BACHELOR THESIS – ME14 1502

A HYBRID DECISION-MAKING APPROACH TO MEASURE EFFECTIVENESS OF SAFETY MANAGEMENT SYSTEM IMPLEMENTATION ON ROPAX VESSELS

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Surabaya
2016

SKRIPSI – ME14 1502

PENDEKATAN PENGAMBILAN KEPUTUSAN CAMPURAN UNTUK MENGUKUR EFEKTIFITAS DARI SISTEM MANAJEMEN KESELAMATAN IMPLEMENTASI DI KAPAL ROPAX

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APPROVAL FORM

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Proposed to One of Requirments Obtaining a Bachelor Engineering Degree
On
Marine Reliability and Safety (RAMS) Laboratory
Study Program Bachelor Double Degree Marine Engineering
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SURABAYA
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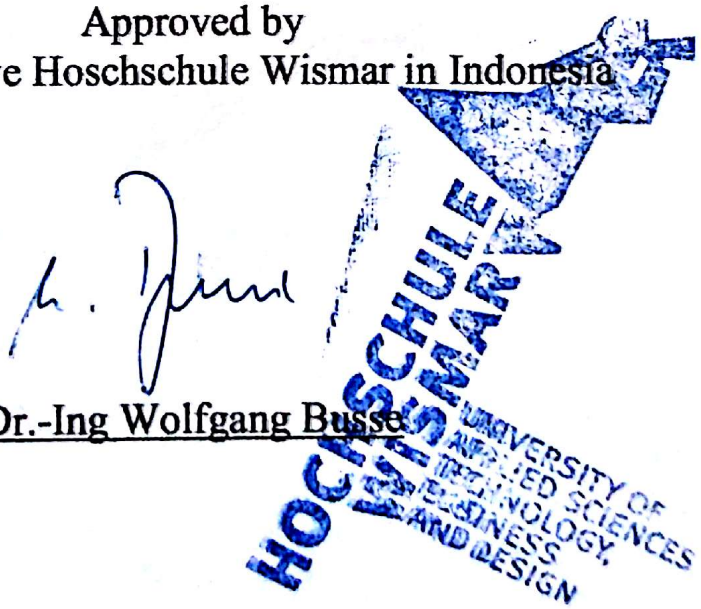

Dr.-Ing Wolfgang Busse

ABSTRACT
A HYBRID DECISION-MAKING APPROACH TO MEASURE EFFECTIVENESS OF SAFETY MANAGEMENT SYSTEM IMPLEMENTATION ON ROPAX VESSELS

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Abstract

Ensure safety of passengers is one obligations of operator passenger ship. Main focus on shipping safety is improvement Safety Management System (SMS) in every ROPAX vessel. The SMS is one ways to achieve maritime regulatory compliance with ship operational requirements. Supervisory functions performed by government to ensure safe operations on ROPAX vessels. In fact, there are still many accidents on ferry port authority. This is indicates that one of safety supervisory functions on-board has not done optimally. This research focus to evaluate Safety Management System (SMS) effectiveness. The maritime research context focuses on a hybrid decision-making approach develop previous research to measure effectiveness of Safety Management System (SMS) implementation on ROPAX (Ro-ro & Passengers) vessels using Analytical Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). The location of this research study on ferry port authority Merak that has highest trip level at Indonesia. The proposed approach enables to review the SMS practice is using the key performance indicators (KPIs) which has been established by previous research based on condition survey reports of comparison ship data was operating in ferry port authority Merak. The main findings that DPA internal audit and ship detention has the lowest effectiveness of SMS

implementation on ROPAX vessels based on hybrid decision-making using AHP-TOPSIS method calculation. DPA should be able to knowledge implementation ISM Code on board. Necessary for supervisory functions from regulator conducted to ensuring DPA shipping operator doing evaluation and improve SMS on their ROPAX vessels. Regulator should giving punishment or warning to shipping operator does not implementation ISM Code on ROPAX vessels. It also giving ISM Code training to DPA shipping operator that to improve ship safety level especially on ROPAX vessel in Indonesia.

Keywords : *hybrid decision making, ISM Code, safety management system, , Ro-ro & Passengers (ROPAX) vessel.*

ABSTRAK
PENDEKATAN PENGAMBILAN KEPUTUSAN CAMPURAN UNTUK MENGUKUR EFEKTIFITAS DARI SISTEM MANAJEMEN KESELAMATAN IMPLEMENTASI DI KAPAL ROPAX

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Abstrak

Menjamin keselamatan penumpang merupakan salah satu kewajiban operator kapal penumpang. Fokus utama pada keselamatan pelayaran adalah perbaikan Sistem Manajemen Keselamatan (SMK) di setiap kapal ROPAX (Ro-ro & Passengers). SMK adalah salah satu cara untuk mencapai kepatuhan terhadap peraturan maritim dengan persyaratan operasional di kapal. Fungsi pengawasan yang dilakukan oleh pemerintah untuk memastikan operasi yang aman pada kapal ROPAX. Faktanya, masih banyak kecelakaan di pelabuhan penyeberangan. Ini menunjukkan bahwa salah satu fungsi pengawasan keamanan di atas kapal belum dilakukan secara optimal.. Fokus penelitian ini adalah untuk mengevaluasi keefektifitas Sistem Manajemen Keselamatan (SMK). Konteks penelitian maritim fokus pada pendekatan pengambilan keputusan campuran dengan mengembangkan penelitian sebelumnya untuk mengukur keefektivitas Sistem Manajemen Keselamatan (SMK) pelaksanaan di ROPAX kapal menggunakan Analytical Hierarchy Process (AHP) dan Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). Lokasi penelitian ini berada di pelabuhan penyeberangan otoritas Merak yang memiliki trip kapal feri terbanyak di Indonesia. Pendekatan yang diusulkan

memungkinkan untuk meninjau praktek SMK menggunakan indikator kinerja utama (KPI) yang telah ditetapkan oleh penelitian sebelumnya berdasarkan perbandingan laporan survei kondisi data kapal beroperasi di pelabuhan penyeberangan otoritas Merak. Temuan utama bahwa DPA audit internal dan penahanan kapal adalah efektifitas yang paling rendah dari implementasi SMK di kapal ROPAX berdasarkan pengambilan keputusan campuran menggunakan kalkulasi metode AHP-TOPSIS. DPA harus memiliki pengetahuan implementasi ISM Code di atas kapal. Diperlukan fungsi pengawasan dari regulator untuk memastikan DPA operator pelayaran melakukan evaluasi dan meningkatkan SMK pada seluruh kapal ROPAX mereka. Regulator harus menegakkan hukum atau peringatan kepada operator pelayaran yang tidak melaksanakan ISM Code pada kapal ROPAX mereka. Juga memberikan pelatihan ISM Code untuk DPA operator pelayaran untuk meningkatkan tingkat keselamatan kapal terutama pada kapal ROPAX di Indonesia.

Kata kunci : *kapal Ro-ro & Passengers (ROPAX), ISM Code, pengambilan keputusan campuran, sistem manajemen keselamatan kapal (SMK).*

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CHAPTER 1
INTRODUCTION

1.1 Background

Indonesia is one of the largest archipelago in the world. Accordingly, maritime transportation is one of the important things for connected inter-island in Indonesia. With its role as a mover of economic growth inter-island, be expected movement fluency passenger and goods overall could more efficient and effective. But due to many factors, a lot of ship accidents occurred every year, and claiming a large number of casualties. Generally, ship accidents in Indonesia causes overload factor either goods or passengers (Faturachman & Muslim, 2012). Type of ship accidents such as sinking, groundings, collisions, fires and other types of accidents. Totally, number of ship accidents more higher year per year. Data report from Mahkamah Pelayaran (2011), total of ship accidents in Indonesia on period 2005-2010 is 276 cases.

Table 1.1 Data Ship Accidents 2005-2010

No	Classification	2005	2006	2007	2008	2009	2010	Total
1	Western Indonesia	16	20	23	22	22	9	112
2	Middle Indonesia	10	6	7	13	11	8	145
3	Eastern Indonesia	3	12	2	0	0	2	19
Total		29	38	32	35	33	19	276

Source : Mahkamah Pelayaran, Kementerian Perhubungan Republik Indonesia

1.2 Statement of Problems

To evaluation effectiveness SMS implementation based on KPI model in ROPAX vessel at Ferry port authority Merak. The author have some research question who discuss and analyze in this research are.

1. What is the lowest effectiveness KPI model implementation on SMS based on AHP and TOPSIS method?

2. What is the evaluation from KPI to improve SMS on the shipping companies especially ROPAX vessel?
3. How to increase the level of transportation shipping safety standard in Indonesia?

1.3 Research Limitation

Limitation of this research is discuss about evaluation SMS based on KPI model. Accident area only on Ferry port authority Merak. The author using five data ship comparison in this research as representatives of ROPAX vessel operating on port area. Respondents on this research such as auditor safety surveyor, DPA shipping company ROPAX (Ro-ro – Passenger) vessel, , National Transportation Safety Committee (NTSC) and others stakeholder which is considered essential.

1.4 Research Objectives

Objective of this research are :

1. To knowing the lowest effectiveness KPI model implementation on SMS based on AHP and TOPSIS method.
2. To given evaluation from KPI to improve SMS on the shipping companies especially ROPAX vessel.
3. Giving recommendation for stakeholders to improve shipping transportation safety standard in Indonesia.

1.5 Research Benefits

Benefit of this research are :

1. Knowing evaluation SMS based on KPI model.
2. Knowing how to process AHP and TOPSIS method from respondents (government, ship owner and port authority).
3. Knowing prospective issues for enhancement maritime safety in Indonesia.

1.6 Writing systematic

This thesis contains an introduction, study literature, methodology, analysis and discussion, conclusion with the following stages :

1. CHAPTER 1 (INTRODUCTION), contains about background, statement of problem, research problem, research objectives, research benefits and writing systematic.
2. CHAPTER 2 (STUDY LITERATURE), contains about kind of accidents in maritime, theory and history of ISM Code, SMS and AHP model,.
3. CHAPTER 3 (METHODOLOGY), explains about method will be used to solving problem on this thesis.
4. CHAPTER 4 (ANALYSIS AND DISCUSSION), contains about analysis result of evaluation SMS based on KPI model using hybrid decision-making approach AHP-TOPSIS.
5. CHAPTER 5 (CONCLUSION), contains about conclusion from analysis result for this thesis

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CHAPTER 2
STUDY LITERATURE

On this study literature should be explain about the theory and another research topic material to support and base for doing this research.

2.1 Maritime Transport in Indonesia

Waterborne transport of humans, materials and goods has importance role in Indonesia. This is impact of economic activity and social cultural community activities. The cost of maritime transport is very competitive compared with land and airborne transport, and the increase to the total product cost incurred by shipping represents only a few percent (Kristiansen, 2005). Negative effect of waterborne transport especially on passengers ship include duration of a long journey, facilities on ship its not clean and comfort for passengers, all daily needs very expensive, passengers not following the instruction such as smoking. In view of the relatively low cost of transport, a standard procedures of safety on ship should make decrease for efficient economic budget.

In shipping there are a number of actors that have an influence on safety (Kristiansen, 2005), and the most important of these are

Table 2.1 Actors in shipping that influence safety

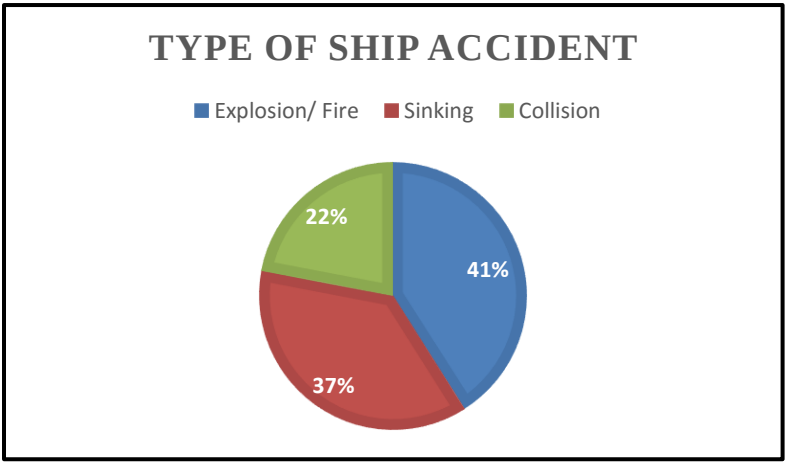
Actor	Influence on safety
Shipbuilder	• Technical standard of vessel
Shipowner	• Decides whether technical standards will be above minimum requirements • Selects crew or management company for crew and operation • Make decisions regarding operational and organizational safety policies

Cargo owner	• Pays for the transport service and thereby also the quality and safety of the vessel operation • May undertake independent assessments of the quality of the shipper
Insurer	• Takes the main part of the risk on behalf of the shipper owner (i.e. vessel, cargo, third party – P&I) • May undertake independent assessment of the quality of the shipper
Management company	• Responsible for crewing, operation and upkeep (i.e. maintenance) of the vessel on behalf of the shipowner
Flag state	• Control of vessels, crew standards and management standards
Classification society	• Control of technical standards on behalf of insurer • Undertakes some control functions on behalf of the flag states
Port administration	• Responsible for safety in port and harbor approaches • May control safety standard of vessels, and in extreme cases deny access for substandard vessels

Source : (Kristiansen, 2005)

Increasing economic activity also affect the incidence rates of accidents at maritime transport. Based on investigation of the National Transportation Safety Committee Indonesia (2011), there are 28 cases of ship accident was investigated from 2007 to 2011 with several types of ship accident.

