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# A Maritime Research Concept through Establishing Ship Operational Problem Solution (Shipos) Centre via Information Technologies Integrated With or/Ms

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**Abstract**

The recent developments in maritime transportation have been leading to integrate advance management systems into ship fleet operations. Design and implementations of such systems are highly required managerial skills and methodological tools. This study conceptualizes a ship fleet operational problem solution centre (SHIPOS) to systematically analyse the various cases, facts and figures promoting with comprehensive outcomes. The SHIPOS initiative has been established to additionally support the sub-tasks of WP#1 (database network, industry information sharing network, research network) within research project entitled "Human Reliability Analysis and Monitoring System Proposal in Shipboard Operations (H-RAMS)" (Project no: 114M352) supported by the Scientific and Technological Research Council of Turkey (TUBITAK). Besides the feedbacks from ship operating environment, the solution centre also considers the technology expectations specified in the recent global initiatives (i.e. Horizon'2020, IMO strategies) to predict the required future maritime innovations. As another aspect, the methodological background of solution centre takes the advantage of OR/MS techniques comply with the focused problems. Consequently, this paper presents the critical milestones of providing information technology solutions to ship fleet management such as data acquisition, modelling, shipboard integration, verification, etc. in a continuous maritime research concept.


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## 1. Introduction

Maritime transportation has some advantages over other transportation modes, such as; economic, safe, secure, environmental, and sustainable. These advantages have become more attractive in recent years, because of the global economic crisis, energy shortages, and on-going environmental concerns (reducing the carbon and sulfur dioxide emissions). However, maritime transportation is considered complex dynamic system; the high level of international, national, organizational interactions and communication networks generates a complex business environment (Celik and Topcu, 2009). Therefore, it has been a great challenge for maritime industry to become an excellence mode of transportation Roumboutsos et al. (2005). At this insight, maritime shareholders should run their business not only respect to the international, national conventions, codes, regulations, rules but also organizational, operational, and proprietary process, as well.

Maritime transportation is one of the most global industries so that, in order to operate efficiently and effectively, its regulations and standards are must be generated and implemented on an international basis. International Maritime Organization (IMO), which is authorized agency that responsible for the safety and security of ships and prevention of pollutions from ships, is international regulatory forum for maritime transportation. The most important IMO conventions are Standards of Training Certification and Watchkeeping (STCW); International Ship and Port Facility Security Code (ISPS Code); International Convention for the Prevention of Pollution from Ships (MARPOL); International Convention for the Safety of Life at Sea (SOLAS). It has been aimed to establishing acceptable quality level, determines minimum requirements, set a general framework etc. in an international basis by entering into force such conventions. However, to become an excellence mode of transportation, maritime organizations should do more than just compliance their organizations, and operations with international rules.

At that point, organizational, operational, proprietary process becomes more critical for maritime organizations, since operational reliability, safety, cost etc. is concern for companies' executives. Furthermore, providing cost effective, safe, secure transportation is challenging issue in maritime mode, where increasing complexity of the system allows greater scope for organizational shortfalls Goulielmos and Tzannatos (1997). Therefore, managing the sustainability in maritime transportation requires establishing competent companies integrated with advance technologies and reliable scientific models. However, it's not the current situation; there are still great milestones for the maritime transportation to become one of the excellence transportation modes Celik (2008). Indeed, the demand of innovative research and development has been increased tremendously in order to provide sustainable maritime transportation. The motivation behind this research is to fulfil in the research and development needs of the maritime companies in terms of developed model base solutions with respect to the maritime dilemmas previously cited by Celik et al. (2009b). For accomplished these purposes, the study is aimed to conceptualize a ship fleet operational problem solution center to systematically analyses the various cases, facts and figures promoting with comprehensive outcomes. In addition, the feedbacks from ship operating environment, the solution center also considers the technology expectations specified in the recent global initiatives (i.e. Horizon'2020, IMO strategies) to predict the required future maritime innovations. The methodological background of the research is based on OR/MS techniques that comply with the focused problems. The study begins with the introduction section that clarifies the motivation behind the study. Next, ship operational management literature review is presented. SHIPOS Centre is introduced in the third section. The study results are argued at the conclusion.

