	Positioning	1	–	–	–	1
	Instruments	1	–	–	–	1
	Other	1	–	–	–	1
Tables		4	1	2	–	7
TOTAL		9	5	2	–	**16**

(*) It refers to works of a more general character that include a part on navigation. Source: Authors.

The War of Independence and the reign of Fernando VII negatively influenced the production of works, which decreased not only quantitatively but also qualitatively. As shown in Table 1, in 26 years only 16 works were edited, mostly tables and treatises, with only a first edition of the latter: *Elementos de astronomía náutica ...* (Barcelona, 1816-17) by Agustín Canellas. It is also worth mentioning the *Reflexiones sobre el método de hallar la latitud en la mar por medio de dos alturas de sol observadas fuera del meridiano* (Cádiz, 1823) by J. Sánchez Cerquero, as it is one of the scarce Spanish contributions to the advancement of navigation in this century.

An interesting fact is that most of the works published during the war (reprints of the treatises by Macarte and Ciscar, and the Tables by Faquineto[20]) were printed in 1813, in Palma de Mallorca, location geographically distant from the armed conflict[21]. The scarce number of translations also outstands, which reflects the cultural isolation that Spain suffered during this period.

The establishment of absolutism in 1814, after the War of Independence, and in 1823, after the liberal triennium, meant, as mentioned, persecution for some scientist and exile for others. In the nautical field, among those affected, Martín Fernandez de Navarrete and Gabriel Ciscar outstand, but the less known case of Pedro José Rodríguez (1803-1838) has to be added[22].

Rodríguez fled in 1823 and ended up joining the US Navy in 1827 with the appointment of Acting Sailing Master, bound for the Norfolk Naval School, where he participated in the training of midshipmen as professor of navigation, mathematics and languages[23]. Among his works, *Elements of spherical trigonometry, designed as an introduction to the study of nautical astronomy* (New York, 1829), *On the observations of Comets* (*American J. of Sci. and Arts*, 1829) and *Tablas para calcular la latitud por medio de la estrella polar* (N. York, 1830), are to be numbered (Valera, 2006, pp. 182-183). Additionally, Rodríguez left some unpublished manuscripts, among which there is a treatise on nautical astronomy[24].

[19] During the second half of the 18th century, numerous Nautical Schools were founded along the Spanish coast with the exclusive purpose of training Merchant Navy officers. Their shortage was in evidence as the traffic with America was deregulated, a process that culminated in 1778 when the *Reglamento de Libre Comercio con los Puertos Americanos* was promulgated. The increase in the number of these Schools together with the progress in the navigation techniques, raised awareness on the need to modernize and homogenize the nautical studies. As a consequence, the so-called *Instrucción Winthuysen* was passed in 1790. See, e.g.: Ibáñez, Llombart and Louzán, 2002.

[20] Faquineto, F. (1813) *Colección de tablas auxiliares a la navegación para uso de los alumnos de náutica de la Escuela de Náutica del Consulado de Mallorca* . Palma de Mallorca: Imprenta de Miguel Domingo.

[21] The Napoleonic invasion favored the commercial and maritime prosperity of the island of Mallorca and, as a side effect, the enrollment at the Nautical School of Palma increased significantly. The *Consulado* of the city even founded a second Nautical School in 1811. To facilitate the study of students who followed the career of seamanship various teaching facilities were acquired and several reprints were ordered: nautical treatises and astronomical tables. See: Llabrés Bernal, 1925, pp. 18-25.

[22] About the case of M. Fernández de Navarrete, see: Guillén, 1944, p. 912. On Ciscar's case, see, e.g.: La Parra, 1995, p. 4. Vernet (1975, p. 221), mentions that Rodríguez was another escapee after the liberal triennium.

[23] According to information received from Jim Cheevers (U.S. Naval Academy Museum): "The published annual registers of U.S. Navy and Marine Corps Officers for the period 1828 to 1838 list a P. J. Rodriguez who entered the service on 4 August 1827, was given a commission as an Acting Sailing Master, and was assigned to the naval school at Norfolk, Virginia. By the mid-1830s the Navy began listing Rodriguez and others as "Teachers at Naval Schools" and calling them professors of mathematics and languages, but, from 1836 to 1838, he is only a Professor of Mathematics [...]". Although there is no reference to the job of P. J. Rodríguez as professor of navigation, a piece of evidence has been found in the memoirs of Admiral Charles Steedman, as quoted by Burr (1939, p. 180): "At last the dreaded day for me to appear before the Board arrived [...] After the commodore had asked a few questions, he turned me over to Captain Bolton, who put me through my seamanship and then handed me over to professor Rodriguez, to be examined in mathematics and navigation. This was the branch I dreaded, but I got through quite creditably and received my certificate of having passed (Jan. 14, 1834), and was shaken by the hand and congratulated by the members of the board".

[24] According to Llabrés (1955, p. 71), at his death, Rodríguez bequeathed some professional manuscripts to the Philosophical Society of Philadelphia, including a treatise on nautical astronomy. It is the unique reference found about this text. We requested information from the *American Philosophical Society of Philadelphia*, but, this manuscript does not seem to be in their documentary collection.

5.2. Signs of recovery, which strengthened in the second half of the century

The reign of Isabel II created a more favorable environment for the dissemination of scientific knowledge. Book publishing was made easy, mainly translations of foreign texts, and also specialized scientific journals emerged (Ten and Aragón, 1996).

Table 2: Spanish works on navigation, by subject and edition typology, 1834-1850.

Subject		First Edition	Reprint	Translation	Translation Reprint	Total
General (*)		–	1	–	–	1
Treatise		1	3	–	–	4
Monograph	Positioning	–	–	–	–	–
	Instruments	2	–	1	–	3
Tables		5	1	2	2	10
TOTAL		8	5	3	2	**18**

(*) It refers to works of a more general character that include a part on navigation. Source: Authors.

As for the production of works on navigation, Table 2 depicts their distribution in the initial phase of this progressive period. It shows not only a clear trend of quantitative growth, but also an increase in the number of translations, signs of the new, more permissive order. The highlights of these works are the *Apuntes de pilotaje de altura* (Santander, 1834) by José M. Montalvo, teacher at the Nautical School of Santander, and, among the tables used to help with the navigation calculations, the already mentioned *Colección completa* (Madrid, 1850) by José Mendoza.

Nautical journals were also encouraged in the reign of Isabel II (Llabrés, 1930), and the reorganization of civil nautical studies took place in 1850, the syllabus for which remained in force until the second decade of the twentieth century[25].

As shown in Table 3, the growth trend was consolidated in the second half of the century, despite some fluctuations, as the decrease experienced over the final years of the reign of Isabel II, before the Revolution of 1868 (see Fig. 1).

Table 3: Spanish works on navigation, by subject and edition typology, 1851-1900.

Subject		First Edition	Reprint	Translation	Translation Reprint	Total
General (*)		8	–	–	–	8
Treatise		6	11	1	–	18
Monograph	Positioning	16	–	2	1	19
	Instruments	21	4	1	–	26
Tables		10	16	5	4	35
TOTAL		61	31	9	5	**106**

(*) It refers to works of a more general character that include a part on navigation. Source: Authors.

In this second half of the century, the attempt to modernize the nautical instruction stands out, by means of the publication of treatises and manuals that completed or replaced that one by Gabriel Ciscar, which still knew five reprints. In fact, Ciscar's treatise on navigation was added, in 1864, by Francisco Fernández Fontecha, who decided to publish his most complete *Curso de astronomía náutica y navegación* in 1875. The first edition of the *Manual del navegante* by Antonio Terry was edited in 1873; although its main character was practical, it was also used as textbook in some Nautical Schools. Likewise, the *Compendio de navegación astronómica* (1883) by Miguel González Aveño and the *Lecciones de navegación* (1885) by Ramón Estrada were employed in the nautical instruction (Ibáñez *et al.*, 2004).

Other remarkable works in this period are the monographs on the so-called 'new celestial navigation', the emergence of which is marked by the line of position discovered in 1837, and published in Boston in 1843, by the Captain of the U.S. Merchant Navy, Thomas H. Sumner (1807-1876). These works helped to spread and discuss the new positioning techniques that were developed as from 1843 and made it possible to obtain the ship's coordinates simultaneously. Among them, it is worth mentioning the *Nuevo método de situarse en la mar del capitán de la marina mercante de los Estados Unidos Thomas H. Sumner* (Madrid, 1864 and San Fernando, 1864) by José S. Montojo; the *Reflexiones sobre la memoria del teniente de navío don José Montojo* (San Fernando, 1865) by Cecilio Pujazón; the *Problemas sobre la nueva navegación astronómica* (Barcelona, 1883) by Salvador Millet Pagés; the *Nueva navegación astronómica en los buques rápidos* (Barcelona, 1895) by José Ricart and the *Nuevos procedimientos de navegación astronómica* (El Ferrol, 1897) by José A. Barreda.

Another striking aspect is the number of works on instruments that are devoted to the magnetic compass: 17 out of the referenced 26. This is explained, first, by the numerous studies conducted during this century for the determination of deviations in magnetic needles produced by the presence of steel in their vicinity, material whose use had increased in shipbuilding since the advent of steam ships. In addition, other event that favored the publication of these works was the installation in Spanish vessels of the magnetic compass designed by William Thomson (1824-1907)[26].

6. Conclusions

During the nineteenth century, the development of navigation in Spain, like the rest of scientific and technical activities, reflected the political instability that characterized the period. This becomes clear from the analysis of the production of nautical literature presented above, which shows how the overall cultural scenario described by López Piñero or Vernet, among others, is also visible in this field.

Focusing on the general trends throughout the century, the negative impact of some war periods is noticeable, as well as the upward trend in the number of works as from 1833. In fact, after this year there was a quantitative increase in the production of nautical works, as well as in the number of translations,

[25] Adopted by Royal Decree of 20 Sept 1850, this syllabus came to substitute the one in force since 1790. See, e.g.: Arroyo Ruiz-Zorrilla, 1989, pp. 128-31.

[26] This instrument presented numerous advantages over ordinary compasses. Thomson developed a binnacle that incorporated an improved mechanism for compensating the deviation caused by the presence of steel in the vicinity of the magnetic compass. First patented in the United Kingdom, this binnacle received U.S. patent protection in 1878 and was adopted by most maritime nations in the late nineteenth century. See, for instance, Martínez-Hidalgo, 1946, ch. 16.

which reflected a new, more permissive regime. Despite its fluctuations, this tendency was maintained and consolidated during the second half of the century.

Within this context, unlike in previous centuries, the Spanish contribution to navigational science was limited. In addition, the diffusion of the new methods of navigation that had evolved abroad was very slow to take place. As a consequence, the initial question about the local innovation on this matter has been overcome with the challenge to inquire into the quality of the instruction delivered to Spanish Merchant Navy officers along that century.

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Six Sigma Approach For the Straddle Carrier Routing Problem

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ABSTRACT

This paper discusses how to route straddle carriers in port container terminals. This problem is solved in the context of optimizing transport operations. The contribution of the work lies in the formulation and subsequent development of a Six Sigma Approach solution for the problem. Generating and prioritizing the critical Six Sigma transportation plans, however, are real challenges in practice. This study aims to develop a novel approach based on a combined ANP and DEMATEL technique to help container terminals determine critical Six Sigma transportation plans. An empirical case study is used to explore the effectiveness of the proposed approach.