Chart 2.1 Percentage Type of Ship Accident



Source : National Transportation Safety Committe of Indonesia (2011)

2.2 Type of shipping accident

Definition of accident an unplanned event that results in harm to people, damage to property or loss to process (Industrial Accident Prevention Association, 2007). Shipping accidents are unexpected events that result in financial loss and properties, damages and either loss of people (Cehyun, 2014). The reasons for shipping accidents are so many and complicated. One example, many shipping operator bought secondhand ship for reduced the price of tickets for passengers. But shipping operator did not care and improved safety standards of the ship. This is because safety standard regulation not explicitly impose sanctions against shipping operator. Impressed no reaction from stakeholders to reorganize and giving solutions to improved safety standard

regulation in Indonesia and contributing factor in marine accidents. This is would increased risk of passengers life. There are three kinds of consequences includes injuries and fatalities for humans, environmental pollutions, damage or loss of vessel and cargo. There are many types of shipping accidents and can effect to the environment around the ship, its property from the ship, and can effect to the people (Lestari, et al., 2014). Collision or contact (can be ship to ship or ship to other structures), capsize, sinking, breaking up, breakdown of the ship underway, stranding, and fire or explosion are examples of shipping accidents commonly (Akten, 2006).

There are many factors that make accident happen. Generally can be classified as several factors (Akten, 2006).

I. Natural conditions could be natural phenomena such as tidal stream, high wave, strong winds, restricted visibility due to fog, smoke, rain or snow, storm, etc.
II. Technical failure such as lack of repair and maintenance, steering failure, engine failure, and structure failure as a result from lack of accurately ship design.
III. Human factors are all of human factor which contribute accident happen both of organization, group, or individual factor.

The most common human factors causes were errors of judgment and improper lookout or watch keeping, followed by failure to comply with regulations (Lestari, et al., 2014). The 'human-caused' as it is often termed in the shipping has responsible for accidents.

Data from Laporan Akhir Pekerjaan Kajian Analisis Tren Kecelakaan Transportasi Laut Tahun 2007-2013 National Transportation Safety Committee (2014), shipping accidents going fluctuation increase and decrease per year. Shipping accidents data who investigated NTSC from 2007 until 2013, there are 4 accidents on 2009 with 447 victims, 5 accidents on 2008 with 10 victims, 5 accidents on 2010 and 2013, 4 accidents on 2012, 6 accidents on 2011, and 7 accidents on 2007. Total victims from 2007 until 2013

are 736 victims. Percentage accidents who investigated NTSC based on type of shipping accidents on 2007-2013, 28% caused by collision, 42% caused by fire/explosion, 30% caused by sinking.

Table 2.2 Threats and hazards in maritime activities

Maritime sector	Hazards
Shipping	• Dangerous cargo : fire, explosion, poisoning, environmental damage. • Ocean environment and weather • Substandard ships and substandard shipowners • Difficult to control safety due to its international character
Fishing	• Relatively small vessels with critical features (e.g. hatches) • Ocean environment and weather • Operation in coastal waters – grounding and steep waves • Partly one-person activities (increases vulnerability if something happens) • Development of damage and flooding is fast • Lack of training
Offshore	• Many new kinds of activities, limited experience and knowledge • High pace of development work and construction • Continuous development of technology and ways of operation • Large concentrations of energy resulting in high fire and explosion risk

	• High utilization of the space on platforms
Diving	• Increasing water depth (high pressures, difficult to control) • Lack of knowledge about physiological factors • Ocean environment – splash zone risks • New work processes

Source : (Kristiansen,2005)

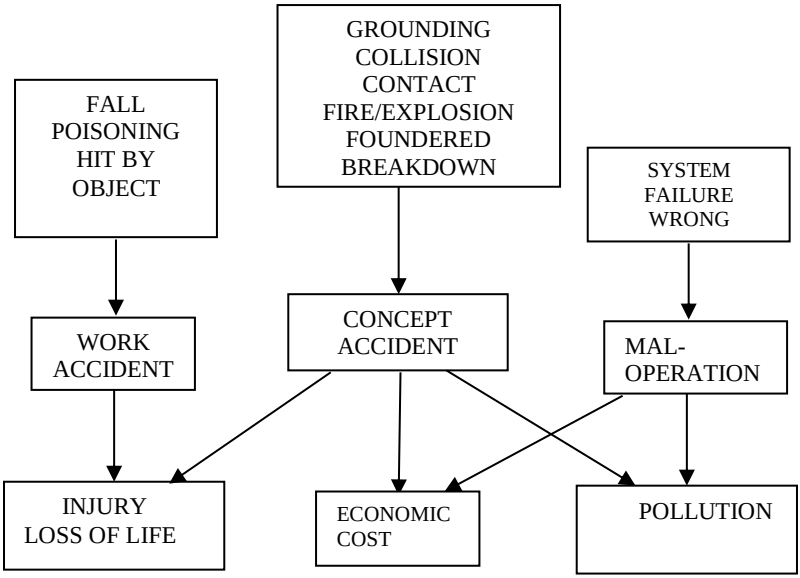


Figure 2.1 Maritime accident types and consequences
Source : (Kristiansen,2005)

In accordance with Kristiansen (2005), If want to specify maritime accident, there are three concept accident namely, work accident, concept accident and mal-operation. Work accident criteria include fall, poisoning and hit by object. Concept accident

criteria are grounding, collision, contact, fire/explosion, foundered and breakdown. Mal-operation criteria is system failure wrong.

Table 2.3 Accident phenomena

Type	Comments
Collision	Striking between ships
Contacts/impacts	Striking between ship and other surface objects
Grounding and stranding	Hitting the seabed or shore
Foundering and flooding	Opening and flooding of hull
Hull and machinery failure	Hull or machinery failure is directly responsible for the accident
Fire and explosion	Fire, explosion or dangerous goods release
Missing	
Other miscellaneous	

Source : (Kristiansen,2005)

2.3 Shipping Safety

According to Indonesia Marine Safety Coordination Agency (2009), every shipping line and shipping operator must has Safety Management System (SMS) for operate the ship. SMS is designed to ensure the implementation of protection effective from possible risks and hazard that should be expected and anticipated as the cause of injuries, death, property and environmental destruction are not supposed occur on the company operation activities. Based on Indonesia law regulation No. 17 of 2008, these requirements are :

I. Overall physical conditions of ship. They are construction, stability, electrical, and machinery while sailing.
II. Ships must be is equipped with a certificate and compliance document of ships while sailing.
III. Ships must be equipped with navigation equipment and/ or ship's electronic navigation that comply with requirements according to the type, size, and its shipping area.

IV. Ships must be equipped with radio communication device and its accessories that comply with requirements according to the type, size, and its shipping area.
V. Ships are fitted with metrology equipment that comply with requirements according to the type, size, and its shipping area.
VI. There are good information systems between ships and shipping information providers about the weather and sea conditions and its forecast.
VII. The ship is equipped with enough safety equipment (Life jackets, lifeboats, life raft, lifebuoy) according to the number of passengers and crew while it ship is sailing.
VIII. Ships are equipped with adequate fire fighting equipment while it ship is sailing.
IX. Ships are equipped with an alarm signal that have well functioning when it ship is sailing.
X. Navigational equipment can help to improve safety and efficiency of navigation while it ship is sailing.
XI. Operation of telecommunications systems can help to improve shipping safety while it ship is sailing.
XII. Repair and maintenance are done periodically as an effort to increase of shipping safety.
XIII. Monitoring and checking to shipping safety requirements that be done by the competent authority is conducted as an effort to increase shipping safety.

Focus on shipping safety have been also regulated by international regulations in the world liked International Maritime Organization (IMO), which under the United Nations (UN). One important factor in achieving the safety and sustainability of the marine environment is the human factors, It human factors related to managing, supervising, competence level, stress, and motivation of people (Lestari, et al., 2014). Human factor should on the good function and condition, due to the failure of the human factor then it will be vain.

2.4 Human Error

A universally accepted definition of human error does not yet exist. Human error is sometimes described as being one of the following : an incorrect decision, an improperly performed action, or an improper lack of action (Rothblum, 2006). Some author's reference defined as the performance of an incorrect or inappropriate action, or a failure to perform a particular action (Salmon, et al., 2005).

2.4.1 Types of Human Error

According to (Kletz, 1999) types of human error includes

1. Mistakes
   Does not know what to do – poor training or instructions.
2. Violations
   Does not want to do it – poor motivation
3. Mismatches
   Is not able to do it – beyond ability
4. Slips or lapses of attention
   Inevitable from time to time

2.5 Human Factor

The term used for human factors and human error somehow interpreted almost equal and mutual influence. The terms are usually used for knowing cause motive of the accident on industry area. Human factors are scientific study of interaction between human and machine (Gordon, 1996). According to Smallegange, et al (2001), definition of the human factor in accidents at sea can be defined as those accidents involving ships and their crew and cargo, which accidents are in some way linked to a human error as opposed to a purely technical failure. There are three categories influencing human factors. They are individual factors, group factor, and organizational factors (Wilpert, 1995). Individual factor which includes competence level, stress, and motivation. Group Factors include: management weaknesses, supervision and crew

factors. And organizational factors which include company policies, company standards, systems and procedures.

2.6 Theory of AHP (Analytical Hierarchy Process)

AHP is a general theory of measurement, because of its multi-criteria, AHP is widely used in prioritizing (Latifah, 2005). Hierarchy of problems compiled to help decision-making process that takes into account all elements decisions involved in the system . Most problems become difficult to resolve because the solution process is done without see the problem as a system with a structure certain. AHP is a hierarchy in the collection elements are arranged in several levels, where each the rate includes several elements that are homogeneous. An element the criteria and standards forming elements are below shows a hierarchy of decision.

AHP technique consists of following stages (Cheng, et al., 1999) :

- To divide the complex problems into small part and rank them hierarchically.
- To compare the elements by making pair-wise.
- To assess the relative importance of the elements.
- To unit these relevant importance and determine entire ranking of decision alternatives.

There are several steps to resolve problem using AHP into following steps (Saaty, 2008)

1. Define the problem and determine the kind of knowledge sought.
2. Structure the decision hierarchy from the top with the goal of the decision, then the objectives from a broad perspective, though the intermediate levels (criteria on which subsequent elements depend) to the lowest level (which usually is a set of the alternatives).
3. Construct a set of pairwise comparison matrices. Each element in an upper level is used to compare the elements in the level immediately below with respect to it.

4. Use the priorities obtained from the comparisons to weigh the priorities in the level immediately below. Do this for every element. Then for each element in the level below add its weighed values and obtain its overall or global priority. Continue this process of weighing and adding until the final priorities of the alternatives in the bottom most level are obtained.

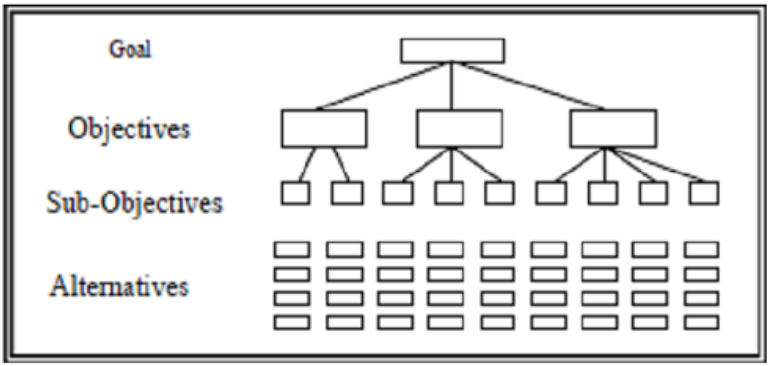


Figure 2.2 AHP hierarchy model
Source : (Saaty,2008)

To make comparisons, we need a scale of numbers that indicates how many times more important or dominant one element is over another element with respect to the criterion (Saaty, 2008).

Table 2.4 The Fundamental scale of absolute numbers

Intensity of Importance	Definition	Explanation
1	Equal Importance	Two activities equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgement slightly

		favour one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgement slightly favour one activity over another
6	Strong plus	
7	Very strong	An activity is favoured very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of a affirmation
1.1-1.9	If the activities are very close	May be difficult to assign the best value but When compared with other contrasting activities the size of the small numbers would not be too noticeable, yet they can still indicate the relative importance of the activities.

Source : Saaty (2008)

AHP helps capture both qualitative and quantitative criteria measurement (Akyuz & Celik, 2014). On many times, it has been used for resolving complex decision problems in any kind of disciplines such as logistics for automobile spare parts (Li & Kuo, 2008), strategic planning for knowledge assets value creation map (Carlucci & Schiuma, 2007), knowledge management for technology acquisition (Bititci, et al., 2001). AHP technique could combine together with hybrid method used to many different disciplines. The example of hybrid method is the AHP in SWOT analysis (Kurttila, et al., 2000).

Expert choice is an application that is specifically used as a tool implementation models in the Decision Support System (DSS) or better known as decision support systems. Calculation matrix of pairwise comparisons matrix performed using Expert Choice program, in which the input data is based on the respondents by providing an assessment criteria.