## 2. Ship Operational Management Studies

Ship operational management is one of the focused topics within the maritime literature and several high cited studies that interested in these topics have been examined. Goulielmos and Tzannatos (1997) suggested the establishing a management information system (MIS) for the promotion of safety in shipping. The study underlined the fact that human decisions affecting the ship operations generally based on the executives biases and available

information, which important information might not be available. Roumboutsos et al. (2005) also investigated the information management considering the security perspective in shipping industry. In order to improve shipping technical reliability, management of information has a vital role in decision making within shipping operations. Deris et al. (1999) and Mokashi andVermar (2002) investigated the shipping maintenance scheduling process. Mitroussi (2004) studied the third-party ship management and its evaluation. Lyridis et al. (2005) conducted a research that intended to increase the liner shipping services quality. Bendall and Stent (2005) investigated market choice for investment decision, while, Alizadeh and Nomikos (2007) analyzed the ships sale and purchase, which is both considered one of the most complex and critical process in shipping industry. Celik (2008) dedicated a research that identifies the key issues within the concept of ship management in shore-based organization. Celik and Topcu (2009) developed model selection mechanism that based on the Integrated Decision Aid (IDEA) whereas; Celik and Er (2009) also developed a model selection interface on the basis of the fuzzy axiomatic design (FAD) methodology. Celik et al. (2009a) examined the shipping registry selection process. Celik et al. (2009b) suggested a computer-based systematic recruitment model for maritime transportation industry. Celik et al. (2009c) developed a decision aid mechanism that aimed to help shipping company executives to select the most proper shipyard with respect to the relative constraints. Celik (2009) developed a novel Integrated Process Management System (IPMS) on the basis of quality aspects, environmental concerns, and occupational health and safety requirements. Wang and Meng (2012) examined the operations of the liner ship fleet deployment. Ko et al. (2013) conducted a research that intended to optimization the ships maintenance scheduling. Christiansen et al. (2013) suggested four basic models that handle the ship routing and scheduling and related problems and Christiansen and Fagerholt (2014) investigated ship routing and scheduling within the industrial and tramp shipping. Moon and Woo (2014) analysed the impact of port operations on efficient ship operations. Jeon et al. (2014) studied the success factors for ship management companies. Lam and Notteboom (2014) investigated the port management tools that used by leading ports in Asia and Europe in terms of the environmental concerns. Pantuso et al. (2014) conducted a comprehensive survey on maritime fleet size and mix problems.

According to the literature review, despite the remarkable efforts put into by maritime researchers, there are still huge research gaps in the systematic analysis of ship operations and management processes. Especially, holistic and integrated approach should be taking into account to improve ship operational efficiency and effectiveness. Therefore, the aim of this study is to fulfil in the research and development needs of the maritime companies in terms of developed model base solutions with respect to the holistic and integrated approach

## 3. SHIPOS Centre

This paper introduces a creative solution for ship fleet operational problem by proposing ship fleet operational problem solution centre which is establishing and executing problem research and solution centre. The next section defines the SHIPOS center respectively.

### *3.1. Aim of Concept*

The aim of the SHIPOS centre is to establish a model-based distance knowledge centre for ship fleet operational problem in marine industry incorporated with operational research/management science (OR/MS). The SHIPOS center aims at focusing on the on-going problems of ship fleet management with the collaboration of interdisciplinary research contributions from maritime transportation, operational research, and computer science fields. In this context, the main goals behind the SHIPOS center is to play pioneering role in establishing a conceptual ship fleet operational problem solution centre to systematically analyze the various cases, facts and figures promoting with comprehensive outcomes in respect with following objectives:

- Conducting great amount of research and modelling studies with consistent deliverables which fulfil the maritime industrial expectations.
- Producing satisfactory solutions to critical operational problems in ship fleet managements.

- Providing information technology solutions to ship fleet management such as data acquisition, modelling, and shipboard integration.
- Proposing model based management philosophy in maritime science and technology.
- Targeting excellence quality and performance in maritime operations.
- Establishing global knowledge centre of maritime industry.

Considering the multi-methodological background, the approach behind the SHIPOS Centre is very keen to design the future of maritime via maritime information technologies which open up innovative horizons in maritime science and technology era.