1. Introduction

Within container terminal different types of material handling equipment are used to transship containers from ships to storage yard, trucks and trains and vice versa. Over the past decades, ships have strongly increased in size, up to 8000 TEU (Twenty feet equivalent unit container). In order to use these big ships efficiently, the docking time at the port must be as small as possible. This means that large amounts of containers have to be loaded, unloaded and transshipped in a short time span, with a minimum use of expensive equipment.

A handling system for the retrieval and transport of containers is the straddle carrier (SC). SC is used for the retrieval of containers from the stack and for the transport to the quay cranes. This paper gives a planning to efficiently route the SC inside a container terminal for loading operations.

One of the success factors of a terminal is related to the time in port for container vessels and the transshipment rates the ship operators have to pay. We focus on the process of container transport by SC between the container ship and the storage yard. The primary objective is the reduction of the time in port for the vessels by maximizing the productivity of the Quay cranes, or in other words, minimizing the delay times of container transports that causes the Quay cranes to stop.

Six Sigma is one of the powerful business strategies that improves quality initiatives in many industries around the world. It is a company-wide systematic approach to achieving continuous process improvements. Not only a technique but also as a philosophy, performing at Six Sigma means producing only 3.4 defects out of every million opportunities for a business process (Pandey, 2007). There has been a significant increase and development of Six Sigma technology and methodology in organizations (Pande, Neumann, & Cavanugh, 2000, Pyzdek, 2003). Especially in the last decade, as a change and improvement strategy, Six Sigma has received considerable attention in global companies to generate maximum business benefit and competitive advantage (Su & Chou, 2008; Yang & Hsieh, 2009). This strategic approach consists of five basic phases: define measure, analyze, improve and control which can also be symbolized by initials, as D-M-A-I-C.

2. Related Works

Container terminals are very specific from a material handling point of view, because of the special characteristics of both the containers and the handling equipment.

Terminals have become increasingly important and more and more scientific literature is devoted to them. This is even truer for the automated terminals which are being established to manage with the increase in costs. The additional increase

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in ship sizes makes productivity perfection in container handling more important and therefore more research is to be expected. In this paper, we have discussed the related routing problems within container handling.

Operations Research has made important contributions for container terminals. The techniques employed vary from Mixed Integer Programming formulations, queuing models and simulation approaches.

In 1993, Dirk Steenken et al. adopted two models to solve the MSCRP. In the first model they reduce the problem to a simple TSP with assumptions that one Straddle Carrier (SC) is engaged. They use the balance and connect heuristic applied to solve the sequencing insertions in printed circuit board assemblies, referencing to Ball and Magazine (1988), various heuristics were investigated to solve this problem like the nearest neighbour heuristic (NN), the successive or cheapest insertion (SUC) and a 2- optimal exchange method (2OP), best results was found using the SUC method.

The expansion of this problem to multiple one is achieved by introducing fictitious vehicle depots and by using an assumption that two jobs should not succeed each other within the same tour if there is a great difference in their due dates. They also reported that they have added another procedure to their initial solution and a new term not explained.

The second model is developed using an analogy to machine scheduling (MAS) mentioned by Maas and Vob (1991). This model is based on some dispatching rules to select insertion positions.

In 2003, V. Franqueira presents a discussion about the multiple straddle carrier routing problem. Two constraints of this routing problem are discussed; the conflicts between SCs must be resolved; and container stock in the storage yard must be shared between all SCs.

The first constraint is divided into two types; a travel conflict exists when SC tries to cross another SC and a space conflict when a SC tries to move the same location where another SC is already placed.

The resolution of these types of conflict between SCs is presented by Ki Young Kim in 1998 for the travel conflict of two SCs. He proposes two strategies; the waiting strategy and the exchanging roles between SC's strategy. For the space conflict he uses a waiting strategy and a substitutive one.

The routing problem of multiple SCs (more than two) was also presented by K. Y. Kim with considering that containers are located in one or multiple blocks according to the assumptions that a pseudo work schedule would be constructed by appending the work schedules of all SCs, and there is no interference between equipments. Therefore the multiple routing is reduced to a single routing one.

By solving the single SC problem for the pseudo work schedule would theoretically solve the overall problem.

However V. Franqueira suggest that these assumptions turn the problem completely artificial, since each SC route will have to be selected manually from the output and each SC routing will have to occur in sequence and never in parallel.

V. Franqueira present a solution to some multiple routing problem, using the single SC routing procedure, by providing (through manual work) the container distribution table for each SC separately.

However, this procedure seems inappropriate since the potential parallelism of multiple SCs is ignored.

The paper presents by L.N. Spasovic et al. in 1999 results of a research designed to evaluate the potential for improving productivity and the quality of service for a straddle carrier operation. A methodology was developed to quantify possible savings from redesigning the straddle operation. The main effort was to develop and evaluate a series of algorithms for straddle assignment and control. The algorithms differ in a manner in which the straddles are given assignments to move containers. Their research focused only on trucks. The productivity of the whole group of straddles is not analyzed. This should include the straddles servicing on-dock rail, the cranes during ship loading and unloading as well as re-warehousing of containers in the yard.

E. Nishimura et al. in 2005 presents in their paper a Genetic Algorithm heuristic to solve the trailer routing problem using a dynamic routing assignment method. They focus on the tours related to one cycle operation of the quay cranes. Experimental results demonstrate that the dynamic assignment is better than static one. The drawback to their solution procedure is the complexity of the trailer routing, which may increase the possibility of human error. Trailer drives may find difficult to follow the complicated itineraries assigned to them, resulting in mistakes in driving.

In this paper we analyzed the routing problem of SCs to support tasks between quay cranes and yard areas. Since inbound containers are usually unloaded into a designated open space, the Straddle Carriers do not have to travel much during the unloading operation. However, the time for loading depends on the loading sequence of containers as well as the number of loaded containers. In this paper we focus on minimizing the travel time of the Straddle Carriers for loading outbound (export) containers. As Six Sigma is is regarded as a well-structured methodology for improving the quality of processes and products.

It helps achieve the container terminal's strategic goal through the effective use of container-driven approach, it is essential to prioritize the set of containers which provide maximum financial benefits to the organization. This study aims to develop a novel approach based on a combined ANP and DEMATEL technique to help terminals determine critical Six Sigma containers and identify the priority of these containers especially in loading process.

There are numerous techniques applied in evaluating Six Sigma methodology. According to De Koning and De Mast (2006), the Six Sigma program offers a wide range of tools and techniques, which might be statistical or non-statistical, that are intended to assist the project leader. Those methods even can be utilized in different phases of the Six Sigma containers. The successful implementation of Six Sigma requires stringent application of tools and techniques at different stages of the methodology (Antony, 2006).

The tools and techniques applied in the evaluation of six sigma phases can be classified as statistical tools like sampling

(Anderson- Cook, Patterson, & Hoerl, 2005; De Koning & De Mast, 2006), ANOVA (Yang, Choi, Park, Suh, & Chae, 2007), statistical process control (Anderson-Cook et al., 2005; Antony et al., 2007; De Koning & De Mast, 2006; Knowles et al., 2005; Nonthaleerak & Hendry, 2008; Yang et al., 2007), regression analysis (Antony, 2006; Antony & Banuelas, 2002; Knowles et al., 2005), correlation studies (Antony, 2006; Antony & Banuelas, 2002; Yang et al., 2007) etc., quality tools like quality function deployment (Antony, 2006; Antony & Banuelas, 2002; Antony et al., 2007; Anderson-Cook et al., 2005; Banuelas, Tennant, Tuersley, & Tang, 2006; De Koning & De Mast, 2006; Dedhia, 2005; Pyzdek, 2000, 2003; Pande et al., 2000; Yang et al., 2007), quality costing (Antony, 2006; Antony & Banuelas, 2002), or multi-criteria decision making methods especially analytic hierarchy process (AHP) (Dinesh Kumar, Crocker, Chitra, & Saranga, 2006; Pyzdek, 2000; Pyzdek, 2003; Yang et al., 2007).

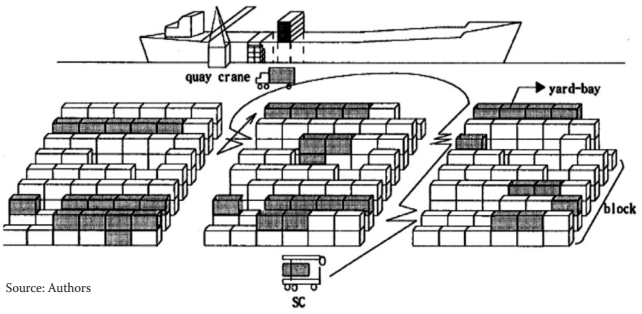
The effectiveness of decision-making depends on the ability of decision-makers to analyze the complex cause–effect relationships (Lin & Wu, 2008). In recent years, DEMATEL and ANP tools have been successfully used in some areas especially including project selection. Both methods are based on a pairwise comparison foundation and allow including the influence of intangibles. According to Wu (2008), DEMATEL is a wise option to calculate inner dependencies since it can produce more valuable information for making decisions. Following this statement, in this study we preferred to use the same approach applying DEMATEL to obtain relations of influence between sub-factors in a pairwise manner when inner dependency occur within an evaluation cluster, and ANP to calculate the weights of elements of evaluation clusters and to select the optimum alternative in selection of the Six Sigma containers framework. DEMATEL method is a potent method that helps in gathering group knowledge for forming a structural model, as well as visualizing the causal relationship of sub-systems through a causal diagram (Wu & Lee, 2007). ANP was used by Saaty (1996) to overcome the problem of dependence and feedback among criteria or alternatives (Liou et al., 2007). Here, DEMATEL is used to detect complex relationships and build relation structure among criteria for selecting Six Sigma containers. Additionally, ANP is adopted to deal with the problem of the subsystems interdependence and feedback; set priorities among goal, strategy and criteria and to determine the most appropriate container.

The rest of the paper is organized as follows. In Section 2, the proposed Six Sigma container evaluation framework is presented. In Section 3, the developed model is detailed. In Section 4, an empirical case study is given to explore the effectiveness of the proposed approach. In the last section, the findings of this research are discussed.

3. Six Sigma transportation plan evaluation framework

3.1. Straddle Carrier definition

By a "subtour" of a SC, we mean a visiting sequence of yard-bays which a SC visits to pick up all the containers which will be loaded onto a cluster of cells in the ship. An overview of a container terminal is presented in Figure 1.



Source: Authors

Figure 1: An overview of a container terminal.

3.2. Optimization model

An optimization model will be developed to display the container arrivals and yard locations and the actual and optimized assignment of straddles to containers.

The main part of this modeling is to develop and evaluate the algorithms for assigning straddles to containers.

The discussion from the previous section illustrates the fact that the manner in which the straddles are assigned container jobs impacts the cost and service quality of operation.

In general, the problem of assigning straddles to containers can be formulated as the assignment problem, a mathematical programming problem presented by L.N. Spasovic et al. in (1999).

$$Min\ Z = \sum_i \sum_j c_{ij} x_{ij} \qquad (1)$$

s.t

$$\sum_{i=1}^{n} x_{ij} = 1 \quad for \quad j = 1,2,...,n \qquad (2)$$

$$\sum_{j=1}^{n} x_{ij} = 1 \quad for \quad i = 1,2,...,n \qquad (3)$$

Where:

i, j= indices

n = number of containers.

$x_{ij} = \begin{cases} 1 \text{ if the feasible assignment of container "t" to straddle "j" is selected} \\ 0 \text{ otherwise} \end{cases}$

c_{ij} = cos *t of hte* (*i,j*) *assignment*

Equation (1) is an objective function that minimizes costs. Constraints (2) and (3) are typical assignment problem restrictions that ensure that a straddle can be assigned to only one container and vice versa.