Advantages of AHP technique would explained on this paragraph, this resource from (Saaty, 2000).

- Unity
  The AHP makes the problem and unstructured be a flexible model and easy to understand.

- Complexity
  AHP solved complex problems through approach integration system in deductive.

- Inter dependence
  The AHP could be used on the elements system mutually free and required no linear relationship.

- Hierarchy structuring
  The AHP represents a natural thought that tends classifying system elements at different levels of each level contains elements that are similar

- Measurement
  The AHP support scale measure and method to determine priority.

- Consistency
  The AHP consider logical consistency in assessment used to determine priorities.

- Synthesis
  The AHP leads to an overall estimate of how wanted each alternative.

- Trade off
  The AHP consider the relative priority of factors on the system so that people are able to choose the best alternative based their purpose.

- Judgment and consensus
  The AHP does not required the existence of a consensus, but combining the result of different judgments.

- Process repetition
  The AHP is able to make the filter definition of a problems and develop assessment and understanding them through the process of repetition.

There are some disadvantages of AHP technique method (Akyuz & Celik, 2014). The disadvantages is used limitation of 9 scale become there are limit for valuation using AHP method.

2.7 Theory of TOPSIS (Technique for Order Preference by Similarity to Ideal Solution)

TOPSIS is a tools who including on multicriteria decision – making problems. It was first introduced by Hwang & Yoon (1981) based the concept that the chosen alternative should have the shortest distance from the ideal solution and the farthest from the

negative-ideal solution. TOPSIS considers the distances to both the ideal and the negative-ideal solutions simultaneously by taking the relative closeness to the ideal solution (Hwang & Yoon, 1981).

2.8 International Safety Management (ISM) Code

International Safety Management Code is a international standard safety management of ship operation and prevention /control of environmental pollution. It came into force on 1 July 1998 as SOLAS Chapter IX, ‘‘Management for the Safe Operation of Ships’’ (ConsultISM Ltd, 2007). International Safety Management Code created because of there are ship accident and damaging the environment, the famous accident is Exxon Valdez oil spill and damaging the environment around the sea area. the ISM Code specifically focuses on the management of people and processed in the maritime industry, perhaps for the first time (Wu, 2010).

This rules because of IMO looked its important human factor and increasing performance ship management operation to prevent ship accident and prevented marine pollution. The impact of ISM Code on industry making improvement in safety and environmental performance.

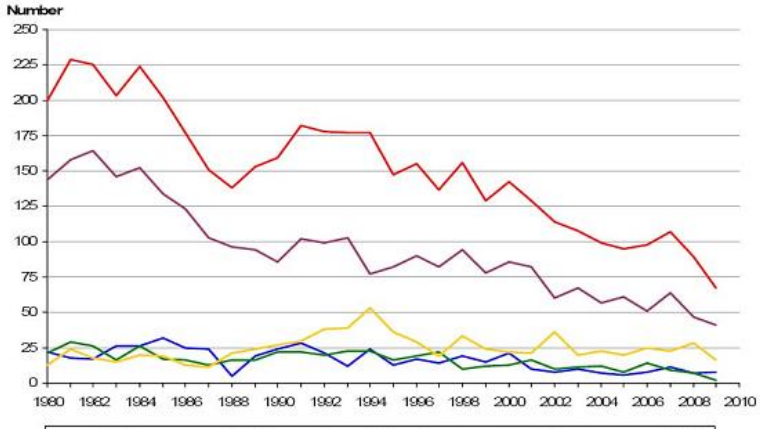


Chart 2.2 Reduction of Total Ship Losses by Number (Ships over 500 GT)
Source : International Union of Maritime Insurance (2010)

Shipping companies should pay attention to guidelines for the operational implementation of the International Safety Management (ISM) Code. The application of the ISM Code should support and encourage the development of a safety culture in shipping (IMO, 2014). Success factors for the development of a culture that promotes safety and environmental protection. List of ISM Code guidelines that must be understood by shipping company to complete implementation of safety and pollution prevention (IMO, 2014), for example :

- Verification and certification responsibilities.
- Ability of the safety management system to meet general safety management objectives.
- Ability of the safety management system to meet specific requirements of safety and pollution prevention.
- Annual verification of Document of Compliance.
- Safety management audits.
- Company responsibilities pertaining to safety management audits.
- Responsibilities of the organization performing the ISM Code certification.
- Responsibilities of the verification team.

The functional requirements of ISM Code are noted in section 1.4 (IMO, 2014) would showing in following Table 2.5.

Table 2.5 Element of ISM Code

Description	**Section**
General objective, application, functional requirement	Section 1
Safety and environmental policy and SMS	Section 2
Company responsibility	Section 3
Designated person	Section 4
Master's responsibility	Section 5
Resource and personnel	Section 6

Development of plans for shipboard operation	Section 7
Emergency preparedness	Section 8
Report and analysis	Section 9
Maintenance of ship equipment	Section 10
Documentation	Section 11
Company verification, review an evaluation	Section 12

Source : IMO (2002)

2.9 Safety Management System (SMS)

Safety Management System is a system documentation making possible to crew applying safety management policy and evaluation safety management system manual from company effectively.

Safety management system manual is a document containing policy and procedure to implementation of safety management system in companies and ships. The shipping company should established an appropriate Safety Management System and the company takes proper action to ensure the effective running of the SMS. The safety management system (SMS) therefore ensures that each and every ship comply with the mandatory safety rules and regulations, and follow the codes, guidelines, and standards recommended by the IMO, classification societies, and concerned maritime organizations.

There are a few things basic functional requirements on safety management system (SMS) to ensure safety of every ship (Marine Insight, 2016). They are :

- Procedure and guidelines to act in an emergency situation
- Safety and environmental protection policy
- Procedure and guidelines for reporting accidents or any other form of non-conformities
- Clear information on level of authority and lines of communication among ship crew members, and between shore and shipboard personnel

- Procedures and guidelines to ensure safe operations of ships and protection of marine environment in compliance with relevant international and flag state legislations
- Procedures for internal audits and management reviews
- Vessel details

Safety management system is devided into sections for easy reference (Marine Insight, 2016). They are :

- General
- Safety and environmental policy
- Designated person (DP)
- Resources and personnel
- Master's responsibilities and authority
- Company's responsibility and authority
- Operational procedures
- Emergency procedures
- Reporting of accidents
- Maintenance and records
- Documentation
- Review and evaluation

DPA (Designated Persons Ashore) is a person which has a direct relationship with the officials on the company. From PT. Biro Klasifikasi Indonesia (2014) DPA has jobs such as implementation ISM code, documentation of the ship, evaluation ship accident, coordination internal audit and external audit, monitoring implementation safety drill and safety meeting on ship.

In accordance with the ISM Code, all shipping companies must applying Safety Management System (SMS) to the company and the ship. Company who accepted requirement would published Document of Compliance (DOC) and each ship who accepted the requirements would published Safety Management Certificate (SMC). DOC and SMC has expired 5 years since activated. DPA must prepared all document for meet the requirements DOC and SMC. In this paragraph would explained procedure to getting DOC as follows (PT. Biro Klasifikasi Indonesia (Persero), 2016):

1. Submit the application form with attachment of Safety Management System manual to the relevant authorities (such as BKI or Ditjen Perhubungan Laut).
2. The relevant authorities would approval Safety Management System manual. If there is a mistake or revision, the SMS manual would revision by company.
3. After SMS manual accepted, so the relevant authorities doing initial verification to the company. The function is compared SMS manual with the real condition on the company. The relevant authorities would sent competent auditor to checked application system on the company.
4. If the requirement accepted, the relevant authorities would published temporary DOC applicable during 5 months.
5. Permanent DOC could published after all non-conformity founded while verification which fixed.

Procedures to getting Safety Management Certificate (SMC) as follows (PT. Biro Klasifikasi Indonesia (Persero), 2016) :

1. Ship must operated by a company has DOC certificate
2. Submit application form with attachment DOC copied to the relevant authorities and would checked suitability requirements of the ISM Code on board.
3. The relevant authorities would sent competent auditor to doing verification on board to checking suitability requirements of the ISM Code on board.
4. If required, so the relevant authorities would published audit report and temporary SMC applicable during 5 months.
5. Permanent SMC could published after all non-conformity founded while verification which fixed.

2.10 Port conditions

In this research, there is port operation would be focused. The author reason chosen in ferry port authority Merak. Supported with strategic positions, The ferry port is expected to be a fast,

comfortable and safe. The description of the ports would be explained in the next paragraph.

Table 2.6 Data ship accident on 3 different biggest port in Indonesia 2010-2015

Port Area	Total Accident
Ferry port authority Merak	8
Port of Tanjung Perak Surabaya	10
Port of Tanjung Priok Jakarta	11

Source : NTSC (2016)

2.10.1 Ferry port authority Merak

Ferry port Merak-Bakauheni is a port to connected between Java and Sumatera. With the important role status, ferry port authority Merak could driver for economic growth. Data from PT. ASDP Indonesia Ferry, last year there are 1566 trips. And this year increased 2% become 1597 trips (ASDP Indonesia Ferry, 2016). This is makes ferry port authority Merak become the busiest ferry port in Indonesia. It needs to be supported with safety in maritime public transportation in Merak-Bakauheni because there is no transportation safety standard on ferry ship through seeingship condition and ferry ports condition. Data from NTSC showed there are eight accident (even more) happened since 2010-2014.

Figure 2.3 Ferry port authority Merak
Source : tempo.co (2013)

Table 2.7 Ship data Accident 2010-2014 at Ferry Port Authority Merak

Date	Name of ship	Type of accident
23/02/2010	KM. Laut Teduh 2	Grounded
08/02/2010	KMP. Bina Jaya	Sink
17/01/2011	KM. Mitra Nusantara	Fire
29/07/2011	KMP. Bahuga Jaya	Collision
03/09/2011	KMP. SMS Kartanegara	Collision
11/05/2011	KM. Saraswati	Fire
12/09/2013	KM. Pramudita	Fire
03/05/2014	KMP. Marisa Nusantara	Collision

Source : NTSC (2016)

2.11 KPIs for SMS

Key Performance Indicator (KPIs) is used to measure and monitoring performance resource. KPIs measurement serves to determine the repairs needed. SMS instruction execution on board sometimes not recorded properly by the crew on board. DPA as person in charge should be responsible for monitoring operation of the ship, safety and environmental pollution. The crew on board should reported relevant records and evidences of SMS to DPA. So that continuous monitoring of the KPIs will gave idea about the state of SMS implementations on board ship. Moreover, the KPIs based analysis improves safety performance on board ships (Akyuz & Celik, 2014). In this research focused on measuring the effectiveness of SMS implementations based on KPIs using the hybrid decision making approach (AHP-TOPSIS). The KPIs standard according Akyuz & Celik (2014) paper with title *a hybrid decision-making approach to measure effectiveness of safety management system implementations on-board ships* would explained in the following table.

Table 2.8 KPIs description and code

Name of KPIs	Code of KPIs	Descriptions
Number of deficiency observed on board ships	KPI_1	Number of deficiency refers to the lack of requirements and environment on board and related regulatory requirements. Deficiency should be recorded and identified at least once a year. The main category of deficiency on board, observed Port State Control (PSC) such as : - Certificates and documents - Condition of watertight (street, alley to rescue passengers) - Life saving equipment - Prevention of pollution
Number of completed training on board ships	KPI_2	The goal is to provide improved crew awareness of the safety and environmental requirements. DPA sends training procedures related to ship authorities to improve the competency requirements. Therefore, training should at least once a year.
Number of major non-conformity	KPI_3	Major non-conformity is defined become a serious threat that may lead to vital failure for crew safety, ship or environment requiring corrective action as soon as possible. If PSC operator find major non-conformity during checking, it must be repaired before ship sailing. For example, there is not Safety Management Certificate (SMC) on ship.

Number of detention	KPI_4	If the corrective/preventive action procedures are not remedy the major non-conformities, the ship is not allowed to sail. This is called the detention.
Number of *near-miss*	KPI_5	It is defined as unexpected events that do not resulted in loss of life or injury but had to potential danger still exists. *Near- miss* is recorded on board to see the potential events that almost lead to the danger of the ship to prevent reoccurrence.
Number of successful psychometric test applied for officer	KPI_6	According to maritime regulation, every company should provide the ship with qualified crew and medically fit. To required this requirement, DPA apply psychometric test for the crew. This test has objective way to monitor physical and mental performance the crew.
Number of crew injury on board ship	KPI_7	Crew injuries are the most common issues on board and the crew always face the risk. In ISM Code explained that, ensure safety at sea, prevention of human injury or loss of life is classified as one of the main objectives. Therefore, a record number of crew injuries should be kept and reported to DPA.
DPA internal audit judgement	KPI_8	DPA responsibilities defined in the ISM Code is a security monitoring and prevention pollution in the ship. DPA was present on board to conduct regular internal audit to ensure that SMC practice has been good.

Health Safety Environment and Quality (HSEQ) Manager audit judgment	KPI_9	On the company, there are HSEQ department to improve the safety, quality and environment performance in management and operation of ship. HSEQ department concentrating on adopted principle quality, health life, safety and environment.