### *3.2. Problem Scope*

In this part, scope of problems is ship fleet operational are addressed in order to tackle in advance by adopting SHIPOS centre approach. Ship fleet operations are an onerous aspect of maritime transportation recognizing to be safe, secure, efficient and environmentally friendly mode of global transportation. It has a close nexus with enhancing performance and quality in ship operations. However, there are still great milestones for shore-based organizations to achieve operational excellence. Indeed, the maritime researchers need to call for more effort in terms of innovative research and development.

The centre focuses on intelligent solutions of ship operational problems via an interdisciplinary research plan including marine engineering, maritime transportation engineering, and operational research fields. Considering the operational feedbacks, the SHIPOS Centre deals with the problems and provides requested responses in various modes (i.e. engineering solutions, training, and process redesign). For instance, the problems are welcomed along with the key aspects of ship operations such as performance, safety and reliability, maintenance, human factor, marine environment issues, training, regulatory issues, quality assurance, administration issues, marketing, purchasing, ship financing, etc. In SHIPOS Centre facilities, the core focus of research methodology is to overcome data uncertainties and quantification in ship operations modelling studies.

### *3.3. Methodology*

The targets of the ship operational problem solution centre are to provide useful outcomes towards the enhancement of maritime industry, in particular ship fleet managements. It includes two creative research groups that collaboratively fulfil the technological and management related needs of the maritime society via advance methodological approaches in OR/MS in terms of generating innovative ideas and modelling studies. In practice, the SHIPOS knowledge and information centre principally provides decision aid to ship fleet managements under various IT solutions such as data acquisition, modelling, shipboard integration, verification, etc. in a continuous maritime research concept. The derivable from SHIPOS centre enables quality excellence in safety, environment, security, and performance dimensions of maritime industry, in particular ship fleet management, by taking the advantage of OR/MS models via information technologies. Its knowledge generation principles comply with the self-regulation efforts and restructuring tendencies of various maritime research groups. In the early design phase of SHIPOS centre knowledge platform, cooperative efforts of both research groups consider the gathering industrial experiences and methodological contributions respectively. When it is principally considered as a decision support system (DSS), the approach consists of database management system (DBMS) and model base management system (MBMS). Figure 1 depicts the SHIPOS Centre IT knowledge platform in marine communication network.

