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Preface

Since 1987, the Naval Architecture and Marine Engineering branch of the Portuguese Association of Engineers (Ordem dos Engenheiros) and the Centre for Marine Technology and Ocean Engineering (CENTEC) of the Instituto Superior Técnico (IST), University of Lisbon, have been organizing national conferences on Naval Architecture and Marine Engineering. Initially, they were organised annually and later became biannual events.

These meetings had the objective of bringing together Portuguese professionals giving them an opportunity to present and discuss the ongoing technical activities. The meetings have been typically attended by 150 to 200 participants and the number of papers presented at each meeting was in the order of 30 in the beginning and 50 at later events.

At the same time as the Conferences have become more mature, the international contacts have also increased and the industry became more international in such a way that the fact that the Conference was in Portuguese started to hinder its further development with wider participation. Therefore, a decision was made to experiment with having also papers in English, mixed with the usual papers in Portuguese. This was first implemented in the First International Conference of Maritime Technology and Engineering (MARTECH 2011), which was organized in the same year as Instituto Superior Técnico completed 100 years, with the presentation of 90 papers. In the Second International Conference of Maritime Technology and Engineering (MARTECH 2014), approximately 150 papers were accepted and compiled in a book, representing thus a substantial increase in the scope and depth of the Conference.

In this Third International Conference of Maritime Technology and Engineering (MARTECH 2016), around 230 abstracts have been received and approximately 150 papers were finally accepted, numbers which show the widespread interest that this Conference continues to raise.

The Scientific Committee has played a major role in the review process of the papers although several other anonymous reviewers have also contributed and deserve our thanks for the detailed comments provided to the authors, allowing them to improve their papers. Participants come from research and industry sectors and from almost every continent, which is also a demonstration of the wide geographical reach of the Conference.

The contents of the present books are organized in the main subject areas corresponding to the sessions at the Conference and within each group the papers are listed by the alphabetic order of the authors.

We want to thank all contributors for their efforts and we hope that this Conference will be continued and improved in the future.

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Conceptual design of a Vessel Traffic System

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ABSTRACT: The design of a VTS (Vessel Traffic System) is characterized by being very complex because it involves a wide range of user profiles and thus several sub-systems must be designed and integrated in order to meet all of the customer needs in a secure and efficient. This paper discusses briefly the main stages and care necessary so that the conceptual design of a VTS may display such characteristics. The methodology used in this case consists of the analysis of each sub-system in the light of the rules and recommendations of the IMO (International Maritime Organization) and the IALA (International Association of Lighthouse Authorities) in order to ensure project quality. At the end will be also discussed the ongoing project in the Department of Naval Architecture and Ocean Engineering, University of São Paulo, funded by FINEP – (Financier of Studies and Projects) and entitled "Projeto VTS".

1 INTRODUCTION

This work deals with the study for the development of the conceptual design of a VTS (Vessel Traffic System) in Brazil. The main point is that this project will focus in the most demmanding necessities and the characteristics of Brasilian ports. VTS, VTMS or VTMIS are also acronyms used for designation of port traffic control systems. Regulatory agencies often refer to these systems as VTS. The distinction in nomenclature tries to differentiate the level of automation implemented in the system that have direct relation with the characteristics of the port where it will be deployed and also with the services that will be provided by the system.

When the acronyms VTMS and VTMIS are used, the terms "Management" & "Information" are added to the original acronym. In this paper it will only be adopted the acronym VTS.

According to (SOLAS, 2004), the functions of a VTS contribute to: the safety of life at sea, safety and efficiency of navigation, protection of the marine environment, adjacent coastal areas, workplaces and offshore installations that can affect the maritime traffic. In addition, VTSs strengthen supervision and the compliance with laws and maritime regulations.

To achieve these goals, a VTS system gathers information from a variety of sensors and sources of information, treats such data and provides a view of the status of all port traffic, in real time, to the control center. In the command center, operators have access to the image of the entire harbor and ships traveling in it. Such information is usually crossed with the closed loop system of TV cameras (CCTV) of the port, providing access to real-time information of any ship in the port area. In this way operators can provide information to users so that they can make quick and conscious decisions.