Source : Akyuz & Celik (2014)

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CHAPTER 3
RESEARCH METHODOLOGY

3.1 Conceptual Framework

This research focused on evaluation SMS based on KPI model by Akyuz & Celik (2014) used a hybrid decision-making methodology Analytical Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). The type of ship selected in this research is a Ro-ro – Passenger (ROPAX). Introduction of AHP-TOPSIS was explained in chapter 2.

This chapter outlines explained the KPIs model from Akyuz & Celik (2014) to evaluation effectiveness SMS implementation on ROPAX vessel. The research location on Ferry Port Authority Merak. This is a beginning step to answer the research objective *: to knowing the lowest effectiveness KPI model should to implementation on SMS based on AHP and TOPSIS method, to given evaluation from KPI to improve SMS on the shipping companies especially ROPAX vessel and giving recommendation for stakeholders to improvement shipping transportation safety standard in Indonesia.* More specifically, this research using questionnaire from respondents as a data of classification collection process. Data from questionnaire would presented to evaluation effectiveness SMS on ROPAX ship at ferry port authority brach Merak using hybrid decision-making approach AHP-TOPSIS.

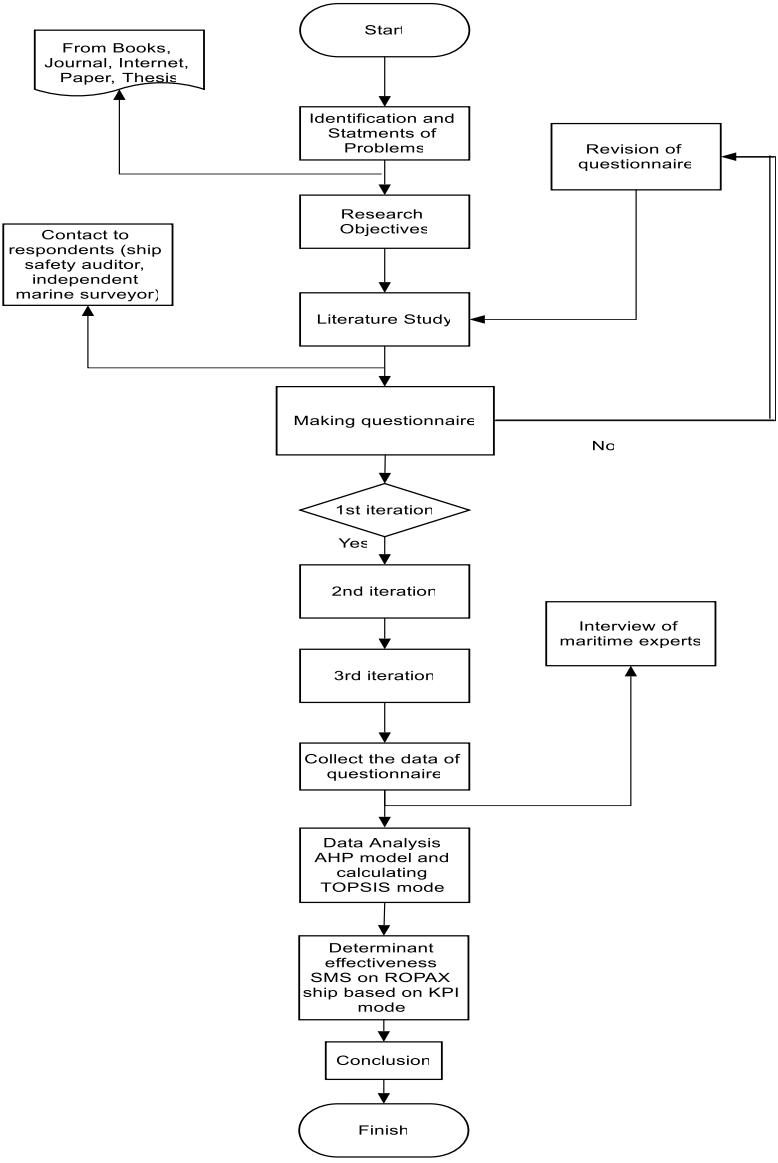

Chart 3.1 Methodology research flowchart

3.2 Research design

The research design is the planning stage of collecting and analyzing research unit and variables that provide relevancy, causation and integration according to research objectives (Gable, 1994). This research design in this thesis enables the experiences of respondents, and their understanding and giving information what is the classification KPIs model to evaluation effectiveness SMS on ROPAX ship at port of Tanjung Perak, Surabaya. In order to do so, the research process is designed to give a detailed description according to the research questions (Gurning, 2011).

Chart 3.1 (see on page 31) shows the flowchart of methodology research process outlining the steps in which all research objective are become the topic of this research. First step, beginning with identification and statement of problems, the author discuss about measure effectiveness of safety management system (SMS) based on KPIs in ROPAX ship. The research location are in the three ports, there are port of Tanjung Perak, Surabaya, port of Tanjung Priok, Jakarta and ferry port authority Merak. The author start to reading the reference from book, journal, paper and thesis who related with this case. From literature study, the author knows that ROPAX vessel has not applied ISM Code well. This is evidenced by the final investigation ship accident reports from NTSC (National Transportation Safety Committee), almost in every ship accident reports especially ROPAX vessel said that there is not safety management system (SMS) records onboard ship.It is difficult for NTSC investigator to collect the data. Other than that, data from NTSC said that increasing total of ship accident in Indonesia. The ideal condition, ROPAX vessel operator should be guarantee the safety of the crew, passengers and goods in accordance with ISM Code regulations. The next process is making questionnaire using AHP model. The question is about respondents opinions regarding the effectiveness of SMS implemented on board. In this case study researched is type of ROPAX vessel. After that, iteration answer result the questionnaire from respondents. Iteration performed until three times used for validation result.

Some KPIs determined by judgments of maritime experts. The experts determined using scale 1-5. The job titles of maritime experts are independent surveyor, DPA from some shipping company and investigator from NTSC. After getting result of AHP method. The next step is measure effectiveness safety management system (SMS) from comparison ship data on three different operation area. The goal is knowing ships that highest effectiveness point in implementing SMS on ROPAX ship and analyze the results of TOPSIS method to giving recommendation about improve shipping standard safety in Indonesia.

3.3 Proposed approach

Consider advice supervisor and several references indicated that hybrid decision-making approach AHP-TOPSIS would be presented to evaluate SMS effectiveness on ROPAX ship in a few ports in Indonesia. The AHP technique is first utilized to determined evaluation criteria hierarchy. And then, a pair-wise comparison matrix is developed. After that, calculate the criteria weights. TOPSIS method is used to determine the scale of KPIs criteria. The proposed hybrid decision-making approach AHP-TOPSIS consist of few steps (Akyuz & Celik, 2014) :

1. First step, specifying Key Performance Indicators (KPIs). It is depends on the nature of the problem, data and expert opinion such as DPA and HSEQ in the decision-making process in order to establish evaluation criteria of comparison matrix.
2. Second step, composing a pair-wise comparison matrix with a measurement 1-9 scale of the AHP. The definition scale :
   - scale 1 : equal importance.
   - scale 3 : moderate importance.
   - scale 5 : strong importance.
   - scale 7 : very strong importance.
   - scale 9 : extreme importance.

   The intermediate scales are 2,4,6,8 used for if in doubt. In matrix A, each $a_{ij} = 1$ when $i = j$ and $\propto_{ji} = 1/\propto_{ij}$.

$$A = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ a_{21} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{n1} & a_{n2} & \cdots & 1 \end{bmatrix} a_{ii} = 1, a_{ji} = \frac{1}{a_{ij}}, a_{ij} \neq 0$$

3. Third step, calculating criterion weights (KPIs priorities) and consistency ratio (CR). After composing of a pair-wise comparison matrix, normalized value of matrix is found by dividing each entry in to the column to the sum of entries in column. Thereafter, the priority weights of criterion are calculated. The average of value in each row gives estimates of relative weights of criterion The normalization of matrix and priority weights of criterion $(W_1, W_2, \dots, W_j)$ can be calculated with following equations :

   $r_{ij} = \frac{a_i j}{\sum_{i=1}^{n} a_i j}, \quad i = 1,2, \dots, n$ and $j = 1,2, \dots, n$

   $W_j = \frac{1}{n}\, x\, \sum_{i=1}^{n} a_{ij}, \quad i = 1,2, \dots, n$

   In order to provide consistency of data in methodology. Accordingly, consistency index (CI) can be calculated as follows :

   $CI = \frac{\lambda_{max} - n}{n-1}$

   In equation, n is the order of the matrix, and λmax is maximum eigenvalue of the matrix and it can be found with following equation (Vargas, 1982).

   $\sum_{j=1}^{n} \alpha_{ijwj} = \lambda_{max.wi}$

   Consistency ratio (CR) value should be calculated. If the CR value is equal or less than 0,10. It's mean consistent. The formulation of CR is :

$CR = CI/RI$

The random index (RI) is the indicator for random and it is subjected to the number of items that is compared in matrix.

4. Fourth step, constructing decision matrix (D). This is to represent all information available for the attribute in the decision matrix. The structure of the decision matrix can be defined as follows :

$$D = \begin{bmatrix} & C_1 & C_2 & C_3 & \cdots & C_n \\ A_1 & X_{11} & X_{12} & X_{13} & \cdots & X_{1n} \\ A_2 & X_{21} & X_{22} & X_{23} & \cdots & X_{2n} \\ A_3 & X_{31} & X_{32} & X_{33} & \cdots & X_{3n} \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ A_m & X_{m1} & X_{m2} & X_{m3} & \cdots & X_{mn} \end{bmatrix}$$

Where $A_i = i^{th}$ alternative related and x_{ij} is the performance value of alternative with respect to criterion c_j.

5. Fifth step, calculating normalized decision matrix by using formula :
$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}, i = \mathbf{1}, \mathbf{2}, \mathbf{3}, \ldots, m$ and $j = \mathbf{1}, \mathbf{2}, \mathbf{3}, \ldots, n.$

6. Sixth step, Calculating weighted normalized decision matrix, associated weight is to be multiplied with its normalized decision matrix. The calculation is as follows :

$v_{ij} = w_j . r_{ij}, \ i = 1,2, \ldots, n, j = 1,2, \ldots, n$
Where w_j is the weight of the jth attribute or criterion.

7. Seventh step, determining the positive ideal solution (PIS) and negative ideal solution (NIS). The PIS and NIS values can be determined via taking the maximum and minimum values within the row of weighted normalized decision matrix.

$$A^+ = \{(\max v_{ij} | j \in J) \text{ or} (\min v_{ij} \,|\, j \in J') \text{ for } i = 1,2,\dots,m\}$$
$$= \{v_1^+, v_2^+, \dots, v_n^+\}$$

$$A^- = \{(\min v_{ij} | j \in J) \text{ or} (\max v_{ij} \,|\, j \in J') \text{ for } i = 1,2,\dots,m\}$$
$$= \{v_1^-, v_2^-, \dots, v_n^-\}$$

Where $J = 1,2,3,\dots,n.$ is associated with benefit (positive criteria) and $J' = 1,2,3,\dots,n$ is associated with cost (negative criteria).

8. Eighth step, Calculating of separation measure. The separation of each alternative from the PIS can be found by following equations :

$$S_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^+)^2}, i = 1,2,\dots,m$$

Likewise, the separation from the NIS could be defined as :

$$S_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2}, i = 1,2,\dots,m$$

9. Ninth step, calculating the relative closeness to the ideal solution. The relative closeness has been measured by following equation :

$$C_i^* = \frac{S_i^-}{S_i^+ + S_i^-}, 0 < C_i^* < 1, i = 1,2,\dots,m$$

10. Tenth step, ranking the preference order (SMS effectiveness evaluation). This step provides a comparison of alternative each SMS which effectiveness.

3.4 KPIs for safety management system (SMS)

Key Performance Indicator (KPI) is a success measure from a purpose and operational strategic target. Each company or institution must has KPI as a priority to achieve target or purpose from company or institution and become material evaluation to performance company/institution in developing target.

To monitor performance of the SMS implementation, relevant data from onboard records. So, DPA could be monitoring of the KPIs. Analysis of KPIs could be improves safety performance onboard ships.

The KPIs would determined by Akyuz & Celik (2014) to measure effectiveness of SMS implementation based on KPI in RO-PAX (Ro-ro & Passengers) ship at port of Tanjung Perak, Surabaya.

3.4.1 Number of deficiency observed on-board ship (KPI_1)

Deficiency generally refers lack of safety and environment requirements onboard ship. Example for shipboard deficiencies are certificates and documents of the ship liked cargo ship safety construction certificate and minimum safe manning certificate, structural condition water/weather tight condition, life saving appliance and pollution prevention. Deficiencies per year must recorded and identified.

3.4.2 Number of completed training on-board ship (KPI_2)

Every month, crew onboard should follows training safety and environment requirements. This function to improve competency of crew. DPA send the training requirements.

3.4.3 Number of major non-conformity (KPI_3)

Major non-conformity is serious threat which a fatal incident to safety of crew, ship or environment. If the port officer found any major non-conformities onboard ship. There must fixed before vessel departure. An example if, there is Safety Management Certificate (SMC) onboard.

3.4.4 Number of detention (KPI_4)

The ship could not sailing of there is not the corrective/preventive action procedures to remedy the major non-conformities. Number of detention is indicator for effectiveness implementation of SMS.