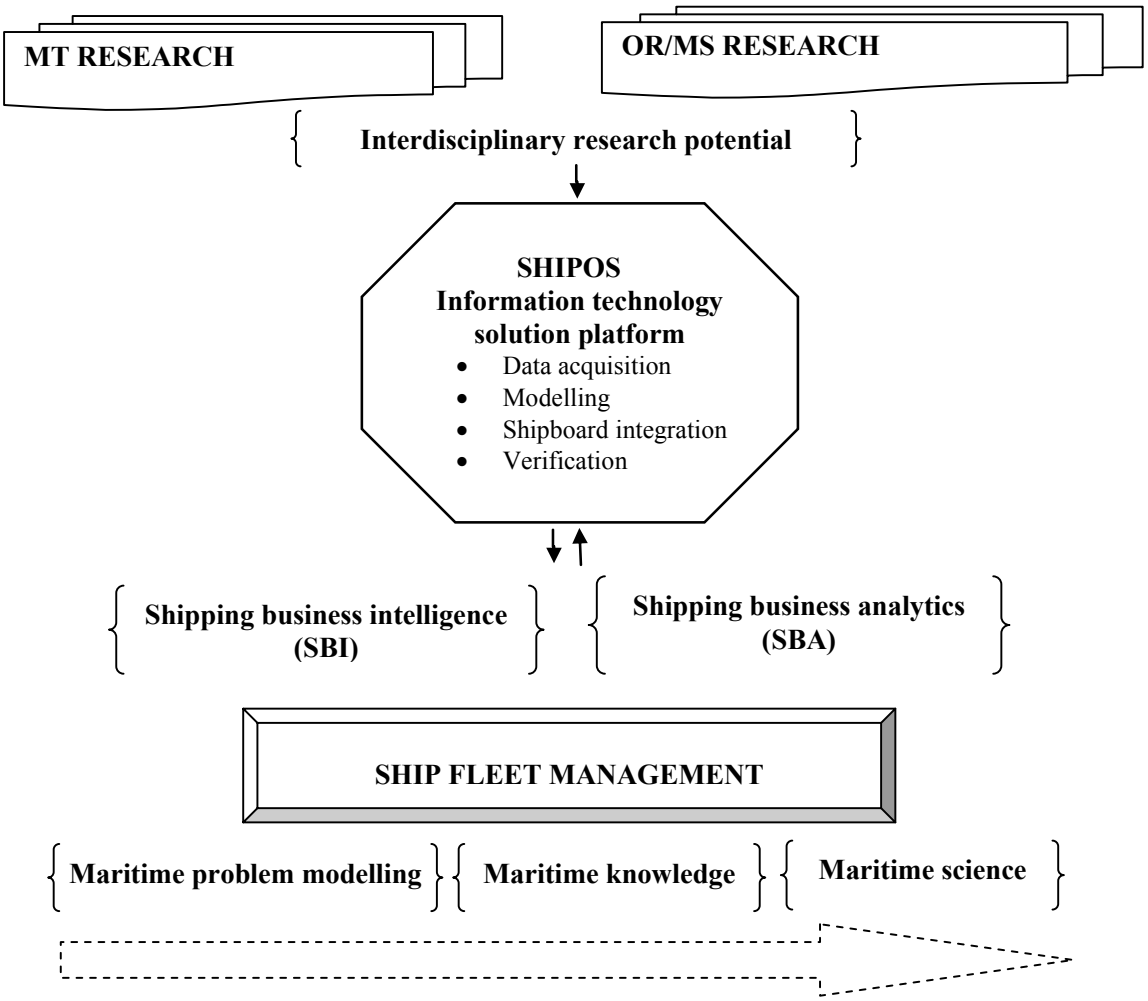


Fig. 1. SHIPOS centre IT knowledge platform in marine environment

Ordinarily, the SHIPOS centre approach initially conducts a maritime industry based survey and carries out wide range of academic literature review on maritime transportation. The assessment on the initial outcomes is used to determine the chronic dilemmas and their problem characteristics in maritime organizations. The obtained feedbacks and reports are stored in DBMS of DSS. Then, the SHIPOS centre research groups have increased their capability on OR/MS models to effectively use of them. Fundamentally, whilst operational research copes with the application of advanced analytical methods to assist better decisions, management science is concerned with developing and applying models and concepts that help to illuminate management issues and figure out managerial problems. Quantitative techniques are applied such as linear programming, goal programming, integer programming, non-linear programming and dynamic programming in deterministic level, queuing theory, Markov process, simulation, decision trees/game theory in stochastic level, and MCDM models, MADM, MOLP, nonlinear goal programming, spreadsheet modelling, graphics, artificial intelligence which can be addressed as a principal research method in modelling maritime problems.

It is the next critical aspect to designing model selection algorithm which provides problem-model sets subsequently. In this context, modelling by focusing maritime issues is the most significant part of the research on which the collaboration of the groups reaches the highest level. Modelling studies are the resource of the advance maritime knowledge that is suitable to be utilized practically and effectively. The produced knowledge is additionally processed to be a role model or guidance in order to solve the same kind of maritime dilemmas in global maritime organizations. The produced advance maritime knowledge is requested and provided via a distance accessible knowledge platform for decision-makers, practitioners, rule-makers, and various authorities in maritime transportation. The established system is periodically improved to receive continues feedbacks and to produce advance maritime knowledge for the relevant ship fleet managements to put it into practice effectively. The results of the model-based solutions to the maritime organizational dilemmas are also monitored. The next part will define procedures how SHIPOS centre will work.

### *3.4. Procedures*

The objectives of the ship operational problem solution centre are to enable useful outcomes towards the enhancement of ship fleet management. To accomplish this, ship fleet executive managers consult to the SHIPOS centre with respect to the any of operational problems that they have brush up against. Then, the problem is forwarded to the research groups in SHIPOS Centre where knowledge and information technology enables decision assist to the ship fleet management in conjunction with a wide range of IT solutions including data acquisition, modelling, shipboard integration as well as verification. Thereafter, the system ascertains the most appropriate and reasonable OR/MS method that is used to solve operational problem via information technologies and it is highly recommended to ship fleet management in order to get solution for operational problem. For instance, ballast water management treatment, which have been stipulated by regulatory authority in the recent times, become a prominent topic as an operational problem in ships. To overcome relevant problem, ship fleet management may consult to SHIPOS centre where marine environment researcher group and OR/MS research group are discussed problem thoroughly. Then, SHIPOS centre recommends the most convenient OR/MS technique from the database to the ship fleet managers.