Several services can be offered by VTSs. The information collected and stored can be treated with the use of optimization and heuristic methods that will make the system much more powerful and able to assist in the process of decision-making. The use of computer systems for traffic organization in a port can greatly increase the performance of terminals, reducing queues and maximizing the speed of traffic in the access channels.

Even without the use of advanced computational optimizations, the VTS increase the capacity of ports that are installed. The use of VTS allows the operation of the port in more extreme weather conditions with greater intensity and speed of operation without increasing the risk of accident for vessels.

The VTSs increase the cargo handling capacity mainly for two reasons: They optimize the use of existing infrastructure and reduce the number of accidents. This is possible because, unlike other traffic control tools, the VTS is an active control system, allowing the team of operators interact and influence the decision-making process on board vessels.

This evolution in the port control system was necessary due to the increasing size of ships and the increased port activity.

The perceived need for such aid to navigation became clear after World War II. It was noticed that the port capacity was not being used to its full potential only using audio-visual aids of short reach, especially in low visibility and high traffic intensity situations.

Thus, in 1948 the first radar base for controlling ports, was installed. At that time the VTSs, yet very simple, were not regulated. It was only in 1968 that

VTSs gave the next important step for their dissemination. This year the IMO approved the document A.158 recommending the installation of such a system.

In 1985, the foundation for the modern guidelines for design and implementation of VTSs were set. The recommendation A.578 (14) was approved by IMO, which was later updated, in 1997, for the recommendation A.857 (20). This document is the main guide of policies and regulations for VTSs, including being the basis of most other guidelines on VTS, as those issued by IALA.

The IALA ("International Association of Lighthouse Authorities") is associated with the development of VTSs since they began to be used. In order to organize the efforts that were being made to improve these systems, in 1980 the IALA created the VTS committee. This committee aims to coordinate international efforts in the VTS area, to study the influence of VTSs in port signaling systems, collecting information about existing systems and develop studies about the harmonization of operational procedures.

The VTS Committee is the main forum for discussion of developments in the area. It meets every six months, divided into groups dedicated to each of the areas of interest of a VTS:

- Operating VTS
- Technical developments
- Information Management
- Personnel Management
- Personal training

The use of computational optimization can be observed in VTSs. The advantage of using such tools is quite evident since the majority of maritime accidents are caused by human error (IALA, 2012d).

On top of this, VTSs can play a coastal surveillance tool function. In this regard the authorities responsible for the installation of the VTS may have two interests in mind: ecological preservation of an area or control of the coastal traffic in areas of strategic importance in order to ensure national security.

In the environmental area, the VTSs are excellent tools because they allow preventing the passage of ships on critical areas, as well as oversee activities such as illegal dumping of waste fishing, unauthorized tourism and any other sort of improper use of the maritime heritage. Finally, VTSs are effective in detecting and aid in the event of oil leakage.

In the exposed areas, another advantage obtained from its installation consists of using a database. Grouped information can serve allied agencies in order to improve the services offered by the port as well as their safety. Immigration, ship owners and pilotage are examples of entities that can benefit from access to information stored by VTSs.

2 LITERATURE REVIEW

On the subject discussed here, since it will only explore the steps that must be followed for developing the conceptual design of a VTS, the state of the art lies in the documentation published by the following international organizations: IMO (International Maritime Organization) and IALA (International Association of Lighthouse Authorities).

In this regard the following documents published by the organizations mentioned above were reviewed:

IALA. Vessel Trafic Services Manual. [S.l.]: IALA, 2012. IALA. Recommendation V-127 On Operational Procedures For Vessel Traffic Services. [S.l.]: IALA, 2011. IMO. Resolution A,857(20) Guidelines For Vessel Traffic Services. [S.l.]: IMO, 1997. SOLAS. International Convention For the Safety of Life at Sea. [S.l.], 2004. IALA. Recommendation V-128 On Operational And Technical Performance Requirements For VTS Equipment. [S.l.]: IALA, 2007. These documents supported the development of this paper.

3 SCOPE

This paper will focus its efforts in the conceptual design of a VTS to be implemented in Brazil that does not have anyone installed in the country yet. Like any complex system, the design and implementation of a VTS involve several areas of study, detailed knowledge of matters that vary according to the laws, rules and regulations of local and international entities, including decision-making and the definition of communication protocols and Security to be used in the system.