3.4.5 Number of *near-miss* (KPI_5)

Near-miss is a condition where accident almost happened. Near-miss report should be making by crew onboard. Record of near-miss could be prevent accident happened.

3.4.6 Number of sucsessful psychometric test applied for officer (KPI_6)

Psychometric test has a function to monitor crew's physical and mental performance.

3.4.7 Number of crew injury on-board ship (KPI_7)

Injuries of crew is a common issue onboard ship and the crew always face a high risk at sea condition. Number of crew injuries should records and reports to shore-base organization.

3.4.8 DPA internal audit judgment (KPI_8)

The responsibility of DPA is clearly defined in ISM Code as monitoring the safety and pollution prevention aspect of the ship. DPA attends on-board ship to conduct an internal audit regularly in order to ensure that good SMS practice on-board ships.

3.4.9 HSEQ Manager audit judgment (KPI_9)

In ship management companies, health, safety, environment and quality (HSEQ) department has recently been established to improve the safety, quality and environment performance in ship management and operation.

3.5 Research approach

Not many researchers has explored and applied hybrid decision making AHP-TOPSIS to evaluation effectiveness SMS ROPAX vessel based on KPI model. Conceptual of AHP method based on theory of decision making with weighting value (Saaty, 1994). The Safety Management System is a working system in a shipping company to ensure safety condition of the crew, passenger and prevention of pollution. The main function of SMS is to define the scope of work, analyze hazards, develop and implement controls, and improve feedback systems (Davis, 1997).

Akyuz & Celik (2014) on their paper discussed about evaluation SMS on board based on KPI model. On that research using chemical tanker ship as type of ship to evaluation SMS based on KPI model. KPI model data were provided through data records which are consisting of PSC reports, vetting control ports and company internal audit reports (Akyuz & Celik, 2014). The data received from company is available for the last three years (Akyuz & Celik, 2014). In addition, subjective data has received from maritime experts. The expert profile contains professional managers (DPA and HSEQ department) and marine superintendents who have seagoing background and professional execution experiences (Akyuz & Celik, 2014).

In this research, the author chosen concept from Akyuz & Celik (2014) with ROPAX vessel as a model research. The reasons used ROPAX as a model research because although ROPAX vessel is the main maritime transportation for crossing between islands. In fact, based on safety checking Directorate of Shipping and Seafarers randomly on passenger ships, ROPAX and ferries. The team found many safety equipment not installed on the ships (DIREKTORAT PERKAPALAN DAN KEPELAUTAN, 2016). The ship must ensure the safety of crew and passengers as well as goods when on board. It was written in the ISM Code regulations (IMO, 2014). The government asked to increase the cost of ferry ship in ferry ports in order to ensure the safety of ferry transport and creating conducive business climate (Bisnis Indonesia, 2014).

3.6 Literature study

Literature study conducted to learn about basic theory of the problems associated with shipping accidents, the factors that cause collision of the ship, the theory of implement using of AHP method application and TOPSIS method. On this session, conducted a study of references based on journal/paper, internet, books supporting of this problem and another reference.

3.7 Data collection

In this step is to data collection related and could help for this research. The main objective of this data collection process is to get more information about causative shipping accident.

3.7.1 Primary data

Data required as primary data is important to answer the research objective. Primary data required to supported this research are :

1. Condition survey data from seven ships in three different operation area.
2. Interview from maritime experts.
3. The result investigation from NTSC with type of ROPAX vessel.

3.7.2 Second data

Secondary data is data originally collected for a different purpose and reused for another research question (Hox & Boeije, 2005). If it was collected by someone else for some other purpose, it is secondary data (Boslaugh, 2000). Secondary data on this research are :

1. The information update from television, radio and newspaper related with this research.
2. Analysis of the ship collision accidents with another case from NTSC investigation report.

3.8 Interview

Interviewer are an expert on maritime and has experience become the crew on the ship. They would ask for judgments on some KPIs.

3.9 AHP & TOPSIS calculation method

After getting questionnaire data from respondents, the author start to determine effectiveness SMS based on KPIs on ROPAX vessel. The next step its determine comparison ships data effectiveness that has the highest value using TOPSIS method.

3.10 Conclusion and recommendation

Conclusion is the last step of overall a process that has been finished before and gift the answers about research objectives. Recommendation is the condition that could be as a good example for develop things.

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CHAPTER 4
DATA ANALYSIS AND DISCUSSION

4.1 Introduction

On this chapter would contain the analysis of AHP-TOPSIS approach will be utilized to measure effectiveness of SMS implementations on board ship using KPI model based on comparison of five sample ROPAX survey condition reports either still active operation.

After this introduction, the second section explain detail about ship data comparison condition survey of some cases ROPAX ship. The author have chosen for study case operation area on ferry port authority branch Merak. The third section explain about respondents of this research and job titles for every respondents and maritime experts. The forth section discuss about empirical analysis measuring effectiveness SMS based on KPI using AHP-TOPSIS and the last section discussing about the result of the research.

4.2 Ships data comparison

The author used ship data comparison condition survey of some cases ROPAX ship at ferry port authority branch Merak. Ship data comparison obtained by the author in one of the independent marine surveyor and consultant company in Indonesia. Example vessels for comparison data have following criteria :

1. The ship types is ROPAX vessel.
2. The scope of the research object was the ROPAX ship that serves from Merak to Bakauheni.
3. The vessels has completed the survey conditions from independent marine surveyor company.

Table 4.1 (see on page 44) shows ship data comparison condition survey of some cases ROPAX ship at ferry port authority branch Merak with condition status are total five active ROPAX vessels.

Table 4.1 Ship comparison data ROPAX vessel

Name of ROPAX ship	Operational route	Status	Year of condition survey report
KMP. EXAMPLE - II	Merak – Bakauheni	Active	2012
KMP. Rajakarta	Merak – Bakauheni	Active	2013
KMP. SMS Kartanegara	Merak – Bakauheni	Active	2014
KMP. HM. Baruna I	Merak – Bakauheni	Active	2014
KMP. Port Link III	Merak – Bakauheni	Active	2014

Source : The author (2016)

Ships data obtainable from independent surveyor. This data totally classified so the name of company couldn't showed on this research. The full complete condition survey reports could be found in attachment 3. Ship data comparison chosen with status operation active ROPAX vessels.

4.3 Analysis of respondents

This section describes the characteristics of respondent profile. The data contains qualitative and quantitative information for KPIs basis last condition survey reports in every ship. The quantitative data were provided through data record from independent surveyor company. The data received from company is available for the last condition survey in that company. The subjective data obtained through interviews with maritime experts, namely DPA from shipping company, auditor ISM Code and investigator National Transportation Safety Committee (NTSC). Maritime expert interviews to be necessary because it would represent judgesment for criteria in some KPIs (KPI_2, KPI_4, KPI_5,

KPI_6, KPI_7, KPI_8, KPI_9) using Likert scale 1 to 5. Number of deficiency (KPI_1) and number of major non conformity (KPI_3) could be knowing on condition survey reports each ROPAX vessels. Maritime experts provide data/judgements for pairwise comparison of KPIs and the subjective data for KPI_8 and KPI_9 in the content of decision matrix (Akyuz & Celik, 2014).

4.3.1 Respondent profiles

In the Table 4.2 shows profiles of the respondents by titles. Total 30 respondents in this research with classification titles are DPA shipping some companies, independent marine surveyor, ship safety auditor, staff of State-Owned Enterprises.

Table 4.2 Profile of respondents

Job titles	**Number**
DPA shipping some companies	10
Ship safety auditor	1
Staff of State-Owned Enterprises	17
Independent marine surveyor	2

Source : The author (2016)

The respondents were also concurrently as maritime experts to be interviewed for judgements some criteria based on KPIs. This data suggests respondents have a significant role on decision making process to measure effectiveness SMS based on KPIs model and therefore were able to provide sufficient insights into their organization for the purposes of the current study.

4.4 Judgements perception of KPIs model

This section explores respondents result of scoring KPIs based on AHP method. There are two kinds process to collecting data for measure effectiveness safety management system (SMS) on ROPAX vessel. The reason why the author using two kinds process because of limited data for this research. If referring to research paper by Akyuz & Celik (2014) used qualitative data (KPI_1 to KPI_7) were provided through data records which are consisting of PSC

reports, vetting control reports and company internal audit reports. The data received from company is available for the last three years. In addition, subjective data (KPI_8 & KPI_9) has received from maritime experts. The expert profile contains professional managers (DPA and HSEQ department) and marine superintendents who have seagoing background and professional execution experiences (Akyuz & Celik, 2014).

In this research, for measuring lowest effectiveness KPIs model implementation on SMS based on AHP method by distributing questionnaire to the respondents with total respondents are 30. For determine ranking effectiveness SMS from comparison five ROPAX vessels at ferry port authority Merak operation area using TOPSIS method. The author used qualitative data KPI_1 (number of deficiency observed onboard ship) and KPI_3 (number of major non-conformity on board ship) based on comparison ship data condition survey reports from independent marine survey company. Another KPIs (KPI_2, KPI_4, KPI_5, KPI_6, KPI_7, KPI_8, KPI_9) using judgements perspective maritime experts approach Likert scale 1 to 5.

Table 4.3 KPIs on previous research

Code	**KPIs model based on previous research**	**Scale on previuos research**
KPI_1	Number of deficiency observed on board ship (-)	Numbers
KPI_2	Number of completed training on board ship (+)	Numbers
KPI_3	Number of major non-conformity observed on-board ships (-)	Numbers
KPI_4	Number of detention (-)	Numbers
KPI_5	Number of near-miss reported by ships (-)	Numbers
KPI_6	Number of successful psychometric test applied for officer (+)	Numbers
KPI_7	Number of crew injury observed on-board ships (-)	Numbers

KPI_8	DPA internal audit judgement (+)	5-Scale judgements
KPI_9	HSEQ Manager audit judgement (+)	5-Scale judgements

Source : Akyuz & Celik (2014)

Table 4.4 KPIs description in this research

Code	**KPIs model in this research**	**Scale on previous research**	**Scale in this research**
KPI_1	Number of deficiency observed on board ship (-)	Numbers	Numbers
KPI_2	Judgement of completed training on board ship (+)	Numbers	5-Scale judgements
KPI_3	Number of major non-conformity observed on-board ships (-)	Numbers	Numbers
KPI_4	Judgement of detention reported (+)	Numbers	5-Scale judgements
KPI_5	Judgement of near-miss reported by ships (+)	Numbers	5-Scale judgements
KPI_6	Judgement of successful psychometric test applied for officer reported by ships(+)	Numbers	5-Scale judgements
KPI_7	Judgement of crew injury observed & reported on-board ships (+)	Numbers	5-Scale judgements
KPI_8	DPA internal audit judgement (+)	5-Scale judgments	5-Scale judgements
KPI_9	HSEQ Manager audit judgement (+)	5-Scale judgments	5-Scale judgements

Adaptation : Akyuz & Celik (2015)

Collecting data 5-scale judgements using questionnaire interview method to maritime experts according to issues regarding ROPAX vessel. Every judgements scale would accompanied by statement to reinforce the result of judgements. Maritime experts interviewed totaled are 3 person. The job title of maritime experts are independent marine surveyor and investigator NTSC.

4.5 Empirical analysis

In chapter two, the author explained about KPI approach to SMS. The main function is monitoring performance of the SMS implementation on board ship. These indicators can also be helpful to review performance of SMS implantation on-board ships (Akyuz & Celik, 2014). After this paragraph would explained step to measure effectiveness SMS based on KPIs using Analytical Hierarchy Process (AHP) method. After that, measure comparison ship data to determine ranking of effectiveness implementation SMS based on survey condition reports using TOPSIS method.

4.5.1 Measuring effectiveness SMS based on KPI model using AHP method

The criteria for measure effectiveness SMS based on KPI model has been showed in Table 4.4 (see on page 47). Table 4.5 (see on page 49) has showed develop a hierarchy problems in this research. The goal of this hierarchy problems is measuring effectiveness implementation safety management system (SMS) based on KPIs using hybrid decision-making AHP-TOPSIS. The criteria of this hierarchy problems are KPI_1, KPI_2, KPI_3, KPI_4, KPI_5, KPI_6, KPI_7, KPI_8, KPI_9. Ship name data comparison for measure effectiveness SMS based on KPIs model using TOPSIS method are KMP. HM. Baruna 1, KMP. Port link, KMP. Kartanegara, KMP. SMS Mulawarman and KMP. Example II.