3.3. The DEMATEL methodology

The DEMATEL method originated for a Science and Human Affairs Program by the Geneva Research Centre of the Battelle Memorial Institute (Fontela & Gabus, 1976; Gabus & Fontela, 1973). It is a comprehensive method for building and analyzing a structural model involving causal relationships between complex factors (Zhou, Zhang, & Li, 2006). It is especially practical and useful for visualising the structure of complicated

causal relationships with matrices or diagraphs (Wu, 2008). The matrices or diagraphs portray a contextual relation between the elements of the system (Tseng & Lin, 2008).

According to the above information, the major application of DEMATEL is to investigate the influential status and strength between the factors and transform them into an explicit structural mode of a system (Chiu, Chen, Tzeng, & Shyu, 2006; Lin & Wu, 2008; Tzeng, Chiang, & Li, 2007). The DEMATEL method has been successfully applied in many fields such as R&D project selection (Lin & Wu, 2008); real estate agent service quality expectation (Tseng, 2008a); evaluation of service solutions in service engineering (Shimomura, Hara, & Arai, 2008); introduction of a new product (Fekri, Aliahmadi, & Fathian, 2008; Zhou et al., 2006); airline safety measurement (Liou, Yen, & Tzeng, 2008; Liou et al., 2007); job performance structuring (Fang, Chen, & Hung, 2008); solid waste management (Tseng, 2008b; Tseng & Lin, 2008); evaluation and selection of knowledge management strategies (Wu, 2008); human factors engineering (Hori & Shimizu, 1999); developing global managers' competencies (Wu& Lee, 2007); evaluation of e-learning programs (Tzeng et al., 2007); hotel service quality (Tseng, 2009), safety and security systems analysis (Su & Zhang, 2007; Tamura, Nagata, & Akazawa, 2002); regional development (Dytczak & Ginda, 2008); strategic planning (Dytczak & Ginda, 2008b; Hung, Chou, & Tzeng, 2007); location selection (Chen & Yu, 2008) etc.

This research explains the definition and steps of DEMATEL with reference to studies of relative scholars (Fang et al., 2008; Lin & Tzeng, 2008; Liou et al., 2007; Tseng, 2008b; Tsai & Chou, 2008; Wu, 2008) are as follows:

Step 1: Generating the direct-relation matrix

Measuring the relationship between criteria requires a comparison scale designed as four levels: no influence (0), low influence (1), medium influence (2), high influence (3), very high influence (4). A team of experts is asked to make pairwise comparisons in terms of influence and direction between criteria. The results of these evaluations form a $n \times n$ matrix called direct-relation matrix $\boldsymbol{A}$, in which a_{ij} is denoted as the degree to which the criterion i affects the criterion j.

Step 2: Normalizing the direct-relation matrix

On the basis of the direct-r elation matrix $\boldsymbol{A}$, the normalized direct-relation matrix $\boldsymbol{M}$ can be obtained through formulas (4) and (5):

$$M = k.\mathbf{A} \tag{4}$$

$$k = \mathit{Min}\left(\frac{1}{\max\sum_{j=1}^{n}\left|a_{ij}\right|}, \frac{1}{\max\sum_{i=1}^{n}\left|a_{ij}\right|}\right) \quad i, j \in \{1,2,3,\ldots,n\} \tag{5}$$

$$1 \le i \le n \qquad 1 \le j \le n$$

Step 3: Obtaining the total-relation matrix

Once the normalized direct relation-matrix $\boldsymbol{M}$ has been obtained, the total relation matrix $\boldsymbol{S}$ can be derived by using formula (6), where the $\boldsymbol{I}$ is denoted as the identity matrix

$$S = M + M^2 + M^3 + \ldots = \sum_{i=1}^{\infty} M^i = M(I - M)^{-1} \tag{6}$$

Step 4: Compute dispatcher group and receiver group

Using the values of $D–R$ and $D+R$ where $\boldsymbol{R}$ is the sum of columns and also $\boldsymbol{D}$ is the sum of rows in matrix $\boldsymbol{S}$ as shown in formulas (7)-(9). Criteria having positive values of $D–R$ have higher influence on one another and are assumed to have a higher priority and are called dispatcher; others having negative values of $D–R$ receiving more influence from another are assumed to have a lower priority and are called receiver. On the other hand, the value of $D+R$ indicates degree of relation between each criterion with others and criteria having more values of $D+R$ have more relationship with another and those having little values of $D+R$ have less of a relationship with others.

$$S = \left[S_{ij}\right]_{n \times n}, \quad i, j \in \{1,2,3,\ldots,n\} \tag{7}$$

$$D = \sum_{j=1}^{n} S_{ij} \tag{8}$$

$$R = \sum_{i=1}^{n} S_{ij} \tag{9}$$

Step 5: Set threshold value and obtain the impact-diagraph-map

The impact-diagraph-map also known as causal diagram can be acquired by mapping the dataset of the ($D+R$, $D–R$), where the horizontal axis $D+R$ and the vertical axis $D–R$, providing valuable insight for making decisions. To obtain an appropriate diagram, decision-maker must set a threshold value for the influence level. Only some aspects, whose influence level in matrix $\boldsymbol{S}$ is higher than the threshold value, can be chosen and converted into the impact-diagraph-map. If the threshold value is too low, the map will be too complex to show the necessary information for decision-making. If the threshold value is too high, many aspects will be presented as independent aspects without showing the relationships with other aspects.

Step 6: Obtaining the inner dependence matrix

In this step, the sum of each column in total-relation matrix is equal to 1 by the normalization method, and then the inner dependence matrix can be acquired.

3.4. D. The ANP methodology

When Straddle carrier routing problem is evaluated, a group of opinions needs to be collected to know the interdependence relationship among criteria which can be analyzed as a Multi-Criteria Decision Making (MCDM) problem. To improve the quality of decision-making, a methodology is required for selecting the optimal set of containers to be transported. AHP is a theory of measurement concerned with deriving domi-

nance priorities from paired comparisons of homogenous elements with respect to a common criteria or attribute (Saaty, 1994). AHP is first developed to help establishing decision models through qualitative and quantitative processes (Saaty, 1980). According to Wu, Lin, and Chen (2007), AHP qualitatively helps to decompose a decision problem from the top goal to a set of attributes, sub-attributes; criteria, sub-criteria; activities, sub-activities, etc. Quantitatively it uses pairwise comparisons to assign weights to the elements at all levels (Wu et al., 2007). ANP goes beyond linear relationships and allows interrelationships among elements. Instead of a hierarchy, it is a network that replaces single direction relationships with dependence and feedback.

The main object is to determine the overall influence of all the elements (Tuzkaya, Onut, Tuzkaya, & Gulsun, 2008).

The definition and steps of ANP with reference to studies of relative scholars (Cheng & Li, 2005; Lin, Chiu, & Tsai, 2008; Saaty, 2001; Tsai & Chou, 2008; Wu, 2008) are as follows:

Step 1: Developing the decision model structure

The research problem should be stated clearly and decomposed into a rational system like a network. The structure is obtained by decision makers through brainstorming, literature survey or other appropriate methods.

Step 2: Conducting pairwise comparisons on the clusters

Experts are asked to make pairwise comparisons with Saaty's (1980) 9-point priority measurement scale ranging from 1 (equal) to 9 (extreme) where two components are compared in terms of how they contribute to their particular upper level criterion. By doing that, the relative weightings and eigenvectors are obtained.

Step 3: Supermatrix formation and transformation

Supermatrix is a partitioned matrix composed of local priority vectors entered in the appropriate columns of a matrix, where each matrix segment represents a relationship between two nodes (components or clusters). The supermatrix must be transformed first to make it stochastic, meaning each matrix column sums to unity, also known as weighted supermatrix and then must be raised to limiting powers until the weights have been converged and remain stable. This new matrix is called the limit supermatrix. The final priorities of all matrix elements can be obtained by normalizing each supermatrix block.

Step 4: Selecting the best alternative

When the supermatrix covers the whole network, the final priorities of elements are found in the corresponding columns in the limit supermatrix. The alternative with the largest overall priority should be the one selected.

4. Model development for six sigma transportation plan selection

Considering the appropriate selection, containers should be linked to the operational needs and priorities of the container terminal. The selection of the right container is a vital factor for gaining early and long-term acceptance of the Six Sigma program. Leading the needs of the container terminal and the customers, appropriate containers is chosen to be transported aiming to improve the performance and reach an optimum solution.

After making a detailed literature survey we can constitute numerous dimensions in selecting the right Six Sigma set of containers.

The purpose is to compare at operational level different strategies to assign straddle carriers (SC) to concrete tasks in a marine container terminal.

There are four types of tasks for straddles carriers: to transport a container to the quay crane to be loaded in the ship (LQ), to pick up an unloaded container from the quay zone and deliver it to the storage yard (ULQ), to pick up a container from the storage yard to dispatch it through the truck gates (LT) and to receive a container from a truck and transport it to the storage yard (ULT).

In this study, we investigate dispatching strategy for SCs to containers by categorizing them under three strategies (The storage of containers in the yard, The land side transportation, and The quay side transportation), four factors (benefits, opportunities, risks, costs) and a total number of 14 sub-factors all defined below. The general evaluation model of Six Sigma transportation plan selection is given in Fig. 2.

Three problems are analyzed in detail; the land side transportation (LS) defined as the side where the straddle carrier is affected to trucks, the quay side transportation (QS) is the side where the straddle carrier is affected to Quay cranes and the storage of containers in the yard (SY) means the side where the straddle carrier is affected to the storage yard.

Benefits (B) can be one of the factors that affect Six Sigma transportation plan selection and it is analyzed in four subfactors: process excellence (PE), customer satisfaction (CS), financial performance (FP) and learning and growth (LG). Process excellence can simply regard to the systematic improvement of transport process which is one of the main targets of the Six Sigma program.

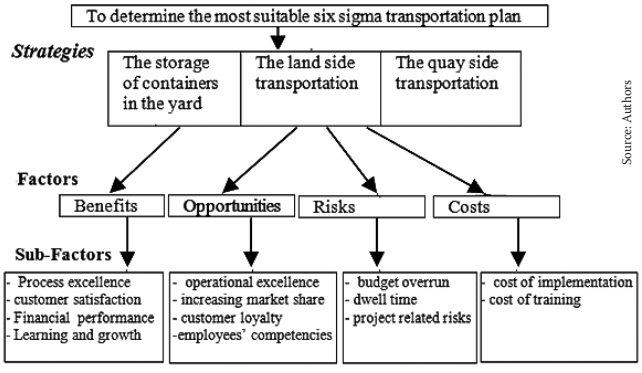


Figure 2: General Six Sigma transportation plan evaluation model.

Process excellence requires the ensemble of activities of planning and monitoring the performance of a transportation process. It is a systematic approach in the Six Sigma projects to help any organization optimize its underlying processes to

achieve more efficient results (Snee & Rodebaugh, 2002). Customer satisfaction is a measure of how products and services supplied by a company meet or surpass customer expectation. As a major objective of Six Sigma program, it is seen a key differentiator and increasingly has become a primary element of business strategy (Anderson-Cook et al., 2005; Fundin & Cronemyr, 2003; Harry & Schroeder, 2000). In terms of retaining existing customers and targeting non-customers, measuring customer satisfaction provides an indication of how successful the company is at providing product and/or services (Antony, 2006; Banuelas et al., 2005).