The detailed study of each of the areas involved in the project is vital and can determine the success of this project. The main areas involved in the conceptual project of a VTS are:

- Offered services
- Legislation
- Risk analysis
- Quality
- Equipment (Technologies to be used)
- Computing Resources
- Port Planning
- Construction
- Management

Thus, this work does not intend to deal with a VTS project subject exhaustively, since a detailed analysis of each of the areas involved should be made to accomplish such a task. The goal is to then present qualitative guidelines of the conceptual part of the project, so that in the end, the given system follows the standards set by the IMO and by IALA and are therefore in line with international standards. It will also be described how the idea of developing the conceptual design of a VTS at the University of São Paulo, funded by FINEP (Financier of Studies and Projects) as well as a brief description will be made of how this project is being developed to be used in Brazil.

4 THE SCENARIO IN BRAZIL

With the growth of the Brazilian economy observed in recent years and, subsequently, the increase in

imports and exports, the most requested ports are reaching their maximum charge level and yet Brazil has no Public or Private Port with a VTS installed and operational. Motivated by the immediate need for increased cargo handling, some Brazilian ports have begun to seek solutions in the VTS area, (CODESP, 2013) and (CODESA, 2014).

The Brazilian Government, through the Special Secretariat of Ports, has been discussing for some time the need for implanting of VTSs at the National Public Ports, grounded by the known and extremely necessary objectives of increasing efficiency and security. In 2013, for example, it launched the first call for the bidding contest of the VTS to the Port of Santos (www.portosdobrasil.gov.br/destaques/noticias-2013/maio/governo-federal-edital-do-sistema-de-monitoramento-do-trafego-de-embarcacoes-vtmis). This bidding process was canceled and re-opened in 2014. In this second attempt was choosing a winning company but the system acquisition process is now paralyzed by the problem of funding availability.

This scenario clearly illustrates the slowness with which these processes occur and we can easily conclude that the solution of the problem will not be immediate. It is worth mentioning that according to the Provisional Measure 595, "MP of the ports" are already filed approximately 161 applications for granting of new ports and terminals in the country. This will necessarily lead to an increase in boat traffic on the Brazilian coast and consequently will require for actions to ensure the operational safety of these vessels that travel along the Brazilian ports.

5 BASIC DEFINITIONS

VTSs, unlike other types of aid to navigation, are active. So VTS operators must necessarily interact with the traffic and interfere with on-board decision-making process. Therefore, it is expected that a VTS meets certain requirements and that also offers a number of integrated services to its operation.

This section will display the minimum needs of a VTS, the process of determining their functions and what services can be offered to vessels operating in the ports.

5.1 *Requirements*

The operation of a VTS is linked to the care of some initial requirements:

- Competent authority authorization
- Staff certified by the competent authorities (course V-103)
- The VTS should be equipped to handle traffic

The VTS should be able to respond to emergencies in real time without affecting the normal operation of the system. This means that both the operators and the infrastructure should be prepared for a work overload at any time.

It should also be equipped to provide at least the following services:

- Information services
- Services for navigation
- Routing services

Systems that do not comply with these minimal requirements are not considered VTS. In general this type of support service is called LPS, "Local Port Service".

5.2 *Types of VTS*

Before being defined the functions and services present in a VTS, we need to differentiate between two types of system.

The VTSs can be port or coastal. The basic difference is that a port VTS worries about traffic inside the port borders, while a coastal VTS is concerned to control the traffic passing through certain region. Usually the control passage is aimed at environmental protection of an ecologically important area or the defense of a strategic coastal area to the country.

The IMO recognizes the importance of VTSs as a vital tool for the management of strategic and ecological risk locations.

The objectives of the operation, and therefore their services are quite different between the two types of systems.

In port VTSs both the navigation assistance service as the information service are primary. By contrast, the coastal VTS are primarily concerned with information services.

The construction of mixed systems can also bring benefits to ports. Mixed VTSs are primarily interested in optimizing the port area, but extend their coast monitoring area in the vicinity. The main motivation for this type of VTS is to increase port security, after all port areas are strategic locations for the countries and are always subject to attack. However the queue management systems can also benefit from information obtained beyond the boundaries of the port. Anticipating the information of ships that are still outside the port area, it can be seen whether they will be able to meet the scheduled arrival times and if not, the preference may be given to ships that are already nearby.