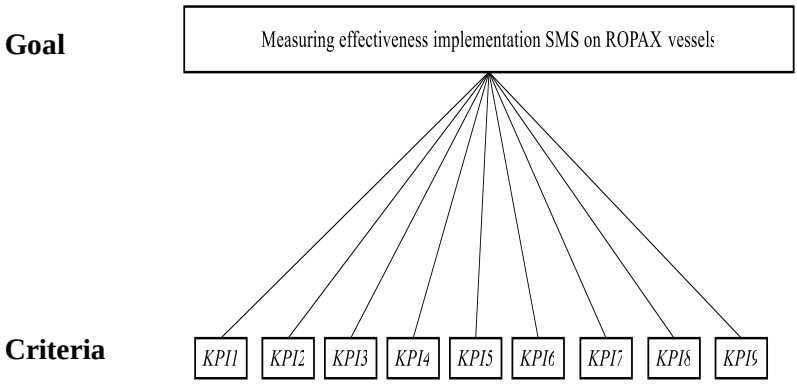

Figure 4.1 Hierarchy structure for research
Source : The Author (2016)

After determine KPIs for SMS approach, the next step is collecting respondent questionnaire result, total 30 respondents. After all respondents questionnaire result already input, compile the criteria to pair-wise comparison inter-criteria into table with Likert scale 1-9. This is process to weighted criteria according to 1-9 scale of the analytical hierarchy process (AHP). Calculation of pair-wise comparison should be carefully and accurately because it affects the final result. The questionnaire answer survey from respondents to construct a pair-wise comparison matrix. Total respondents of questionnaire survey are 30 person. The complete questionnaire data survey could be showed on attachment 2.

Table 4.5 Example questionnaire answer survey from respondents

Respondent 1

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	8	8	0,1429	0,1111	0,1111	0,1111	0,1111	0,1111
KPI_2		1	7	7	7	7	7	7	7
KPI_3			1	0,1667	0,1667	0,2	0,1111	0,1429	0,125
KPI_4				1	7	7	7	7	7
KPI_5					1	0,1667	0,1667	0,125	0,1111
KPI_6						1	7	7	7
KPI_7							1	0,125	0,1429
KPI_8								1	7
KPI_9									1
Total	3	9	16	8,3095	15,278	15,478	22,389	22,504	29,49

Source : The Author (2016)

After input questionnaire result from respondents. The next step is calculating questionnaire result each criteria with total 30 respondents. Each criteria from all respondents multiplied and geometric mean by n=30. Next step, summing per column criteria. The result of questionnaire input to pair-wise comparison are show in Table 4.6 (see on page 50). The intention of this table for example, “number of crew injury observed on-board ships” (KPI_7) has weak importance than “number of detention” (KPI_4).

Therefore, number 2,1413 is assigned for this comparison. Likewise, the reciprocal equation of KPI_7 to KPI_4 is 0,467.

Table 4.6 Pair-wise comparison

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1,000	2,0775	0,9811	1,8664	1,5405	1,5976	1,006409	1,070782	1,688365
KPI_2	0,4813	1,000	0,964	2,0955	1,3287	1,9131	1,265411	0,840265	1,952343
KPI_3	1,0192	1,0373	1,000	3,3934	1,7083	2,009	1,179684	1,309237	1,807353
KPI_4	0,5358	0,4772	0,2947	1,000	0,4632	1,1596	0,467013	0,603133	1,043908
KPI_5	0,6491	0,7526	0,5854	2,159	1,000	2,8753	0,854215	1,194481	2,265536
KPI_6	0,6259	0,5227	0,4978	0,8623	0,3478	1,000	0,563867	0,53413	0,834958
KPI_7	0,9936	0,7903	0,8477	2,1413	1,1707	1,7735	1,000	1,057674	2,411681
KPI_8	0,9339	1,1901	0,7638	1,658	0,8372	1,8722	0,945471	1,000	1,771539
KPI_9	0,5923	0,5122	0,5533	0,9579	0,4414	1,1977	0,414649	0,564481	1,000
Total	6,8313	8,3599	6,4878	16,134	8,8377	15,398	7,696718	8,174184	14,77568

Source : The author (2016)

After composing of a pair-wise comparison, the values are need to normalised. Normalised value produced by dividing each entry in column to the sum of entries in column. The average from every KPI criteria in each row gives estimation of relative weights of KPI criteria. The result of normalisation pair-wise criteria show in Table 4.7 (see on page 51). The normalisation pair-wise comparison (*r)* can be calculated with formula :

$$r_{ij} = \frac{a_i j}{\sum_{i=1}^{n} a_i j}, \quad i = 1,2,\dots,n \text{ and } j = 1,2,\dots,n$$

The priority weights are calculated from the formula in accordance explanation on chapter 3. Numerical weight values and percentages of each KPI are provided in Table 4.7 (see on page 51). After that, priority weights of criteria are calculated. The formula of priority weights of KPI criteria is :

$$W_j = \frac{1}{n}\, x\, \sum_{i=1}^{n} a_{ij}, \quad i = 1,2,\dots,n$$

Table 4.7 Normalised pair-wise comparison

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	0,14639	0,248512	0,151227	0,115683	0,17431	0,10375	0,130758	0,131	0,1143
KPI_2	0,07046	0,119618	0,148594	0,129884	0,15034	0,12425	0,164409	0,1028	0,1321
KPI_3	0,1492	0,12408	0,154136	0,210324	0,1933	0,13047	0,153271	0,16017	0,1223
KPI_4	0,07843	0,057082	0,045423	0,061981	0,05241	0,07531	0,060677	0,07379	0,0707
KPI_5	0,09502	0,090029	0,090227	0,13382	0,11315	0,18673	0,110984	0,14613	0,1533
KPI_6	0,09163	0,062524	0,076722	0,053448	0,03935	0,06494	0,073261	0,06534	0,0565
KPI_7	0,14545	0,094529	0,130659	0,132719	0,13246	0,11518	0,129926	0,12939	0,1632
KPI_8	0,13671	0,142357	0,11773	0,102766	0,09473	0,12159	0,122841	0,12234	0,1199
KPI_9	0,0867	0,061269	0,085283	0,059374	0,04994	0,07778	0,053873	0,06906	0,0677
Total	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

Source : The author (2016)

Table 4.8 KPI Priorities

KPI	Priority	Percentage
KPI_1	0,14621	14,62%
KPI_2	0,126942	12,69%
KPI_3	0,155252	15,53%
KPI_4	0,063972	6,40%
KPI_5	0,12438	12,44%
KPI_6	0,064859	6,49%
KPI_7	0,130393	13,04%
KPI_8	0,120106	12,01%
KPI_9	0,067885	6,79%

Source : The author (2016)

From Table 4.8 showed that KPI_3 (number of major non-conformity observed on-board ships) has the highest weight criterion (0,1552) and percentage is 15,53% in overall. The second position is KPI_1 (number of deficiency observed on board ship) with percentage is 14.62% in overall and the third position is KPI_7 (number of crew injury on-board ship) with percentage is 13,04% in overall. For the lowest weight KPI criteria is KPI_4 (number of detention) and the second position of the lowest weight KPI criteria

is KPI_6 (number of sucsessful psychometric test applied for officer).

Before ensuring that the result of KPI priorities was valid, the next step is validation data test with calculation consistency ratio (CR). This calculation used to ensured that criteria weight value is valid. It could be seen if consistency ratio less than 0,1 ($CR < 0{,}1$). If CR value more than 0,1 ($CR > 0{,}1$) so criteria weight value was not valid and should be checking of formula and calculation before. Table 4.10 (see on page 53) shown to calculated consistency ratio. Total per column every row obtained from sum matrix total every row in Table 4.7 (normalised pair-wise comparison). While column priority weights obtained from the value weights in table 4.8 (KPI priorities). The result obtained from sum total per row of every row (Table 4.7) and KPI priority weights (Table 4.8).

Table 4.9 Random Index

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0,58	0,90	1,112	1,24	1,32	1,41	1,45	1,49

Source : Saaty (1994)

After all calculated in every column and than total per column is 9,1857 (see on Table 4.10). This is as a $\lambda max = 9{,}1857$. The formula to calculated Consistency Index is :

$$CI = \frac{\lambda max - n}{n}$$

n is total of criteria, there are 9 criteria. The result of consistency index is 0,0206.

The formula to calculated consistency ratio (CR) is :

$$CR = \frac{CI}{IR}$$

IR is Index random from index table AHP (see table 4.8). Because ordo matrix or n of criteria is 9 so the value for random index is 1,45. The result of consistency ratio is 0,0142. This result is acceptable because consistency ratio less than 0,1 ($CR < 1$).

Table 4.10 Consistency ratio calculation

Criteria	Total per column	Criterion/priority weight	Result
KPI_1	6,83126	0,1462	0,9988
KPI_2	8,35995	0,1269	1,0612
KPI_3	6,48778	0,1553	1,0072
KPI_4	16,1339	0,064	1,0321
KPI_5	8,8377	0,1244	1,0992
KPI_6	15,398	0,0649	0,9987
KPI_7	7,69672	0,1304	1,0036
KPI_8	8,17418	0,1201	0,9818
KPI_9	14,7757	0,0679	1,003
Total			9,1857

Source : The author (2016)

4.5.2 Discussion of AHP method calculation result

Since KPI_3 is the ranked on the top of priority weight table, the respondents considered as the most highest rated effectiveness safety management system (SMS) implementation on ROPAX vessel. Major non-conformity is becoming serious thing to be noticed. Because it could threaten a system failure on-board and influence to safety of the crew, passengers, the ship and environment. At the operational level, PSC (Port State Control) conducted survey on the ship, if it finds a major non-conformity, it must be repaired before the ship sailing and would not be allowed to depart until confirmed to sail (Akyuz & Celik, 2014). Therefore, a well organized SMS is designed to record major non-conformity in every month especially once a month. The DPA should be control records of major non-conformity and gives orders to crew doing repaired or adjustments to non-conformity.

The KPI_1 is the second most factor accordance with effectiveness of safety management system implementation on ROPAX vessel. Since the ship would depart, then the crew should be responsive to the existing deficiency on board. The most important thing is related to regulation requirements. The DPA should put in record of deficiency in SMS report. Deficiency must recorded and identified once a year.

The third most factor weight criteria effectiveness implementation safety management system on board is KPI_7. The crew has a high risk when sailing onboard. So, the officer should be responsive if there is a crew was injury. The officer has a job to record every crew was injury onboard. On the ship should prepared first aid box for the crew of the ship. If the disease requiring treatment in hospital, the crew was leaving the ship in next trips.

KPI_4 (number of detention) is a lowest effectiveness SMS implementation on ROPAX vessels according to the result of questionnaire respondent survey. Paris MoU on the rules said that, the ship relevant for detention if ships which are unsafe to proceed to sea will be detained upon the first inspection irrespective of the time the ship will stay in port and the ship will be detained if the deficiencies on a ship are sufficiently serious to merit a PSC returning to the ship to be satisfied that they have been rectified before the ship sails. When referring to the minister of transport regulation number. 1 in 2010, port clearance only on delays status because of bad weather. Retraction of port clearance conducted if

1. The ship did not sail more than 24 hours from the time limits set on port area
2. The ships engage in activities that disrupt traffic of ships, endanger the safety and security of shipping and the environment
3. The written order of the court nation

Minister of Transportation regulations in 2012 in Article 30, paragraph 4 and 5 have a conclusion that within a period of 3 months plus 1 month still found a defeciency by the auditors so,

Document of Compliance (DOC) of the ROPAX vessel should be rejected.

Two example of regulations in Indonesia for the detention of ship is not yet fully sufficient to ensnare the ROPAX vessels who does not required non-conformity onboard. Almost no records on the number of ship detention. This is due to lack of control and supervision in ROPAX vessels. This can endanger the safety of passengers and crew of the ship when the ship was sailing and not in accordance with the ISM Code regulation.

4.5.3 Measure effectiveness SMS implementation based on KPI model on comparison ROPAX vessel data used TOPSIS method

In the next step, decision matrix is established. On Table 4.11 (see on page 56) is illustrating data record and judgments provided by the respondents on comparison ship data condition survey reports based on KPI model. The data showed five comparison ROPAX vessel condition survey reports. The source data from independent marine survey company at Jakarta. This research location at ferry port authority Merak.

Beside numerical data information,because of limited data of safety management system of each ROPAX vessel sample, KPI_2 (for completed training on board ship), KPI_4 (detention reported), KPI_5 (near-miss reported by ships judgements), KPI_6 (successful psychometric test applied for officer), KPI_7 (crew injury observed on-board ships), KPI_8 (DPA internal audit) and KPI_9 (HSQE department audit) using judgement scoring with Likert scale 1-5. Scoring given by maritime experts with interview method. Total respondents are three. Job titles of the respondents are independent marine surveyor (2 peoples) and investigator NTSC (1 people). Every respondents would be giving questionnaire based on KPI method. Table 4.11 (see on page 56) show data on each KPI. KPI_1 and KPI_3 are using data from condition survey of five ROPAX vessel on operation area ferry port authority branch Merak sample.

KPI_2, KPI_4, KPI_5, KPI_6, KPI_7, KPI_8, KPI_9 using 5-scale judgements from respondents.

Table 4.11 Data on KPIs

	Information	KMP. HM BARUNA 1	KMP. SMS KARTANEGARA	KMP. EXAMPLE II	KM. PORT LINK III	KMP. RAJAKARTA
KPI1	Numbers	6,000	9,000	11,000	10,000	11,000
KPI2	5-Scale Judgements	1,260	1,260	1,260	2,000	1,260
KPI3	Numbers	3,000	4,000	8,000	8,000	7,000
KPI4	5-Scale Judgements	1,260	1,260	1,260	1,260	1,000
KPI5	5-Scale Judgements	1,000	1,260	1,260	1,260	1,260
KPI6	5-Scale Judgements	1,000	1,260	1,260	2,289	1,260
KPI7	5-Scale Judgements	1,260	1,587	1,260	2,289	1,260
KPI8	5-Scale Judgements	1,000	1,260	1,260	3,000	1,000
KPI9	5-Scale Judgements	1,260	1,260	1,260	1,587	1,587

Source : The author (2016)

The data received from questionnaire (number) and interview scoring method (5 scale-judgements) are utilized to compose initial decision matrix in Table 4.12, the negative factors are reciprocally inserted. Example, KPI_1 (number of deficiency observed on board ship) on KMP. Rajakarta condition survey reports has been reported as 11 number of deficiency. So, on table initial decision inserted as 1/11.