As a following sub-factor, financial performance is one of the most important aspects of business management in an organization (Goldstein, 2001). It is a subjective measure of how well a firm can use assets from its primary mode of business and generate revenues over a given period of time. Financial performance generally involves balancing risk and profitability, while attempting to maximize an entity's wealth and the value of its stock which is one of the major criteria applying Six Sigma methodology (Breyfogle, Cupello, & Meadows, 2001; Pyzdek, 2003).

The final sub-factor of Benefits is learning and growth. It is a perspective that includes employee training and corporate cultural attitudes related to both individual and corporate self-improvement.

Learning and growth refers to implementation of Six Sigma process in company and adaptation of employees and knowledge workers (Antony, 2004; Banuelas et al., 2006). In any case, learning and growth constitute the essential foundation for successful Six Sigma projects of any knowledge-worker organization (Pande et al., 2000; Snee & Rodebaugh, 2002).

Opportunities (O) is another factor including the sub-factors operational excellence (OE), increased market share (MS), customer loyalty (CL) and employees' competencies (EC). Operational excellence is a philosophy of leadership and teamwork resulting in continuous improvement throughout the organization by focusing on the needs of the customer, empowering employees, and identifying wasteful activities from its process which is one of the strategies of the Six Sigma application (Adams, Gupta, & Wilson, 2003).

Employees' competency is the last sub-factor analyzed under the Opportunities factor. It is the ability of employees' to perform a specific task, action or function successfully and it is one of the major intentions of implementing Six Sigma in an organization (Lynch & Soloy, 2003). By visualizing the strengths and weaknesses of each team member and worker leads to refine their skills for their highest level of performance (Gijo & Rao, 2005). This approach can be optimized by well-written job descriptions taking into account the employees' education and experiences.

The following factor Risks (R) consists of the sub-factors budget overrun (BO), dwell time (TD) and plan related risks (PJ). Under the factor of risks, budget overrun can be defined as excess of actual budget which plays a very important role for decision making in any project applied Six Sigma (Pande et al., 2000). Dwell time is the shift of time to a forward date which directly affects the process (Harry & Schroeder 2000).

Last factor stated is costs (C) and it is examined in three different sub-factors as cost of implementation (CI), cost of training (CT) and cost of human resources (HR). Cost of implementation is the cost needed in realization of the Six Sigma program in the container terminal.

It is already a proven fact that the benefits obtained from Six Sigma implementation outweigh the investment costs (Antony, 2007).

Cost of training is the cost utilized in instructional Six Sigma process for employees and workers of the container terminal. Regarding the type of container, cost of training is directly related with the duration scheduled.

Cost of human resources refers to the total charge used in orientation of Six Sigma project phases for employees and workers. The number of managers running the Six Sigma program and the number of departments the project is initiated help to embody the cost involved for staffing (Gijo & Rao, 2005).

5. Application of the proposed framework

In this section, a case study is presented to prove the proposed approach's applicability and validity in order to make it more understandable especially for decision-makers in container terminals.

In this study, we evaluate three six sigma transportation plans named as transportation plan A (improving the assignment processes), transportation plan B (improving customer relations) and transportation plan C (optimizing storage spaces).

Improving the assignment processes can implicate any kind of development in the travel of the straddle carriers such as improving first time delivery, developing operational routines, educating employees and workers, minimizing the dwell times of the containers etc. Improving customer relations deals with all terms concerning customers, especially increasing customer satisfaction, making forward surveys on customer needs and expectations, offerings to keep customer loyalty and so on.

Optimizing storage spaces is directly related with the service levels and arranging containers in the storage yard, forecasting accuracy lead to better inventory flows, preventing overstocks and this eventually helps controlling commercial plan, increasing financial performance, market share and cash flow.

To measure the inner dependency between decision criteria, DEMATEL is employed. According to the pairwise comparisons obtained from DEMATEL method, the inner dependency is structured and symbolized on the model by looped arcs. Additionally, according to the total-relation matrix the impact-diagraph map is formed.

Following that, for obtaining the relative influence between factors and sub-factors, a series of pairwise comparisons is presented. The results gathered and the inner dependences occurred within an evaluation cluster obtained by DEMATEL method are both carried and placed in the supermatrix and further calculations are made to obtain the best transportation plan alternative using the ANP methodology. The calculations of the supermatrix can be easily solved by using the professional software named "Super Decisions".

An overview of the proposed evaluation process is also given in Fig. 3.

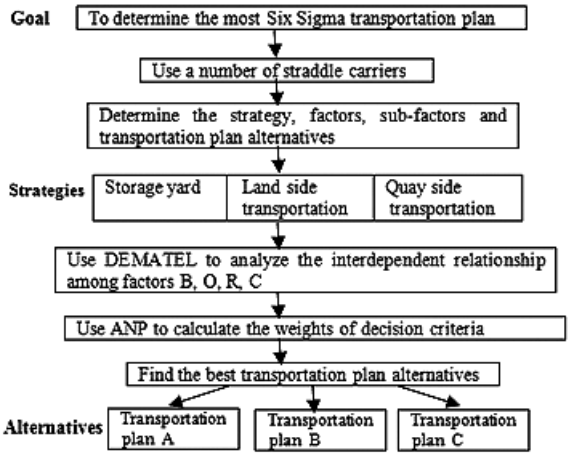


Figure 3: Proposed evaluation framework for Six Sigma transportation plan selection

5.1. Application of DEMATEL

After defining the decision strategies, factors and sub-factors, pairwise comparisons are made to the 4-leveled scale of DEMATEL. Firstly, the inner dependence among strategies composed of storage of containers in the yard, land side transportation and the quay side transportation is calculated.

Following the previously presented steps of DEMATEL, the initial direct-relation matrix for strategies (see Table 1) is produced. Based on the direct-relation matrix, the normalized direct-relation matrix for strategies is obtained by using formulas (4) and (5) (See Table 2): Utilizing the formula (6), the total-relation matrix for strategies is constituted (See Table 3). Then, using formulas (7)-(9) the impact-diagraph map for strategies is acquired by mapping the dataset of (*D+R, D–R*) given in Fig. 4.

Table 1: The initial direct-relation matrix for strategies.

	SY	LS	QS
SY	0	2	4
LS	3	0	3
QS	2	4	0

Source: Authors

Table 2. The normalized direct-relation matrix for strategies.

	SY	LS	QS
SY	0	0.286	0.572
LS	0.429	0	0.429
QS	0.286	0.572	0

Source: Authors

Table 3. The total-relation matrix for strategies.

	SY	LS	QS	***D***	***D+R***	***D–R***
SY	1.577	2.094	2.372	6.042	11.317	0.768
LS	1.884	1.856	2.303	6.042	12.224	−0.140
QS	1.814	2.232	1.996	6.042	12.712	−0.628
R	5.275	6.182	6.670			

Source: Authors

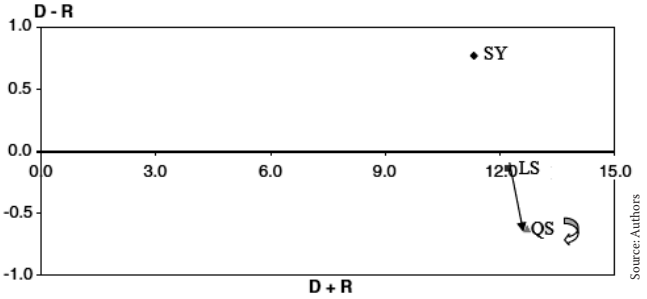


Figure 4: The impact-diagraph-map of total relation for strategies.

The assigned threshold value for strategies is accepted to be 1.85. The value under the threshold value gains too many factors and complex relationships in the system. It is seen that the storage of containers in the yard is the dispatcher and land side and quay side transportation are the receivers. According to the graph, storage of containers in the yard has a high impact on land side transportation and quay side transportation in Six Sigma strategy. Obviously, the convergence of *D+R* values of strategies' elements shows the degree of relation and proves strong inner dependence.

Secondly, the inner dependency between factors is measured.

Based on the pairwise comparisons made for process excellence, customer satisfaction, financial performance and learning and growth sub-factors, the initial direct-relation matrix for benefits (See Table 4) is produced. Derived from the direct-relation matrix, the normalized direct-relation matrix for benefits is obtained by using formulas (4) and (5) (See Table 5).

Utilizing the formula (6), the total-relation matrix for benefits is constituted (See Table 6). Then, using formulas (7)-(9) the impact diagraph map for benefits is acquired by mapping the dataset of (*D+R, D–R*) given in Fig. 5. The assigned threshold value for benefits is accepted to be 0.5.

Table 4: The initial direct-relation matrix for benefits.

	PE	CS	FP	LG
PE	0	2	3	2
CS	0	0	4	1
FP	3	2	0	3
LG	4	2	3	0

Source: Authors

Table 5: The normalized direct-relation matrix for benefits.

	PE	CS	FP	LG
PE	0	0.2	0.3	0.2
CS	0	0	0.4	0.1
FP	0.3	0.2	0	0.3
LG	0.4	0.2	0.3	0

Source: Authors

Table 6: The total-relation matrix for benefits.

	PE	CS	FP	LG	D	***D+R***	***D–R***
PE	0.519	0.607	0.888	0.631	2.645	5.346	−0.056
CS	0.423	0.336	0.798	0.458	2.014	4.328	−0.300
FP	0.822	0.662	0.737	0.752	2.972	6.431	−0.487
LG	0.938	0.709	1.036	0.569	3.252	5.662	0.843
R	2.701	2.314	3.459	2.409			

Source: Authors

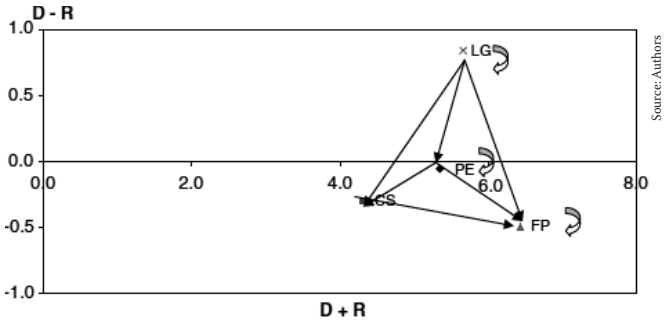


Figure 5: The impact-diagraph-map of total relation for benefits.

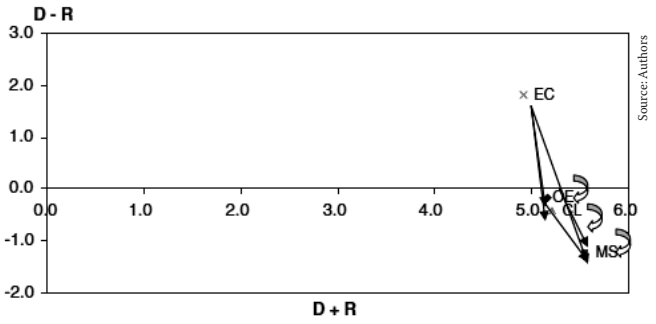


Figure 6: The impact-diagraph-map of total relation for opportunities.

It can be analyzed that under the factor of benefits, learning and growth has a higher impact than customer satisfaction and process excellence in applying the Six Sigma application. Learning and growth is the dispatcher whereas process excellence, customer satisfaction and financial performance are the receivers. Additionally, the close *D+R* values of benefit sub-factors confirm strong inner dependency between each other. Orderly, the inner dependency between the other factors opportunities, risks and costs are measured by applying exactly the same transaction processes given above. Based on the pairwise comparisons made for sub-factors of opportunities, the direct-relation matrix (see Table 7), the normalized direct-relation matrix (see Table 8) and the total-relation matrix (see Table 9) are formed. The assigned threshold value for opportunities is accepted to be 0.45. Placing the numerical values on the impact-diagraph-map for opportunities helps to visualize the inner dependencies clearer (see Fig. 6).