5.3 *Functions*

VTS's have two types of functions: internal and external.

Internal functions, as suggested by the name, are those that do not directly relate to traffic. Usually they have a more basic character, such as the collection and evaluation of data, decision making, etc.

Rather, the external function has as a direct purpose of influencing traffic, usually through the VTS services.

The functions of a VTS may be listed as:

- Safety of Life at Sea
- Navigational safety
- Efficiency navigation

- Environmental protection
- Protection of communities and adjacent infrastructure
- Efficiency of activities related to the port and allied services
- Provision of information
- Maritime security support
- Safety environment VTS

5.4 *Services*

VTSs typically offer three services:

- Information Service (IS)
- Traffic Organization Service (TOS)
- Navigation Support Service (NSS)

Other services such as weather forecasting and other are provided depending on the availability of equipment and information available to the VTS.

Among the services listed, the information is the most common and most important. These services work with broadcasts information via VHF at certain times when deemed necessary by the operators or as required by a vessel.

Other forms of services other than communication are often provided through allied services such as pilotage, tugs and etc.

It is essential that the services offered by VTS, as well as offered through ancillary services are available in some international naval publication that is recognized. The services available and your VHF channel should be listed. The naval publication recommended by IALA is the site World VTS Guide, (VTSFINDER, 2013).

6 REGULATIONS

The VTS system design is subject to local and international regulations.

Professional sailors and the marine environment crave a uniformity of treatment between different ports. This type of goal can only be achieved through international regulations. However, each country is sovereign over its territory, subjecting the first ports to agencies and national authorities.

7 PROJECT ANALYSIS IN BRAZIL

Before moving to the analysis of the installation and training process itself it is necessary to determine the actual need for a VTS in the study area.

Despite being a very interesting control tool for various aspects, one VTS is an expensive system and its installation may or may not bring tangible benefits depending on locale.

The determination of the need for a VTS goes through the following analyzes:

- Determination of the risk of port operations
- Determination of how this VTS will collaborate on risk mitigation, increased navigational safety and the protection of the marine environment
- In general the ports with the following features justify the installation of a VTS:
  - ✓ High traffic density
  - ✓ Traffic of dangerous goods
  - ✓ Adverse hydrological and weather conditions
  - ✓ Interference from other maritime activities in traffic
  - ✓ High number of casualties recorded in the area
  - ✓ Existence of VTSs in adjacent areas and need for cooperation
  - ✓ Intrinsic adversities at the port, as narrow canals, bridges, steep turns and areas with restrictions for traffic
  - ✓ Changes planned in the port traffic profile in the near future
  - ✓ The steps for determining the need of a VTS will be better described, in more detail, along the next items.

7.1 *Idealization*

Decided that the VTS will be built, the idealization task of the project is started.

This step will define the services that will be available in the VTS as well as allied services and verification of adherence of the system to local and international standards.

At the end of this phase of the project should be determined the interactions between the systems to construct a functional VTS. Basic guides of building systems (equipment and buildings) should be developed, as well as the planning of the interaction of subsystems.

It is important to consider alternatives for the development of functional requirements do not lead to unnecessary costs in the future. Therefore, it is important that the personnel involved in determining the system needs to be independent of equipment manufacturers or VTS companies.

This phase should worry about leaving a framework for project development tabbed requirements, cost and steps runtime.

7.2 *Risc analysis*

The planning, implementation and even the operation of a VTS is basically a risk management problem trying to balance an acceptable level of risk with investment needed to neutralize it.

This analysis aims to verify that the actions suggested in other planning steps are effective measures for risk mitigation.

According to IALA, the best way to determine the influence of VTS security for navigation is through a risk analysis. The very IALA recommends the following tools for this purpose:

- IWRAP
- PAWSA
- Simulation

The use of simulations for risk analysis is becoming an increasingly interesting practice and is expected that this trend will grow even more.

7.3 *Cost analysis*

Two costs are important for a VTS: cost of deploying and operating costs.