### *3.5. Solution Concepts*

Since SHIPOS centre has aimed at establishing and executing ship operational problem research and solution centre, it focuses on intelligent solutions of ship operational problems via an interdisciplinary research plan including marine engineering, maritime transportation engineering, and operational research fields. In this context, procedural imrovement, technological solution, IT based solution, training, process re-design can be considered as solution concepts. The brief explanation of them are provided as follows.

- **Procedural improvement**: This is an procedural improvement is an aspect of organizational development in which a number of actions are taken by a ship owner/manager to identify, assess and enhance existing process within an organization to meet new objectives and aims such as increasing ship and crew performance, growing profits, reducing operational and management costs. The actions frequently follow a specific methodology or strategy to increase the probability of successful results.
- **Technological solution**: It is the application of computer based systems integrated with comprehensive network where creative and smart solutions are developed in SHIPOS Centre concept. Thus, a high level of communication network is established.
- **IT-based solution:** The system is focusing information technology by establishing a high level of communication network supported with workshops, interactive solution, displaying information or etc. In this concept, a wide range of information technology systems are utilized such as decision support systems, transaction processing systems, knowledge management systems, database management systems and learning management systems.
- **Training:** One of the important aspects of ship fleet operation rests on the crew manning. In order to establish a high level of ship fleet operational management, it is required to provide a high level of crew who have adequate experience and trained. Therefore, SHIPOS Centre provides an alternative training

solutions including thematic workshops, occupational seminars, e-learning based training, practical training as well as interactive methods in order to figure out the most effective training techniques.

- **Process re-design**: This examines the efficiency and effectiveness of a ship fleet company's most critical processes. The SHIPOS Centre provides working groups for each ship fleet management to prioritize key processes based on the value at stake. Thus, the highest-quality of service at the most competitive cost and time can be achieved. The SHIPOS Centre enables to work together with a cross-functional team to identify series of principles which can address the problem solution and create a vision of the future state of each management.

## 4. Conclusion

Consequently, the SHIPOS Centre can be recognized as a relatively new initiative in maritime industry. This paper introduced the aim, scope, methodological background, solution concepts, and relevant principles and procedures. Briefly, the centre encourages the professionals of maritime industry to systematically challenge with the ongoing problems. The first and the major issue is determined as enabling the industrial awareness. The platform is required to establish a high level of communication network supported with operational survey feedbacks, organizational audits, thematic workshops, occupational seminars, etc. These activities have been providing a greater scope in problem clustering.

On the other hand, the solution consistency highly depends on adopted methods thorough established models. At this insight, the team approach in an interdisciplinary concept will be provided. The model selection interfaces also support analysts and practitioners to designate problem-method assignments. The research team has capability to utilize relevant methods in OR/MS foundation to analyse the problems in a shipping business intelligence (SBI) or business analytics platforms. The solution concepts might cover technological products, IT solutions, procedural improvements, training supports, etc.

Therefore, the SHIPOS Centre enables specific process improvements in the light of continuous maritime research conducting by interdisciplinary team collaborated with maritime industry. Regarding with the success of centre, one of the important advantages is that the research group has industrial contact; moreover, the members have already derived the various outputs (i.e. MSc thesis, PhD dissertation, manuscripts, and national project) in ship operations and management field. The existing studies provide an onerous background to SHIPOS Centre which opens up innovative horizons in maritime science and technology era throughout the forthcoming decades.

## 5. Acknowledgement

The SHIPOS initiative has been established to additionally support the sub-tasks of WP#1 (database network, industry information sharing network, research network) within research project entitled "**Human Reliability Analysis and Monitoring System Proposal in Shipboard Operations (H-RAMS)**" (**Project no: 114M352**) supported by the Scientific and Technological Research Council of Turkey (**TUBITAK**). The authors wish to give their appreciation to **TUBITAK** for financial support.

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