The following factor risks, is examined in three sub-factors budget overrun, dwell time and transportation plan related risks.

Table 7: The initial direct-relation matrix for opportunities.

	OE	MS	CL	EC
OE	0	3	2	2
MS	2	0	3	1
CL	2	4	0	1
EC	4	3	3	0

Source: Authors

Table 8: The normalized-relation matrix for opportunities.

	OE	MS	CL	EC
OE	0	0.3	0.2	0.2
MS	0.2	0	0.3	0.1
CL	0.2	0.4	0	0.1
EC	0.4	0.3	0.3	0

Source: Authors

Table 9: The total-relation matrix for opportunities.

	OE	MS	CL	EC	***D***	***D*** + ***R***	***D*** − ***R***
OE	0.492	0.861	0.693	0.454	2.500	5.163	−0.162
MS	0.583	0.550	0.684	0.340	2.157	5.548	−1.235
CL	0.628	0.900	0.505	0.366	2.399	5.215	−0.417
EC	0.960	1.080	0.934	0.393	3.367	4.920	1.814
R	2.663	3.391	2.816	1.553			

Source: Authors

Table 10: The initial direct-relation matrix for risks.

	BO	TD	PJ
BO	0	4	3
TD	4	0	2
PJ	3	3	0

Source: Authors

Table 11: The normalized direct-relation matrix for risks.

	BO	TD	PJ
BO	0	0.572	0.429
TD	0.572	0	0.286
PJ	0.429	0.429	0

Source: Authors

After running the similar operations step by step given formerly, derived from the pairwise comparisons made the direct-relation matrix (see Table 10), the normalized direct-relation matrix (see Table 11) and the total-relation matrix (see Table 12) for risks factor are obtained.

Table 12: The total-relation matrix for risks.

	BO	TD	PJ	***D***	***D*** + ***R***	***D*** − ***R***
BO	3.602	3.966	3.109	10.677	21.461	−0.107
TD	3.644	3.280	2.788	9.712	20.496	−1.072
PJ	3.538	3.538	2.529	9.605	18.031	1.179
R	10.784	10.784	8.426			

Source: Authors

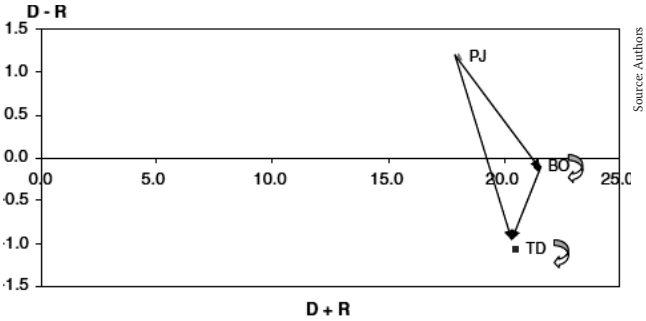


Figure 7: The impact-diagraph-map of total relation for risks.

Table 13: The initial direct-relation matrix for costs.

	CI	CT	HR
CI	0	0	0
CT	1	0	0
HR	0	0	0

Source: Authors

Table 14: The normalized direct-relation matrix for costs.

	CI	CT	HR
CI	0	0	0
CT	1	0	0
HR	0	0	0

Source: Authors

Table 15: The total-relation matrix for costs.

	CI	CT	HR	*D*	*D* + *R*	*D* − *R*
CI	0	0	0	0	1	−1
CT	1	0	0	1	1	1
HR	0	0	0	0	0	0
R	1	0	0			

Source: Authors

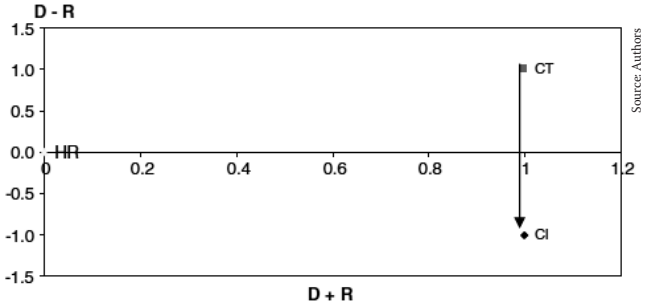


Figure 8: The impact-diagraph-map of total relation for costs.

The assigned threshold value for risks is agreed to be 2.8. Placing the numerical values on the impact-diagraph-map for risks (see Fig. 7) assists to envision the inner dependencies.

It can be observed that under the factor of risks, transportation plan related risks sub-factor has a higher impact than budget overrun and dwell time in applying Six Sigma. Transportation plan related risks prove to be the dispatcher; budget overrun and dwell time are the receivers. Moreover, the close *D+R* values for risks sub-factors verify the high inner dependency between each other.

The final factor costs, is also analyzed in three sub-factors given as cost of implementation, cost of training and cost of human resources. Operating the formulas (4)-(9) on the pairwise comparisons made for costs factor, the direct-relation matrix (see Table 13), the normalized direct-relation matrix (see Table 14) and the total-relation matrix (see Table 15) are formed.

Table 16: Inner dependence matrix for strategies.

	BE	RG	PR
BE	0.299	0.339	0.356
RG	0.357	0.300	0.345
PR	0.344	0.361	0.299

Source: Authors

Table 17: Inner dependence matrix for benefits

	PE	CS	FP	LG
PE	0.192	0.263	0.257	0.262
CS	0.156	0.145	0.231	0.190
FP	0.304	0.286	0.213	0.312
LG	0.347	0.306	0.299	0.236

Source: Authors

Table 18: Inner dependence matrix for opportunities

	OE	MS	CL	EC
OE	0.185	0.254	0.246	0.292
MS	0.219	0.162	0.243	0.219
CL	0.236	0.265	0.179	0.236
EC	0.361	0.318	0.332	0.253

Source: Authors

The assigned threshold value for costs is approved to be 1. The relationship between the sub-factors of costs is investigated considering the positioning of values on the impact-diagraph-map for costs (see Fig. 8). As seen on the diagraph-map of costs, the discrete *D+R* values of costs' sub-factors prove to have no inner dependency on each other. Cost of training seems to have a priority considering deployment of the Six Sigma transportation plans. It is observed to be the dispatcher and the other sub-factors cost of implementation and cost of human resources are the receivers.

After analyzing the relationships between factors and sub-factors by DEMATEL technique we can now regenerate and finalize our evaluation model for Six Sigma transportation plan selection. According to the results obtained, it is found out those strategies and the factors benefits, opportunities and risks show strong inner dependency as given in Fig. 9.

As a further step in the proposed decision making model, to combine ANP and DEMATEL we obtained the inner dependence matrix by normalizing the total-relation matrix which prove to have inner dependency.

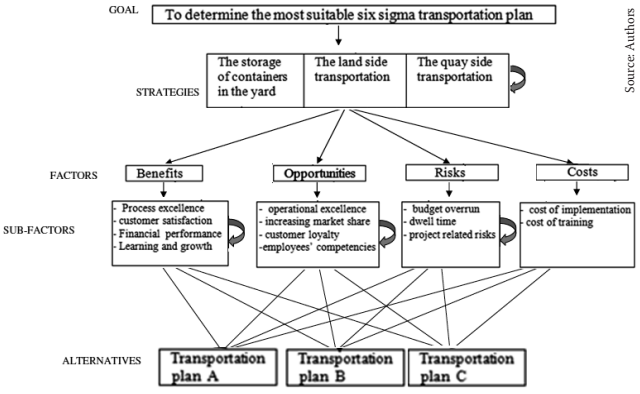


Figure 9: Final Six Sigma transportation plan evaluation model.

Table 19: Inner dependence matrix for risks.

	BO	TD	PJ
BO	0.0.334	0.368	0.369
TD	0.338	0.304	0.331
PJ	0.328	0.328	0.300

Source: Authors

Table 20: Pairwise comparison of strategy with respect to the goal.

Goal	BE	RG	PR	Weights
BE	1	1/2	3	0.300
RG	2	1	6	0.600
PR	1/3	1/6	1	0.100
CR				0.00013

Source: Authors

Table 21: Pairwise comparison of strategy with respect to revenue growth.

RG	BE	PR	Weights
BE	1	2	0.667
PR	1/2	1	0.333
CR			0

Source: Authors

According to the results and the given diagraph- maps of total relation matrix, strategies and the factors benefits, opportunities and risks have inner dependency. The normalized inner dependency matrix for strategies (see Table 16), benefits (see Table 17), opportunities (see Table 18) and risks (see Table 19) are directly utilized in unweighted supermatrix during ANP application.

5.2. Application of ANP

After determining the relationship structure with DEMATEL methodology, the ANP method is applied to calculate the weight of each criterion. Here again, the series of pairwise comparisons are evaluated with Saaty's 1-9 scale where 1 represents equal importance, while 9 represents extreme importance that favours one element over another. If the element has a weaker impact than its comparison element the scale ranges from 1 to 1/9 indicating indifference. This ANP model is solved using the Super Decisions software.

The consistency ratio (CR) values of obtained results are all acceptable and the eigenvectors displayed are ready to enter into the supermatrix. Such an example, the pairwise comparison of strategies with respect to the goal is given in Table 20, and in Table 21 the pairwise comparison of strategies with respect to revenue growth is given.

All pairwise comparison matrices are computed and given in the form of unweighted supermatrix as shown in Table 22. A weighted supermatrix is transformed first to be stochastic as shown in Table 23. After entering the normalized values into the supermatrix and completing the column stochastic, the supermatrix is then increased to sufficient large power until convergence occurs. Table 24 provides a final limit matrix. This limit matrix is column stochastic and represents the final eigenvector. According to obtained results, Transportation plan C, optimizing inventory, is the most effective Six Sigma transportation plan alternative. The second transportation plan alternative is improving the Transportation processes.

Table 22: The unweighted supermatrix.

	Goal	SY	LS	QS	B	O	R	C	PE	CS	FP	LG	OE	MS	CL	EC	BO	TD	PJ	CI	CT	HR	PA	PB	PC
Goal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SY	0.300	0.299	0.339	0.356	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LS	0.600	0.357	0.300	0.345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
QS	0.100	0.344	0.361	0.299	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PE	0	0	0	0	0.195	0	0	0	0.192	0.263	0.257	0.262	0	0	0	0	0	0	0	0	0	0	0	0	0
CS	0	0	0	0	0.231	0	0	0	0.156	0.145	0.231	0.190	0	0	0	0	0	0	0	0	0	0	0	0	0
FP	0	0	0	0	0.426	0	0	0	0.304	0.286	0.213	0.312	0	0	0	0	0	0	0	0	0	0	0	0	0
LG	0	0	0	0	0.148	0	0	0	0.347	0.306	0.299	0.236	0	0	0	0	0	0	0	0	0	0	0	0	0
OE	0	0	0	0	0	0.185	0	0	0	0	0	0	0.185	0.254	0.246	0.292	0	0	0	0	0	0	0	0	0
MS	0	0	0	0	0	0.370	0	0	0	0	0	0	0.219	0.162	0.243	0.219	0	0	0	0	0	0	0	0	0
CL	0	0	0	0	0	0.345	0	0	0	0	0	0	0.236	0.265	0.179	0.236	0	0	0	0	0	0	0	0	0
EC	0	0	0	0	0	0.100	0	0	0	0	0	0	0.361	0.318	0.332	0.253	0	0	0	0	0	0	0	0	0
BO	0	0	0	0	0	0	0.500	0	0	0	0	0	0	0	0	0	0.334	0.368	0.369	0	0	0	0	0	0
TD	0	0	0	0	0	0	0.250	0	0	0	0	0	0	0	0	0	0.338	0.304	0.331	0	0	0	0	0	0
PJ	0	0	0	0	0	0	0.250	0	0	0	0	0	0	0	0	0	0.328	0.328	0.300	0	0	0	0	0	0
CI	0	0	0	0	0	0	0	0.250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CT	0	0	0	0	0	0	0	0.250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HR	0	0	0	0	0	0	0	0.500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PA	0	0	0	0	0	0	0	0	0.400	0.250	0.297	0.400	0.500	0.297	0.250	0.400	0.216	0.286	0.400	0.286	0.433	0.300	0	0	0
PB	0	0	0	0	0	0	0	0	0.200	0.500	0.163	0.200	0.250	0.163	0.500	0.200	0.102	0.143	0.200	0.143	0.101	0.100	0	0	0
PC	0	0	0	0	0	0	0	0	0.400	0.250	0.540	0.400	0.250	0.540	0.250	0.400	0.682	0.572	0.400	0.571	0.466	0.600	0	0	0

Table 23: The weighted supermatrix.