- Initial investments involve phases of studies, projects, construction of necessary infrastructure (operating buildings, control center, radar, etc.), purchase of equipment in general, project management and organization for the start of operations.
- Operating costs mainly involve maintenance of buildings and equipment, personnel, supplies and insurance.
- The benefits to be considered in the analysis against the costs are:
- Risk Reduction
- Improvement in economic performance
- In addition to these direct benefits, the VTS can bring benefits to communities adjacent to the system.

The non-operating time, whether from boats or from harbor areas, the problems caused by the occurrence of fog, congested roads and other circumstances, are good indicators of operating costs if the port does not have a VTS.

One of the procedures suggested by IALA for benefit calculation follows the following line:

- Inventory of accidents that have already occurred in the area, along with a description of what happened.
- Inventory of delays due to traffic delays and reduced speed in the area of interest.

8 IMPLEMENTATION OF A VTS IN BRAZIL

8.1 *Planning*

The planning of VTS's has many variables. A complete description of this procedure is too complex to be covered in this paper. However topics that need attention are described below.

Factors influencing the process of decision-making can be physical, operation of the port or the VTS operation. The physical parameters are immutable and therefore should be the first to be considered. The characteristics of the port operations are generally determined by the customer and therefore are not available many possibilities of change in this regard as well. Finally, the VTS operating parameters are where most of the decisions will be taken.

The geography of the region is a very important factor in most decisions to be made in the planning process of a VTS. Geography affects the proper position of the equipment to be installed, such as radar, VHF and AIS antennas. Some characteristics of the port affecting the VTS are also defined by geography. In such cases the geography affects the VTS project indirectly, but no less critical. The port traffic scheme, their areas of anchorage and geographical hazards to navigation are examples of such characteristics. These data types should be considered at the first iteration of a VTS design spiral.

The geography of the area will also influence the number of sectors present in the VTS. This decision affects mainly in maritime communication. The number of sectors of a VTS will determine the requirements for allocation of frequencies needed to communicate with VHF system. This allocation is subject to approval of the regulatory authority, and therefore must be within the standards set by this. In Brazil, ANATEL is the regulatory agency of VHF frequencies, its rules are found in (ANATEL, 2013). It should take into account the allocation of frequencies in adjacent areas to minimize interference.

Prohibited or dangerous areas may also be determined through major navigational hazards or areas of ecological importance. Such areas should be kept free of traffic. These measures influence the planning of routes and subsequently the operation of the VTS and the port itself. So that the movement ban in certain areas is fulfilled, it requires constant vigilance.

Such as geography, meteorology and hydrology of the region also influence the VTS planning process.

Given the main parameters of a physical nature affecting the planning process of a VTS, the port operations features are the next thing to note. First, the commercial factors of port operation. A VTS system will not be interesting if it disrupt the main activity of your customer.

Data concerning the placement of terminals, movement of the load in land and about the means available to transfer and receive such cargo are of great value in the planning of the VTS.

The main port feature that affects the decisions of a VTS is the number and types of ships. A simple craft count is not enough for planning purposes. Vessel type, size, draft, maneuverability, cargo and equipment on board are important parameters for determining the ideal service to be deployed.

Different ports may have different design constraints. The cases presented here highlight important points that are usually common to most terminals.

The decision making final stage includes the specific parts of the VTS operation. It is at this stage that most of the decisions about how the VTS will be, will happen. The foregoing conditions merely restrict which can be decided at this step, establishing a set of boundary conditions to the problem of determining the characteristics of the VTS.

Much of the decisions made in the project have effect at different stages of VTS planning. For example, the determination of the required positioning accuracy will influence the choice of equipment and the level safety obtained with the system.

Decisions regarding the VTS can be divided into areas

- The service level desired for the VTS
- Provided (internal and allies)
- Operation Management
- Emergencies
- Security in the navigation
- VTS Security

These decision areas are not completely independent. For example, the service level of a VTS is influenced largely by the services it offers to the ships. The provision of services can be voluntary or compulsory, according to what it considers best for the system design. However, the VTS can only establish the obligation of services within territorial waters. Outside these areas the jurisdiction of the VTS is limited by UNCLOS.

8.2 *Procedures*

The development of operational procedures of each VTS center is an ongoing process. To ensure the safety of operations is necessary that operators should always be aware of changes made in the procedures.