Table 4.12 Initial decision

	Scale	Weight	KMP. HM BARUNA 1	KMP. SMS KARTANEGARA	KMP. EXAMPLE II	KM. PORT LINK III	KMP. RAJAKARTA
KPI1	Numbers (-)	0,146210331	0,167	0,111	0,091	0,100	0,091
KPI2	5-Scale Judgements (+)	0,126942168	1,260	1,260	1,260	2,000	1,260
KPI3	Numbers (-)	0,155252244	0,333	0,250	0,125	0,125	0,143
KPI4	5-Scale Judgements (+)	0,063972268	1,260	1,260	1,260	1,260	1,000
KPI5	5-Scale Judgements (+)	0,124380407	1,000	1,260	1,260	1,260	1,260
KPI6	5-Scale Judgements (+)	0,064859383	1,000	1,260	1,260	2,289	1,260
KPI7	5-Scale Judgements (+)	0,130392783	1,260	1,587	1,260	2,289	1,260
KPI8	5-Scale Judgements (+)	0,120105648	1,000	1,260	1,260	3,000	1,000
KPI9	5-Scale Judgements (+)	0,067884767	1,260	1,260	1,260	1,587	1,587

Source : The Author (2016)

Afterwards, the normalised decision matrix by using formula :

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}, i = \mathbf{1}, \mathbf{2}, \mathbf{3}, \dots, m \text{ and } j = \mathbf{1}, \mathbf{2}, \mathbf{3}, \dots, n.$$

Table 4.13 Normalised decision

	Scale	Weight	KMP. HM BARUNA 1	KMP. SMS KARTANEGARA	KMP. EXAMPLE II	KM. PORT LINK III	KMP. RAJAKARTA
KPI1	Numbers (-)	0,146210331	0,054	0,032	0,027	0,019	0,028
KPI2	5-Scale Judgements (+)	0,126942168	0,409	0,362	0,378	0,370	0,382
KPI3	Numbers (-)	0,155252244	0,108	0,072	0,037	0,023	0,043
KPI4	5-Scale Judgements (+)	0,063972268	0,409	0,362	0,378	0,233	0,303
KPI5	5-Scale Judgements (+)	0,124380407	0,325	0,362	0,378	0,233	0,382
KPI6	5-Scale Judgements (+)	0,064859383	0,325	0,362	0,378	0,424	0,382
KPI7	5-Scale Judgements (+)	0,130392783	0,409	0,456	0,378	0,424	0,382
KPI8	5-Scale Judgements (+)	0,120105648	0,325	0,362	0,378	0,555	0,303
KPI9	5-Scale Judgements (+)	0,067884767	0,409	0,362	0,378	0,294	0,481

Source : The Author (2016)

The normalised decision matrix is show in table 4.13. Thereafter, weighted normalised decision is calculated in accordance with using formula :

$$v_{ij} = w_j . r_{ij}, \ i = 1,2, \dots, n, j = 1,2, \dots, n$$

Table 4.14 Weighted normalised decision

	Scale	KMP. HM BARUNA 1	KMP. SMS KARTANEGARA	KMP. EXAMPLE II	KM. PORT LINK III	KMP. RAJAKARTA
KPI1	Numbers (-)	0,008	0,005	0,004	0,003	0,004
KPI2	5-Scale Judgements (+)	0,052	0,046	0,048	0,047	0,048
KPI3	Numbers (-)	0,017	0,011	0,006	0,004	0,007
KPI4	5-Scale Judgements (+)	0,026	0,023	0,024	0,015	0,019
KPI5	5-Scale Judgements (+)	0,040	0,045	0,047	0,029	0,047
KPI6	5-Scale Judgements (+)	0,021	0,023	0,024	0,027	0,025
KPI7	5-Scale Judgements (+)	0,053	0,059	0,049	0,055	0,050
KPI8	5-Scale Judgements (+)	0,039	0,043	0,045	0,067	0,036
KPI9	5-Scale Judgements (+)	0,028	0,025	0,026	0,020	0,033

Source : The author (2016)

Table 4.14 (see on page 57) show weighted normalised decision matrix. The next step is determining positive ideal solution (PIS) and negative ideal solution (NIS) values for each KPI. PIS is defined as the sum of the best values which could be achieved for each criteria, while NIS consist of all worst values for each criteria. The PIS and NIS values can be determined via taking the maximum and minimum values within the row of weighted normalised decision matrix. The formula for PIS and NIS are :

$$A^+ = \{(\max v_{ij} | j \in J) \text{ or} (\min v_{ij} | j \in J') \text{ for } i = 1,2,\dots,m\} = \{v_1^+, v_2^+, \dots, v_n^+\}$$

$$A^- = \{(\min v_{ij} | j \in J) \text{ or} (\max v_{ij} | j \in J') \text{ for } i = 1,2,\dots,m\} = \{v_1^-, v_2^-, \dots, v_n^-\}$$

Table 4.15 Positive/negative ideal solution

Criteria	A^+	A^-
KPI_1	0,008	0,004
KPI_2	0,052	0,046
KPI_3	0,017	0,006
KPI_4	0,026	0,015
KPI_5	0,047	0,029
KPI_6	0,027	0,021
KPI_7	0,059	0,049
KPI_8	0,067	0,036
KPI_9	0,033	0,020

Source : The author (2016)

After knowing result of positive ideal solution and negative ideal solution (see Table 4.15). The next step is calculating of separation measure. The separation of each alternative from the PIS and NIS could are :

$$(PIS)S_i^+ = \sqrt{\sum_{j=1}^{n}(v_{ij} - v_j^+)^2}, i = 1,2,\dots,m$$

$$(NIS)S_i^- = \sqrt{\sum_{j=1}^{n}(v_{ij} - v_j^-)^2}, i = 1,2,\dots,m$$

After getting distance values between PIS and NIS, the next step is calculating relative closeness to the ideal solution. The relative closeness has been measured by following equation :

$$C_i^* = \frac{S_i^-}{S_i^+ + S_i^-}, 0 < C_i^* < 1, i = 1,2,\dots,m$$

Table 4.16 Distance calculation, relative closeness and ranking

	KMP. HM BARUNA 1	KMP. SMS KARTANEGARA	KMP. EXAMPLE-II	KM. PORT LINK III	KMP. RAJAKARTA
S+	0,03021	0,02660	0,02773	0,02775	0,03445
S-	0,02269	0,02319	0,02322	0,03157	0,02338
C*	0,42900	0,46574	0,45573	0,53221	0,40423
Rank	4	2	3	1	5

Source : The author (2016)

Final step is making graphic from ranking, in accordance with relative closeness and ranked the preference order. On Chart 4.1 (see on page 60) showed that KM. Port Link III is the highest effectiveness SMS implementation on board with relative closeness 0,516. The second position is KMP. SMS Kartanegara with 0,47146 point. The third position is KMP. Example II with 0,45582 point. The forth position is KMP. HM. Baruna 1 with 0,44232 point. The lowest effectiveness SMS implementation on board is KMP. Rajakarta has relative closeness 0,40522 point.

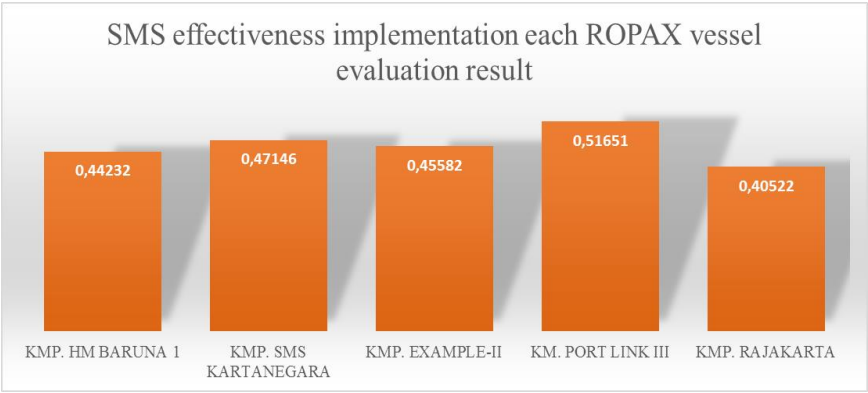

Chart 4.1 SMS effectiveness implementation each ROPAX vessel evaluation result
Source : The author (2016)

4.5.4 Discussion of TOPSIS method calculation result

To determine the effectiveness of each comparison ROPAX vessel using the distance values of each KPI for alternative ROPAX to positive ideal solution (PIS). This calculation is substraction PIS from weighted normalised decision. The values, KPI based distances to PIS are provided in Table 4.17.

Table 4.17 KPIs based distance to PIS

	KMP. HM BARUNA 1	KMP. SMS KARTANEGARA	KMP. EXAMPLE II	KM. PORT LINK III	KMP. RAJAKARTA
KPI1	0,000	0,003	0,004	0,005	0,004
KPI2	0,000	0,006	0,004	0,005	0,003
KPI3	0,000	0,006	0,011	0,013	0,010
KPI4	0,000	0,003	0,002	0,011	0,007
KPI5	0,007	0,002	0,001	0,018	0,000
KPI6	0,006	0,004	0,003	0,000	0,003
KPI7	0,006	0,000	0,010	0,004	0,010
KPI8	0,028	0,023	0,021	0,000	0,030
KPI9	0,005	0,008	0,007	0,013	0,000

Source : The author (2016)

The distance values of each KPI per ROPAX vessel to PIS can give idea to decision makers (superintendent, DPA or shipping operator) about critical issues in SMS implementations. For cluster analysis per ROPAX vessels. Figure 4.2 – 4.6 illustrate the spider web diagram SMS effectiveness implementation based on KPIs.

As it seen in Figure 4.2, KPI_8 (DPA internal audit), the distal point, is determined as the most remarkable factor to take into consideration. Furthermore, critical aspects SMS effectiveness implementation at KMP. HM. Baruna 1 are KPI_7 (crew injury observed on-board ships), KPI_6 (successful psychometric test applied for officer) and KPI_5 (near-miss reported by ships).

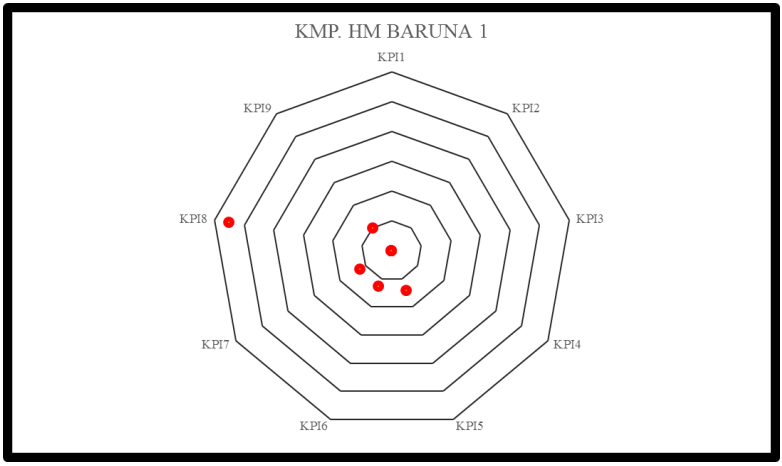

Figure 4.2 SMS overview based on KPIs at KMP. HM Baruna 1
Source : The author (2016)

In KMP. SMS Kartanegara, The distal point is KPI_8 (DPA internal audit). Meanwhile, KPI_2 (number of completed training on-board ships), KPI_3 (major non-conformity observed on-board

ships) and KPI_9 (HQSE manager audit) are the other critical aspects at KMP SMS Kartanegara.

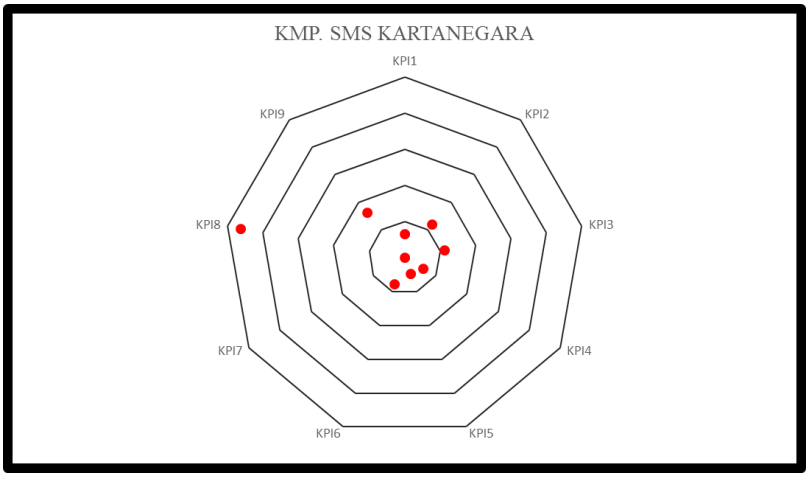

Figure 4.3 SMS overview based on KPIs at KMP. SMS Kartanegara
Source : The author (2016)

In Figure 4.4 (see on page 63) show that KPI_8 (DPA internal audit judgement) is the distal point SMS effectiveness implementation based on KPIs at KMP. Example II. More critical aspects at KMP. Example II are KPI_3 (major non-conformity observed on-board ships), KPI_7 (crew injury observed on-board ships) and KPI_9 (HQSE manager audit).