	Goal	SY	LS	QS	B	O	R	C	PE	CS	FP	LG	OE	MS	CL	EC	BO	TD	PJ	CI	CT	HR	PA	PB	PC
Goal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SY	0.300	0.058	0.065	0.069	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LS	0.100	0.069	0.058	0.066	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
QS	0.600	0.069	0.069	0.058	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	0	0.282	0.282	0.282	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O	0	0.103	0.103	0.103	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R	0	0.160	0.160	0.160	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	0	0.263	0.263	0.263	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PE	0	0	0	0	0.195	0	0	0	0.096	0.132	0.129	0.131	0	0	0	0	0	0	0	0	0	0	0	0	0
CS	0	0	0	0	0.231	0	0	0	0.078	0.073	0.116	0.095	0	0	0	0	0	0	0	0	0	0	0	0	0
FP	0	0	0	0	0.426	0	0	0	0.152	0.143	0.106	0.156	0	0	0	0	0	0	0	0	0	0	0	0	0
LG	0	0	0	0	0.148	0	0	0	0.174	0.153	0.150	0.118	0	0	0	0	0	0	0	0	0	0	0	0	0
OE	0	0	0	0	0	0.185	0	0	0	0	0	0	0.092	0.127	0.123	0.146	0	0	0	0	0	0	0	0	0
MS	0	0	0	0	0	0.370	0	0	0	0	0	0	0.109	0.081	0.122	0.110	0	0	0	0	0	0	0	0	0
CL	0	0	0	0	0	0.345	0	0	0	0	0	0	0.118	0.133	0.090	0.118	0	0	0	0	0	0	0	0	0
EC	0	0	0	0	0	0.100	0	0	0	0	0	0	0.180	0.159	0.166	0.127	0	0	0	0	0	0	0	0	0
BO	0	0	0	0	0	0	0.500	0	0	0	0	0	0	0	0	0	0.167	0.184	0.185	0	0	0	0	0	0
TD	0	0	0	0	0	0	0.250	0	0	0	0	0	0	0	0	0	0.169	0.152	0.166	0	0	0	0	0	0
PJ	0	0	0	0	0	0	0.250	0	0	0	0	0	0	0	0	0	0.164	0.164	0.150	0	0	0	0	0	0
CI	0	0	0	0	0	0	0	0.250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CT	0	0	0	0	0	0	0	0.250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HR	0	0	0	0	0		0	0.500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PA	0	0	0	0	0	0	0	0	0.200	0.125	0.148	0.200	0.250	0.148	0.125	0.200	0.108	0.143	0.200	0.286	0.433	0.300	0	0	0
PB	0	0	0	0	0	0	0	0	0.100	0.250	0.082	0.100	0.125	0.082	0.250	0.100	0.051	0.071	0.100	0.143	0.101	0.100	0	0	0
PC	0	0	0	0	0	0	0	0	0.200	0.125	0.270	0.200	0.124	0.270	0.125	0.200	0.341	0.286	0.200	0.571	0.466	0.600	0	0	0

Table 24: The limit supermatrix.

	Goal	SY	LS	QS	B	O	R	C	PE	CS	FP	LG	OE	MS	CL	EC	BO	TD	PJ	CI	CT	HR	PA	PB	PC
Goal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
QS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PE	0.063	0.063	0.063	0.063	0.122	0	0	0	0.122	0.122	0.122	0.122	0	0	0	0	0	0	0	0	0	0	0	0	0
CS	0.048	0.048	0.048	0.048	0.092	0	0	0	0.092	0.092	0.092	0.092	0	0	0	0	0	0	0	0	0	0	0	0	0
FP	0.072	0.072	0.072	0.072	0.139	0	0	0	0.139	0.139	0.139	0.139	0	0	0	0	0	0	0	0	0	0	0	0	0
LG	0.076	0.076	0.076	0.076	0.147	0	0	0	0.147	0.147	0.147	0.147	0	0	0	0	0	0	0	0	0	0	0	0	0
OE	0.023	0.023	0.023	0.023	0	0.123	0	0	0	0	0	0	0.123	0.123	0.123	0.123	0	0	0	0	0	0	0	0	0
MS	0.020	0.020	0.020	0.020	0	0.106	0	0	0	0	0	0	0.106	0.106	0.106	0.106	0	0	0	0	0	0	0	0	0
CL	0.022	0.022	0.022	0.022	0	0.115	0	0	0	0	0	0	0.115	0.115	0.115	0.115	0	0	0	0	0	0	0	0	0
EC	0.029	0.029	0.029	0.029	0	0.156	0	0	0	0	0	0	0.156	0.156	0.156	0.156	0	0	0	0	0	0	0	0	0
BO	0.052	0.052	0.052	0.052	0	0	0.178	0	0	0	0	0	0	0	0	0	0.178	0.178	0.178	0	0	0	0	0	0
TD	0.048	0.048	0.048	0.048	0	0	0.162	0	0	0	0	0	0	0	0	0	0.162	0.162	0.162	0	0	0	0	0	0
PJ	0.047	0.047	0.047	0.047	0	0	0.160	0	0	0	0	0	0	0	0	0	0.160	0.160	0.160	0	0	0	0	0	0
CI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PA	0.167	0.167	0.167	0.167	0.172	0.184	0.149	0	0.172	0.172	0.172	0.172	0.184	0.184	0.184	0.184	0.149	0.149	0.149	0	0	0	0	0	0
PB	0.111	0.111	0.111	0.111	0.123	0.137	0.073	0	0.123	0.123	0.123	0.123	0.137	0.137	0.137	0.137	0.073	0.073	0.073	0	0	0	0	0	0
PC	0.222	0.222	0.222	0.222	0.206	0.179	0.278	0	0.206	0.206	0.206	0.206	0.179	0.179	0.179	0.179	0.278	0.278	0.278	0	0	0	0	0	0

6. Conclusions

Container terminals continuously seek ways to improve the quality of transportation processes and products and differentiate themselves from their competitors to raise customer satisfaction and revenues. Six Sigma is one of the methodologies utilized in the companies. This study aimed to combine two multi-criteria decision making methods, DEMATEL and ANP to effectively identify the most appropriate transportation plan alternative especially in container terminals.

Transportation scheme selection is a complex decision making system composed of goals and sun-systems to better judge differences and interactions which can be referred to a typical multiple decision making criteria application. DEMATEL and ANP techniques are both in conjunction to systematically construct an evaluation model for transportation plan selection. Utilizing only one of the techniques could be satisfactory in choosing the optimum plan; but integrating these two techniques as a combined MCDM approach is a wise option which can be regarded as a consolidated new tool considering inner dependency and weights of criteria. There might be some limitations in combining these two analytical approaches such as different assessment scales; but this non-unification can be improved.

As a result, it is worth to investigate cases and practices responsive to this combined approach.

After making a detailed literature survey and examining Six Sigma appliers' real life experiences, the criteria to be considered in Six Sigma transportation plan selection were determined, and an evaluation model was developed. To support and investigate the effectiveness of the proposed approach an empirical case study from logistics industry was used. It should be noted that an effective transportation plan selection method helps to ensure optimal resource utilization toward container terminal's missions and goals.

For future study, knowledge based or an expert system can be integrated to help decision-makers both make pair wise calculations more concisely, and interpret the results in each step of the DEMATEL and ANP.

Appendix. Pairwise comparison matrices

See tables A1-A19.

Table A1: Strategies with respect to goal.

Goal	SY	LS	QS	Weights
SY	1	1/2	3	0.300
LS	2	1	6	0.600
QS	1/3	1/6	1	0.100

Source: Authors

Table A2. Benefits' sub-factors with respect to benefits

B	PE	CS	FP	LG	Weights
PE	1	1	1/2	1	0.195
CS	1	1	1/2	2	0.231
FP	2	2	1	3	0.426
LG	1	1/2	1/3	1	0.148

Source: Authors

Table A3: Opportunities' sub-factors with respect to opportunities.

O	OE	MS	CL	EC	Weights
OE	1	1/2	1	2	0.185
MS	2	1	1	4	0.370
CL	2	1	1	3	0.345
EC	1/2	1/4	1/3	1	0.100

Source: Authors

Table A4: Risks' sub-factors with respect to risks.

R	BO	TD	PJ	Weights
BO	1	2	2	0.500
TD	1/2	1	1	0.250
PJ	1/2	1	1	0.250

Source: Authors

Table A5: Costs' sub-factors with respect to costs.

C	CI	CT	HR	Weights
CI	1	1	1/2	0.250
CT	1	1	1/2	0.250
HR	2	2	1	0.500

Source: Authors

Table A6: Transportation plan alternatives with respect to process excellence.

PE	A1	A2	A3	Weights
A1	1	2	1	0.400
A2	1/2	1	1/2	0.200
A3	1	2	1	0.400

Source: Authors.

Table A7: Transportation plan alternatives with respect to customer satisfaction.

CS	A1	A2	A3	Weights
A1	1	1/2	1	0.250
A2	2	1	2	0.500
A3	1	1/2	1	0.250

Source: Authors

Table A8. Transportation plan alternatives with respect to financial performance.

FP	A1	A2	A3	Weights
A1	1	2	1/2	0.297
A2	1/2	1	1/3	0.163
A3	2	3	1	0.540

Source: Authors

Table A9: Transportation plan alternatives with respect to learning and growth.

LG	A1	A2	A3	Weights
A1	1	2	1	0.400
A2	1/2	1	1/2	0.200
A3	1	2	1	0.400

Source: Authors

Table A10: Transportation plan alternatives with respect to operational excellence.

OE	A1	A2	A3	Weights
A1	1	2	2	0.500
A2	1/2	1	1	0.250
A3	1/2	1	1	0.250

Source: Authors

Table A11: Transportation plan alternatives with respect to market share.

MS	A1	A2	A3	Weights
A1	1	2	1/2	0.297
A2	1/2	1	1/3	0.163
A3	2	3	1	0.540

Source: Authors

Table A12: Transportation plan alternatives with respect to customer loyalty.

CL	A1	A2	A3	Weights
A1	1	1/2	1	0.250
A2	2	1	2	0.500
A3	1	1/2	1	0.250

Source: Authors

Table A13: Transportation plan alternatives with respect to employees' competencies.

EC	A1	A2	A3	Weights
A1	1	2	1	0.400
A2	1/2	1	1/2	0.200
A3	1	2	1	0.400

Source: Authors

Table A14: Transportation plan alternatives with respect to budget overrun.