In addition, it is important that changes are properly documented. Temporary changes in procedures must be auditable, being formally canceled on documents when they are no longer in effect.

The V-127 recommendation of IALA (IALA, 2011f), assists VTSs in creating operating procedures. As a building block in the creation of procedures are three concepts:

- Message-oriented outcome. The operator shall notify the vessel what it should do, but without specifying how. Given the result that the operator has determined it is up to the tribulation of the vessel to determine how the execution should be carried out.
- Standard phrases. These are determined by resolution A.918 (22) – "IMO Standard Marine Communication Phrases" and A.851 (20) – "General Principles for Ship Reporting Systems and Ship Reporting Requirements", both of the IMO.
- Types of communication messages and message markers. To facilitate communication ship-base-ship. Messages must be classified with one or two of eight markers, as shown in Table 1. In this way it will not leave margins of doubt related to the interpretation of the meaning relying on messages intonation.

8.3 *Equipments*

Typically deciding which equipment should be used is taken in the project idealization phase, allowing further analysis of risk and cost more accurately. The choice of equipment is subject to change in later phases of the project. If such changes are made, a new cycle of a project spiral must be performed.

Several parameters are important in determining the equipment to be used by a VTS. As already discussed, in making the equipment decision, the immutable parameters of the operation should be considered before the desired characteristics of the project. Some of the parameters that influence the choice of the most important form of equipment are:

- traffic density
- Port Structure
- Dangers to navigation
- Local weather
- Topography
- Environmental Requirements
- Commercial aspects
- Extension of the VTS area

In addition, choices made by those involved in the project also need to modify the equipment. Type of services to be provided, service level, security level to be achieved and requirements of users will also influence what equipment should be installed.

The V-128 guide IALA defines the following levels of VTS:

- BASIC: System of information and navigation assistance
- STANDARD: Applied to all types of VTS. IS, SSN and TOS.
- ADVANCED: applied to VTSs with high traffic density and / or great dangers to navigation.

A single VTS may contain different levels in different areas, reducing the need to install many equipment in a low traffic area.

8.3.1 *Communication*

The following types of communication exist in the VTS:

- Between operators from the same VTS center
- Between operators in different centers of the same VTS (when appropriate)
- Between operators of centers of different VTSs
- With ships in the vicinity or within the VTS area
- With allied services
- Port Authorities
- External communication in general

8.3.2 *Radar*

The radar system design greatly depends on the geography of the VTS area.

Depending on the VTS, its planning and geography of the area where it is located, the radar system can have the following settings:

- None (use of AIS only and radio communication)
- Partial coverage
- Full coverage with a radar (no blind spots)
- Complete coverage with two or more radars.

Radars of a VTS should operate simultaneously in short and long range, preferably without the influence of an operator. Meteorological phenomena such as irregularities on the sea surface and temperature inversions ducts can influence terrestrial radars.

The surface irregularities may be fixed or mobile, depending on the nature of the phenomenon that generates. For fixed radars, the irregularities due to geography and no transient characteristics of the region are

Table 1. Message Types used in VTS.

Information	Warning	Advice	Instruction
Question	Answer	Request	Intention

easily treated. Moreover irregularities due to sea surface and readings due to weather variations can present a greater challenge.

8.3.3 *AIS*

Automatic Identification System – AIS is an automatic identification system for ships, as suggested by the name. The aim of this type of system is to assist in the identification of vessels, aid in tracking the same and simplify the exchange of information. In general, AISs enable an increase in the overall understanding of situations in progress by the VTS controllers.

According to the regulation V/19 of SOLAS, AIS should be able to exchange data with other ships and bases ashore. To enable this communication, AIS antennas are required. In general, the range of AIS stations is of the same order VHF antennas, however, as in the case of VHF, accidents in the geography of the area may cause the need for additional bases.

8.3.4 *Closed circuit of TV – CCTV*

These systems can be integrated into VTS so as to offer operators the vision of situations in real-time. Additionally, CCTV information can be provided to vessels to improve decision-making on board, giving an idea of the movement around the port.

Part of the cameras can be actively controlled by the operators, allowing a better view of some areas of interest.