BO	A1	A2	A3	Weights
A1	1	2	1/3	0.216
A2	1/2	1	1/7	0.102
A3	3	7	1	0.682

Source: Authors

Table A15: Transportation plan alternatives with respect to dwell time.

TD	A1	A2	A3	Weights
A1	1	2	1/2	0.286
A2	1/2	1	1/4	0.143
A3	2	4	1	0.572

Source: Authors

Table A16: Transportation plan alternatives with respect to transportation plan related.

PJ	A1	A2	A3	Weights
A1	1	2	1	0.400
A2	1/2	1	1/2	0.200
A3	1	2	1	0.400

Source: Authors

Table A17: Transportation plan alternatives with respect to cost of implementation.

CI	A1	A2	A3	Weights
A1	1	2	1/2	0.286
A2	1/2	1	1/4	0.143
A3	2	4	1	0.571

Source: Authors

Table A18: Transportation plan alternatives with respect to cost of training.

CT	A1	A2	A3	Weights
A1	1	4	1	0.433
A2	¼	1	1/5	0.101
A3	1	5	1	0.466

Source: Authors

Table A19: Transportation plan alternatives with respect to cost of human resources.

HR	A1	A2	A3	Weights
A1	1	3	1/2	0.300
A2	1/3	1	1/6	0.100
A3	2	6	1	0.600

Source: Authors

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Juridical Regime of Pilotage's Service in Spain

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ABSTRACT

Pilotage is a technical-nautical port service that is configured as a service of general economic interest. The provision of this service port corresponds to private individuals after obtaining a license, which may only be obtained by competitive bidding in accordance with the "special specifications" in each case approved by the respective Port Authority.

The patrimonial liability of the Spanish Maritime Administration is directly and secondarily excluded, except in cases where for lack of offer has to support direct management Port Authority (Administration) or for those other cases that must be a pilotage service, this had not provided by the Port Authority.

1. Evolution of port services

The Spanish Law 27/1992 of Ports and Merchant Marine (hereafter LPMM), regulated port services of the ports of general interest (for ports managed by the Spanish State). The important thing at the organizational level of the LPMM was establishing public ownership of port services and consideration of genuine public services whose provision was entrusted to the respective Port Authorities. The rendering was done through direct management by the Port Authority or by indirect management. This Law attributed to the Port Authority the ownership, management, provision of port services and maritime signaling (Acero, 2002; Menéndez, 1996; Navajas, 2000).

The legal framework for the provision of services was the Private Law. The legal relationship between the provider and the receiver of the port service was a private legal relationship. Some authors define this situation as a escape of Administrative Law in the provision of public services to achieve greater efficiency example, the previous regime was fastened to Public Law (Menéndez, 1996; Pérez, 2003).

1.1. From public service to service economic interest

With Law 48/2003 of Economic System and Provision of Services in the Ports of General Interest (hereafter LPSP), a new legal concept of port services based on a system of services liberalization, in order to achieve was introduced greater economic competitiveness that benefit the end user (Arroyo, 2004; Horgué, 2007). This law carried out a "advance transposition" of the Directive of the European Parliament and of the Council on market access for port services. This proposal was not adopted by the EEC, but served the Spanish Administration as an excuse to introduce measures to liberalize port services in Spain. This Act applies to the ports of general interest. Curiously, the posterior Directive 2006/11/EEC on services, expressly excluded from its scope of application Article 2, to transport services, including port services.

The highlights that introduced the LPSP, has been the liberalization or privatization of port services to subsidiarity. The State through the Port Authorities, no longer retains ownership of port services. These services pass paid in free competition over the ownership and management to the private sector under the criteria of efficiency and profitability (Arroyo, 2004). Exception of general services in which ownership and management remain relevant to the Port Authorities. Thus, port services are defined as services of general economic interest (Laguna, 2009). Namely, activities or services for its im-

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pact on the lives of people or services are heavily regulated and controlled by public authorities subject to are provided by individual subjects (Cubero, 2011).

Liberalization creates free access to the realization of port services by companies that comply with requirements and requirements established by the Port Authority, which granted a license to lend (Ariño, 2004). This model attempt to guarantee that any private individual can acquire the status of port services provider, subordinating the acquisition of such license status by meeting the requirements set by the Port Authority. These requirements are set out in the Act and the corresponding "particular specification requirements" of the corresponding service.

The Law 33/2010 deepened the liberalization of port services (Trias, 2011), despite the initial draft of 2009 recuperating public ownership of port services through indirect management. A report of the Commission on Defense of Competition of 25 February 2009 on this draft, did give up that possibility and caused a total change, keeping the system of liberalization set in LPSP. All above rules have been repealed by Royal Legislative Decree 2/2011 of 5 September, approving the revised text of the Law on State Ports and Merchant Marine (hereafter TRPMM) is approved. This text has not changed substantially regulation and standards set by its predecessors. Its adoption has established a coherent and unified regulatory body. The TRPMM regulates within its extensive articulated, providing comprehensive services and port services.

The port activity will develop in a framework of free and fair competition between service operators at the ports of general interest. Applies to State Ports promote competition in the entire port system and the Port Authority in their own territorial and functional areas. The freedom of access to the provision of services in the ports of general interest is also recognized.

1.2. Types of port services

Amongst the various port services, TRPMM defines the general services that are common services that benefit port users without the need for request. It also covers services that are necessary for the performance of the functions of Port Authorities (Pérez, 2003). Corresponds the provision of general services to the Port Authorities that are entitled to these services. We can assert that this is strictly public service to be rendered without any financial compensation by the port authorities in each of the ports of general interest. In these cases, we find that public ownership and management is, in some cases, directly or indirectly through the corresponding management contract.

Port services are:

— The service of organization, coordination and control of port traffic, both maritime and terrestrial.
— The service of coordination and control of the operations associated with the port, commercial services and other activities.
— The services of signage buoying and other navigational aids (nautical engineering) serving approach and access the ship in port.
— The police service in public areas (without prejudice to the competencies that correspond to other authorities).
— The service lighting public areas.
— The cleaning of the common areas of land and water. Not included in this service spring cleaning and concourses as a result of reservoir operations and handling of goods, or spills and discharges of marine pollutants.
— The prevention and emergency control, in the terms established by the legislation on civil protection, in cooperation with the competent authorities on civil protection, prevention and firefighting, rescue and pollution prevention. This service must be coordinated both Safety and Security (IMO, 2013; Martínez M., 2009).

Port services " strictu sensu" are services, which were traditionally owned, and public management legislative developments but have become privately owned services that are offered like any other service in conditions of free competition within the port and are subject a license to the Port Authority.

The TRPMM distinguishes between so-called port services (Article 108) the services' technical-nautical "(Zurutuza 2010)

— Pilotage Service (Figure 1).
— Service port towing.
— Service huggers.
— Passenger service, which includes: Boarding and disem-

Source: Capt. Antonio Cuesta, Pilot of Santander´s Port.

Figure 1: Pilots' boat of Corporation of Santander Port.

barking passengers, loading and unloading baggage and vehicles with passengers.
— Reception facilities for ship-generated waste, including: Receipt of waste and residues of Annex I and/or Annex IV and/or Annex V and/or Annex VI of MARPOL 73/78.

Service handling of goods, consisting of: Loading, unloading, stowage, unstowage, maritime transit and transshipment of goods.

Although it is a service provided by private subjects in concurrence and in a limited space, the granting of licenses to operators must take into consideration all the proper principles of public service in its service provision are: Safety, efficiency, regularity, continuity and non-discrimination.

Can occur the case that in a port do not exist companies willing to provide these services (and unable to ensure the abovementioned principles of regularity and continuity) the need to perform the Port Authority of the port, either directly or indirectly, is where the principle of subsidiarity. This is the case where the licenses issued can not meet the entire demand in the port with the quality indicators in the statement required individual service requirements. The TRPMM provides for this possibility (exceptionally), Port Authority will have to provide a favorable report.

2. Legal status of the Spanish Pilotage Service

The pilotage service is advising masters of vessels and floating structures (IMO, 2010; Osante, 2006; Pérez, 2000, 2002; Zurutuza, 2010) to facilitate the entry and exit port and the nautical maneuvers necessary within the geographical boundaries of the pilotage area ensuring the security (IMO, 2013; Martínez M., 2009; Zurutuza, 2010).

2.1. Definitions & concepts.

The present definition of pilotage service is in the Article 126 of the Law TRPMM (derived from the LPSP 48/2003) after the reform by Law 33/2010 (Trias, 2011). This definition eliminated the reference to as' assisted pilotage "linking" service "from the first radio contact with the pilot station. Now the pilotage service, is limited to advice provided by the convenient but on board ships. Conversely, various maritime specialists (Zurutuza, 2010) say that the service includes the instructions and has' just wanted to lighten the definition missing something that is obvious and can determine the start of the responsibility of the pilot.

2.2. Legal Status

The Law TRPMM has been to simplify into a single text articulated, in particular Articles 126, 279, 280 and 281. It is necessary to emphasize the force of Royal Decree 393/1996, amending the General Pilotage Regulations and Resolution of October 11, 2006 State Ports amending General terms and conditions approved by the Service approves Pilotage. The Particular Specification requirements for each port service must be approved by each Port Authority prior binding report of the State Ports. Therefore, there will be many "special requirements specifications" for each port service as Port Authorities exist in Spain. At present there are twenty-eight in Spain Port Authorities in eleven regions. These Port Authorities managed forty-six commercial ports and feature fifty-three corporations are shown in Tables practical 1-11.

Table 1: Corporations Pilots of Andalucía.

Andalucía	**9 Corporations**
Puerto de Tarifa, S.L.P.U.	
Puerto de Sevilla y Ría del Guadalquivir, S.L.P.	
Puerto de Motril	
Puerto de Málaga, S.L.P.	
Puerto y Ría de Huelva, S.L.P.	
Puerto Garrucha-Carboneras, S.L.P.	
Cádiz, S.L.P.	
Puerto de Almería, S.L.P.	
Bahía de Algeciras, S.L.P.	

Source: Authors.

Table 2: Corporations Pilots of Asturias.

Asturias	**2 Corporations**
Puerto de Gijón, S.L.P.	
Puerto y Ría de Avilés, S.L.P.	

Source: Authors.

Table 3: Corporations Pilots of Canarias.

Canarias	**9 Corporations**
Cementos Especiales de Las Islas, S.A. (Arguineguín) (Las Palmas de Gran Canaria)	
El Hierro, S.L.P.	
Puertos de Tenerife, S.L.P.	
Santa Cruz de La Palma	
La Gomera, S.L.	
Fuerteventura, S.L.P.	
Puerto de Los Cristianos, S.L.P. (Tenerife)	
Puerto de La Luz y Las Palmas, S.C.P.	
Puerto de Arrecife, S.L.P.	

Source: Authors.

Table 4: Corporation Pilots of Cantabria.

Cantabria	**1 Corporation**
Puerto de Santander, S.L.P.	

Source: Authors.

Table 5: Corporations Pilots of Cataluña.

Cataluña	**5 Corporations**
Ports de Vilanova i Vallcarca, SLP	
Puerto de Tarragona, S.L.P.	
Puerto de Palamós	
Puerto Alfaques y Rada de Alcanar	
Puerto de Barcelona, S.L.P.	

Source: Authors.

Table 6: Corporations Pilots of Ceuta and Melilla.

Ceuta and Melilla	2 Corporations
Puerto de Melilla, S.L.P.	
Puerto de Ceuta, S.L.P.	

Source: Authors.

Table 7: Corporations Pilots of Galicia.

Galicia	9 Corporations
PorAlumina Española S.A. - Puerto Privado	
Prácticos Vivero, S.L.P. (Lugo)	
Puerto de Villagarcía y Ría de Arosa, S.L.P.	
Puerto y Ría de Vigo, S.L.P.	
Ría de Ribadeo, S.L.P.U.	
Puerto de Marín y Ría de Pontevedra, S.L.P.	
Coruña Pilots, S.L.P.	
Puerto y Ría de Ferrol, S.L.P.	
Corcubión Sada Laxe, S.L.P.	

Source: Authors.

Table 8: Corporations Pilots of Islas Baleares.

Islas Baleares	4 Corporations
Puerto de Palma, S.L.P.	
Mahón, S.L.P.	
Puerto de Ibiza, S.L.P.	
Prácticos de Alcudia	

Source: Authors.

Table 9: Corporation Pilots of Murcia.

Murcia	1 Corporation
Puerto de Cartagena	

Source: Authors.

Table 10: Corporations Pilots of País Vasco.

País Vasco	3 Corporations
Puerto Pasajes, S.L.P.	
Puerto y Ría de Bilbao, S.L.P.	
Puerto de Bermeo-Mundaka	

Source: Authors.

Table 11: Corporations Pilots of Valencia.

Valencia	8 Corporations
BP OIL Refinería de Castellón, S.A. (Private Port).	
Puerto de Sagunto, S.L.P.	
Valencia, S.L.P.	
Puerto de Torrevieja, S.L.	
Gandía, S.L.	
Denia, S.L.P.	
Puerto de Castellón/Burriana, S.L.P.	
Puerto de Alicante, S.L.P.	

Source: Authors.

In spite of the liberalization and privatization in the delivery of port pilotage, the Administration keeps public powers of the activity. These skills are:

- Determination of the need for pilotage service and, if non-mandatory use and the technical conditions with which service should be provided.
- Determination of minimum requirements and professional qualifications to be met by applicants Practical as well as the establishment and implementation of accurate tests for the recognition of training to provide pilotage services in a port or group of ports.
- The determination of the conditions for lifelong learning (IMO, 2010, Martínez M., Eguren; Martínez, 2012) and recycling of Pilots. Proficiency tests that must pass the Pilots at any time to check their technical skills and physical fitness.
- Carrying out the operations of pilotage in acceptable conditions of maritime safety (Safety and Security) (IMO, 2013).
- The precautionary suspension of accreditation of a Pilot for safety or security requirements in the pilotage service.

2.3. Obligation in the provision of pilotage and exceptions

The pilotage service is a service that is performed by the request of the receiver. This request is obligatory (is determined by the Maritime Administration of the port) for input and output port of the vessels as well as for nautical maneuvers in port. The pilotage is compulsory reception or request.

The previous Law 33/2010, introduced a number of exceptions to compulsory pilotage service reception, which already provided previously in other regulations. They are not obliged to accept Pilotage Service: Vessels and vessels serving the Port Authority, for use in the execution of works in the port public domain, for the fueling and provisioning of vessels, for the provision of port services (same port) and those who are in support of other government (which have their base in the port) and vessels whose master has exercised (even interim) as Pilot at the port in question, or if this Pilot has passed the tests of theoretical and practical qualification at that port. The current Ministerial Order 1621/2002 of the Ministry of Public Works and Transport was already regulating the conditions relating to the granting of exemptions from Pilotage Service. In Figure 2, a pilot going up on board a merchant entering port.

2.4. Issuing of the license: Public tender

The provision of pilotage service in a port of the public interest requires obtaining a license. This license is awarded by the Port Authority of the port, subject to the provisions of TRPMM in the regulatory specifications and particular requirements. The license for the provision of pilotage service is specific. The term of this license shall be determined by the Port Authority on the "particular requirements" and may not exceed 10 years as planned (Article 114.1.a. TRPMM). The licenses for the provision of pilotage service, may not be re-

Source: Capt. Eva Mª Muller.

Figure 2: Pilot on board.

Source: Capt. Antonio Cuesta.

Figure 3: Pilotage, a complicated and dangerous nautical engineering work.

newed. For licensure Pilotage Service will require the applicant demonstrates a number of conditions, including: economic, technical and professional solvency in the service.

As a requirement of professional capacity, the applicant must demonstrate that the service will be performed for pilots duly authorized by the Maritime Administration, appointed by the Port Authority and belong to a professional association, in accordance with current regulations. In Figure 3, the daily work, all year at any hour of a pilot.

In the case of pilotage service, we find with a service that is given by a private and service subject under license. Due to a limited number of providers to a single provider, the granting of the license in each port area must be granted by competition (Art.126.3 TRPMM) prior preparation and adoption of the particular specification requirements for each contests by each Port Authority. The particular specifications shall contain the requirements to participate in the contest, the information and documentation to be provided by the applicant and the award criteria that must be objective and non-discriminatory. Regardless of what the natural or legal person to be granted a license to provide the service on a particular port area, anyone is free to turn to the evidence presented in each case the Maritime Administration to perform obtain the so-called " qualification" as pilot. In this sense TRPMM (Art.126.4.b) establishes the possibility that the company providing the service port may be required by the Port Authority to assist in the discussion of test pilot for preparing aspirants of that empowerment. This qualification does not carry the right to practice as a Pilot on a given port, but to be able to provide such services as convenient as long as the service provider in a particular port area counts it for him. In each port area is the Maritime Administration determines the required number of pilots who have to have every service provider.

2.5. Impossibility of self-provision and incompatibilities

The guarantee of safety at sea (IMO, 2013) in the pilotage service generates positions contrary to privatization and defends their positions particularized treatment. Although the incorporation of the private sector in the provision of such service (Osante Martin, 2006) is accepted, the Workshop has responsibility to the Port Authority and this danger if competitive services to different groups change time slots are installed . The system designed after the MMPA, and now back LPSP contained in TRPMM does not detract in any maritime port security (IMO, 2013) because it has not brought freedom of establishment to provide this service.

The current reality of Spanish ports has expressed the absence of incorporation of the private sector in the provision of port services. We find the maintenance of traditional Port Authority contracts with a single provider for each port services (Osante Martin, 2006). In spite of the theoretical allocation pilotage service to the private sector after the LPSP, the reality is that at present the pilotage service continues to be provided under indirect management through contracts between the Corporation of Pilots and Port Authorities (Zurutuza, 2010).

Despite the asserted liberalization and competition in the provision of port services, pilotage service, due to its character of virtual monopoly (in service provision within a port) only admits the existence of a single provider. In the case of port services and particularly in the pilotage service (the prior authorization check) means the recognition of special rights. As defined Law TRPMM (Article 126.3), due to the uniqueness and special emphasis Pilotage Service in maritime safety, the number of service providers is limited to a single provider in each port area defined. This is done based on the criterion of maximum security (IMO, 2013). Thus the port area sets a single license.

In the case of pilotage service, the scope for competition is limited by its very structure, configuration and technical requirements (IMO, 2010). The number of possible operators in a port is limited or possible only through a single operator making it virtually impossible to enter the competition in the provision of service (Esteve, 2007). The granting of the license for the provision of port pilotage service will precede the competition. The competence and concurrence will be reflected in the preliminary contest, not in terms of effective service delivery. In these cases, the principles of openness, transparency and the granting of authorizations based on objective, proportionate and reasonable criteria are necessary to ensure that the choice of the most suitable for the activity in question (Laguna, 2009). In these cases, the licenses for the provision of port services obviously lose their regulated so you should ensure that these principles are respected character.

This is not a service which to be provided under concession or indirect management is an activity subject to the delivery of prefetching a license, as well as for the delivery of other port services. Not applicable the license renewal for the provision of port pilotage, being a port service providers whose number is limited to only one port area.

In spite of the generally expected TRPMM of its Article 109.2 "in fine" the possibility that the Port Authorities may grant licenses for self-provision and integration of port services, pilotage service is expressly excluded from this possibility, not being able authorize the system of self-provision (Art.135.2 TRPMM). The holder of the license pilotage in the same area port cannot perform other technical-nautical services, such as the harbor towage and mooring services. The Law forbids stating that the holder of a license for the provision of port pilotage shall not engage, by itself or through natural or legal persons lodged in the capital or management companies authorized to provide technical-nautical any other service on the same port.

2.6. Public service obligations in Pilotage Service

Pilotage is essential for the port traffic to develop properly and therefore should be given on a regular and continuous that is what has always characterized utilities. The pilotage service despite not configured at present as a public service in the strict sense, like other technical-nautical port services must be provided on a regular, continuous, and must be operational twenty four hours a day for all day of the year, except in cases of force majeure, and under the conditions established by the Private Prescriptions. The holder of the pilotage service should provide its service to every user on request provided they have been authorized by the Port Authority for docking, undocking and mooring and do non-discriminatory.

This category of the public service obligations means the government intervention for securing the service provided by private operators. This requirement stems from the transfer to the private area of public law (Esteve, 2007).

The Law TRPMM enumerates the public service obligations to be met by all providers of these services. Thus, Article 110 of the Law TRPMM provides as obligations the universal coverage, continuity and regularity, cooperation with the Port Authority and the Maritime Administration among others (Laguna, 2009).

2.8. Subsidiarity of the Port Authority in the service

The holder of the license granted by the Port Authority borrows the pilotage service in private legal regime. Given the possibility that anyone would contest the granting of the license will be the Port Authority (Martínez M., 2009) which has to bear either directly or indirectly provide the service with the obligations described above (Article 109.3 TRPMM). The legal implications that may result from the relationship between provider, Public Administration and the service receiver may be different on patrimonial responsibility.

3. Regime of liability

The LPSP with the privatization of the Pilotage Service provides a legal and contractual relationship between the provider of pilotage service and the user of the service is strictly private. It is a service contract and therefore damages arising from the service will be under the Civil law. Jurisdiction is the ordinary and Management subsidiary cannot be held responsible for damage caused by pilots during the execution of their tasks (Osante, 2006; Zurutuza, 2010).

In advance of the Law LPMM of 1992 was official and the practical management of pilotage service was a direct management of this public service from the Port Authority. Damage due to normal or abnormal operation of that service was attributable to the Administration (Zurutuza, 2010).

The TRPMM establishes (Article 113.8.b.) that the Bidding Particular requirements will regulate the liability of the supplier. The liability for damages resulting from the provision of pilotage service provided for in the Article 24.2 of Royal Decree 393/1996 of 1 March, the General Pilotage Regulations approved. If the accident was the fault of the captain's failure to follow instructions handy, or do carelessly, shall be the sole responsibility of the captain and his shipowner.

In another sense, if the fault of the accident was of the pilot, it would be the responsibility of the Pilot and Pilotage Service. In the event that the damages are attributable exclusively to the deficient or inaccurate provision of pilotage service, which obviously would have to prove, is still even considering the possible existence of subsidiary patrimonial liability the Port Authority

4. Conclusions

1st. Pilotage Service has stopped being a public service to happen to be a service of general economic interest in which the Port Authorities is limited solely to regulate the service and control the adequacy and appropriateness of the provider.

2nd. The juridical relationship between the service provider and user of the private is a legal relationship, a contract for

services responds whose failure or damage the service provider, not the supervisory Administration.

3rd. The Administration has no subsidiarity have to deal with the damage caused by a regulated activity. The Administration acts like supervisory mere subjects that provide a service.

4rd. In the cases in which the pilotage service is not given, being necessary this service and a damage occurred, would be patrimonial liability the Spanish Maritime Administration

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