9 THE FINEP PROJECT

Regarding the implementation of VTS systems in Brazilian ports, as already discussed in item "The Scenario in Brazil," we live a very critical situation and at the same time with a low probability of having a solution for our ports in a short to medium term. Thus, the Department of Naval and Ocean Engineering at the University of São Paulo, through its logistics laboratory, CILIP (Innovation Center in Port Logistics), took the initiative to submit to FINEP (Financier of Studies and Projects), which is a government agency for research support, a proposal for technological development of a national VTMIS (Vessel Traffic Management Information System) facing local port needs and enable greater integration of the existing supply chain in Brazil. This proposal was approved in April 2014 and from there we were able to initiate the activities related to it.

This project, lasting three years, allows us to develop expertise in relation to the technologies associated with that area and focus on a solution totally dedicated to the Brazilian reality. In the beginning of the project, a survey was conducted to identify the technologies that are commonly used in the systems available on the market. The main focus of this research was to select compatible devices with those that are typically used in VTMIS, ie, developed and marketed by specialized companies and also certified by the IMO (International Maritime Organization). Alongside this it was necessary to adjust the investment in equipment plus software libraries to the "budget" available for the project. After several surveys and contacts with suppliers, we could identify two suppliers in Italy that met to our needs.

After a year and a half of working, we are already quite advanced in the assembly of a prototype which we define as a cell of a VTS. This cell consists of a basic unit of a VTS that integrates various equipments (AIS, RADAR, VHF Communication and CCTV) with a computer system that will fulfill the function of supporting traffic management in the port area and provide information to port authorities, end users and allied services. The computer system consists basically of three modules. The server module that enables connection of the server machine with the signals sent by various monitoring equipment of the system (AIS, RADAR and CCTV), processes these data and provides information to the VTS operator workstations. In the workstations where is executed the client module, we have the graphical interface of the system that supports the activities undertaken by VTS operator. The third and final module consists of a web interface that will allow end users to access information provided by the system according to the profile and associated privilege to each end user. It is worth mentioning that such cells of VTS, in a real case, can be replicated and integrated with ease, so as to allow it to cover the whole area associated to a specific harbor.

An application in a Brazilian port is being proposed and there is already interest from the ports of Santos (SP), São Sebastião (SP) and CSN, in Imbetiba (RJ).

10 DISCUSSION ABOUT THE IMPLEMENTATION IN BRAZIL AND CONCLUSION

This paper first presents a summary of the steps to be followed for the development of the conceptual design of a VTS. As initially announced a VTS is characterized by being a complex system which is divided into several subsystems and also interacts with a number of "clients" in the port environment. We therefore conclude that the care to follow the various steps set forth herein, in each cycle of the project spiral, is of utmost importance to ensure that the project does not fail to meet with quality and efficiency to the needs of the many user. The presented work allows us also to conclude the need for constant interaction with the various areas that will use the system, as often as possible, in order to fit to a specific need or a limitation imposed by any particular situation that may compromise the full compliance of other areas. In fact, one VTS is an information system and as such requires a thorough work of analysis to be developed with all future users of the system and deeply explore the internal processes of each user area. Analyzing the process presented is possible to identify that besides being an complex information system, it must meet the regulations of international organizations such as the IMO and IALA so that it can serve international users. Of course each country is sovereign and inside the port area, local regulations must also be met.

Particularly speaking about VTS in Brazil it is known that the Brazilian government has been trying to deploy this sort of system here with no success. In these initiatives, the system specification and the deployment phase of this solution were performed in a wrong way. They specify a very complex system, envolving all of the port areas and the allied services, and, in the following, it is predicted to deploy it along one only step. It is well known that an information system cannot be deployed according to this manner. It is recommended to start with a departmental solution and when the partial solution is mature and robust, you can move to a new phase involving other areas. This should be done in stages until it reaches the full solution. In this case it is necessary to thoroughly plan the entire solution deployment process.

What was mentioned above could be proven in practice through the FINEP project which was also addressed during this work. In relation to this project we can conclude that even though not yet finalized, it has been fulfilling the steps planned and already brings the benefits in relation to the VTS theme. We are demystifying this matter and over the next steps we will begin to further interact with some port, among those with whom we are speaking, and this will be extremely useful. We can conclude in advance, even before the project ends up, that the objectives will be fully achieved.

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