The distal point in Figure 4.5 (see on page 63) is KPI_5 (near-miss reported by ships). Another critical aspects at KMP. Port Link III are KPI_9 (HQSE manager audit judgement), KPI_4 (number of detention) and KPI_6 (successful psychometric test applied for officer).

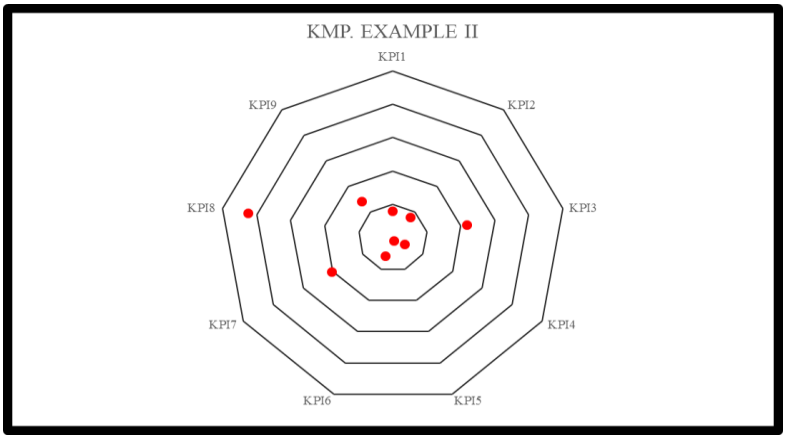

Figure 4.4 SMS overview based on KPIs at KMP. Example II
Source : The author (2016)

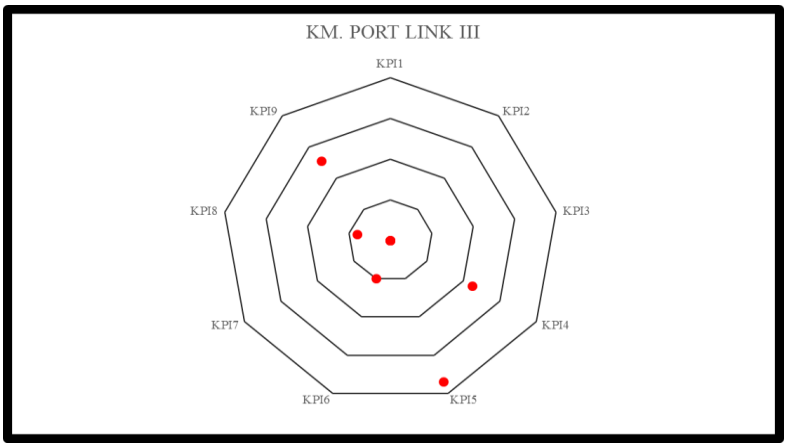

Figure 4.5 SMS overview based on KPIs at KMP. Port Link III
Source : The author (2016)

In Figure 4.6 (see on page 64) show that KPI_8 (DPA internal audit) is the distal point SMS effectiveness implementation based on KPIs at KMP. Rajakarta. More critical aspects at KMP.

Rajakarta are KPI_3 (major non-conformity observed on-board ships) and KPI_7 (crew injury observed on-board ships).

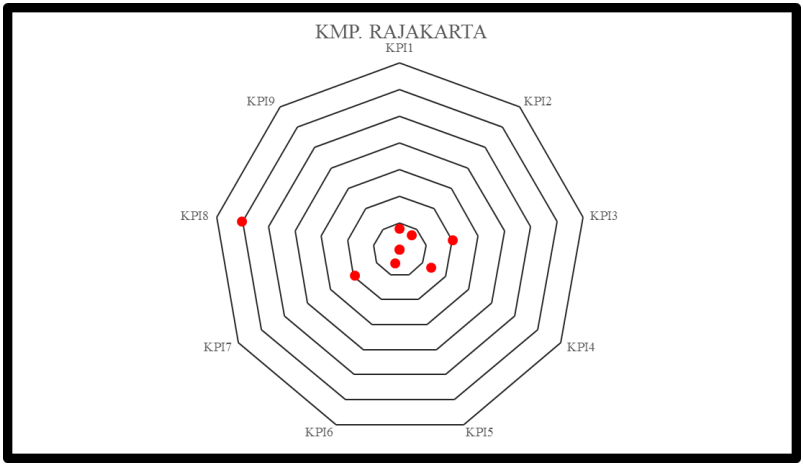

Figure 4.6 SMS overview based on KPIs at KMP. Rajakarta
Source : The author (2016)

Table 4.17 (see on page 60) show that KPI_8 (DPA internal audit) has the distal point to PIS in four ship comparison data namely, KMP. Rajakarta, KMP. Example II, KMP. SMS Kartanegara and KMP. HM. Baruna 1. This is show that KPI_8 is the lowest effectiveness SMS implementation in five sample comparison ROPAX vessel at ferry port authority branch Merak operation area. DPA has a assignment and responsibility to implemented ISM Code on board (PT. Biro Klasifikasi Indonesia (Persero), 2016). But in fact, many DPAs from shipping operator does not capability and knowledge to develop safety management system on management operation. Unfortunately, some shipping operators does not has DPAs for the ships. The work of DPA will be handled by field manager. Necessary concern from regulator to giving training to DPA shipping operator in order to implemented ISM Code on their management operation. The other things are

supervisory function to DPA shipping operator about implementation ISM Code on their safety management operations.

4.6 Improvement strategies of effectiveness safety management system (SMS) implementation on ROPAX vessel

ISM Code as mandatory safety management system of government that should be implemented on all ship related regulations namely, ROPAX (Ro-ro Passenger), oil tankers, chemical tankers, gas carriers, bulk carriers, argo high-speed craft up to 500 GT, other cargo ship and mobile offshore drilling units up to 500 GT. ISM Code ought be to giving protection of environment and safety of crew ship and passenger. According to data from NTSC, ship accidents in Indonesia are still high frequent in average. Some factors affecting the high number of ship accidents are condition of the ship, total passenger overload and standard operating procedures from port authority and ship operator. Standard operating procedures as main thing to ensure that ship is eligible to seaworthiness.

The survey to the respondents explored the issue of improvement actions predominantly within the context of individuals or entities along using implementation SMS on board do. By interviewing maritime experts, various problems should be improved by decreasing the distance values KPIs to positive ideal solution (PIS).

Some SMS implementation problems based on real condition are shipping operator fear of the unknown its new and different, shipping operator fear of additional work and greater bureaucracy, shipping operator tried to resistance to change, shipping operator tried to cultural resistance, shipping operator lack of system improvement on safety aspects, shipping operator lack of management commitment, shipping operator does not serious lack of understand of the purpose and limitations of the ISM Code.

According to the result of measuring effectiveness SMS implementation based on KPIs model on five comparison ROPAX

vessel at ferry port authority branch Merak using TOPSIS model. There are several ways to improvement effectiveness SMS implementation on ROPAX vessels based on each stakeholders (regulator, shipping operator and ship crew).

On regulator evaluation, the harbour master should be consistent in applying/implementing provisions and the applicable rules concerning matters with regard to safety on board, especially the ISM code regulation. Increasing knowledge to the government auditor ISM Code in order to better responsibilities. Improve supervision to the ROPAX vessel when the ship is contain the passengers primarily in safety regulations based on ISM Code. Tighten regulations regarding on ship detention because there is no strict sanctions against ROPAX vessel related with ship detention caused by preventive procedures are not remedy the major non-conformities. Conducting ISM Code training for DPA shipping operator to help improve safety on board. The regulator also must listen suggestions from shipping operator to increase safety on board. Improve supervision of compliance requirements crewing relating to ship crew competence. The regulator also giving warning to ship operator did not report its organization company and DPA does not appointed. The regulator also required to conduct regular inspections of documents and safety equipment on ROPAX vessels.

On shipping operator evaluation should be understanding the responsibility for implementing ISM Code. Shipping operator should be practice training (SOLAS training manual and training on safety matters, etc.) and provide socialization to crew ship about the importance of implementation safety management system (SMS) on board. Introduce the ship culture working procedure on new ship crew. Providing psychiatric tests to the new ship crew recruitment and at least six months to the old ship crew. DPA should implement internal audit consistently and set the target to be achieved and improvements to safety management system on board if the ship is not in accordance with the safety standards requirement. DPA should monitoring condition of ship with crew

of the ship to knowing non conformities and correcting in the future. The ship crew are required to record every incident near miss and reported to DPA so that similar incidents should be overcome and does not happen again. DPA or superintendent from shipping operator should checking deficiency on board to be correcting later. This audit checking records should reported on internal meeting. Giving safety drill and emergency training to all ship crew to improve knowledge about safety on board. SOLAS training manuals and Fire Safety Booklets specific to the ship as required by SOLAS in Bahasa Indonesia to be made available and placed in each of the following places i.e. bridge , engine control room (ECR) and officers & crew mess / smoking rooms. SOLAS guideline (training manuals and fire safety booklet) provided on Bahasa Indonesia. This is certainly easier for crew of the ship to understand in Bahasa.

On ship crew evaluation. The ship crew should be practice safety training on board every months and reported to DPA. The ship crew should understanding SOLAS guideline in case of uncontrol events. The crew of the ship are required to improve knowledge about safety on board. The ship crew should giving information about importance safety culture on board. The officer are required to record injury of ship crew and reported to DPA. If it is a severe injury, the ship should asked for help from the nearest beach radio officer to be given more help to hospital. The ship crew should understand to giving first aid to the ship crew. On Table 4.18 (see on page 68) show summary of improvement strategies SMS implementation on ROPAX vessel based on per KPIs.

Table 4.18 Improvement strategies SMS implementation on ROPAX vessel based on per KPIs

Code	Name of KPIs	Improvement strategies SMS implementation on ROPAX vessel
KPI_1	Deficiency observed on board ship	DPA or superintendent from shipping operator should checking deficiency on board to be correcting later. This audit checking records should reported on internal meeting
		Supervisory function of the regulator to shipping operator related corrective deficiency
KPI_2	Completed training on board ship	Giving safety drill and emergency training to all ship crew to improve knowledge about safety on board
		SOLAS training manuals and Fire Safety Booklets specific to the ship as required by SOLAS in Bahasa Indonesia. This is certainly easier for crew of the ship to understand in Bahasa.
		The ship crew should be practice safety training on board every months and reported to DPA
		The ship crew should giving information about importance safety culture on board.
		Introduce the ship culture working procedure on new ship crew.
KPI_3	Major non-conformity observed on-board ships	DPA should monitoring condition of ship with crew of the ship to knowing non conformities and correcting in the future. This audit checking records should reported on internal meeting
		Supervisory function of the regulator to shipping operator related corrective deficiency
KPI_4	Detention reported	Tighten regulations regarding on ship detention because there is no strict

		sanctions against ROPAX vessel related with ship detention caused by preventive procedures are not remedy the major non-conformities.
KPI_5	Near-miss reported by ships	The ship crew are required to record every incident near miss and reported to DPA so that similar incidents should be overcome and does not happen again
KPI_6	Successful psychometric test applied for officer reported by ships	Providing psychiatric tests to the new ship crew recruitment and at least six months to the old ship crew.
KPI_7	Crew injury observed & reported on-board ships	The officer are required to record injury of ship crew and reported to DPA. If it is a severe injury, the ship should asked for help from the nearest beach radio officer to be given more help to hospital
KPI_8	DPA internal audit	DPA should implement internal audit consistently and set the target to be achieved and improvements to safety management system on board if the ship is not in accordance with the safety standards requirement.
KPI_9	HSEQ manager audit	HSEQ manager should ensure health of ship crew, safety work on board and environment conditions on board.

Source : The author (2016)

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KUESIONER PENELITIAN I

	Survei menilai keefektivitasan dari Safety Management System berdasarkan KPI (Key Performance Indicator) PENELITI : RIPTA RARUNG RASKA NRP : 4212101030 MAHASISWA TEKNIK SISTEM PERKAPALAN FAKULTAS TEKNOLOGI KELAUTAN INSTITUT TEKNOLOGI SEPULUH NOPEMBER SURABAYA	RAHASIA

IDENTITAS RESPONDEN

Nama : ……..

Posisi : …….

Pengalaman : …….

Instruksi :

Berikan tanda cek (**v**) pada kolom skala (A) atau pada kolom skala kriteria (B) yang sesuai dengan pendapat anda.

Definisi kode :

1 : kedua kriteria sama penting
3 : kriteria (A) sedikit lebih penting disbanding dengan (B)
5 : kriteria (A) lebih penting dibanding dengan (B)
7 : kriteria (A) sangat lebih penting dibanding dengan (B)
9 : kriteria (A) mutlak lebih penting disbanding dengan (B)

Catatan : Dan jika ragu-ragu antara 2 skala maka ambil nilai tengahnya, misalkan anda ragu-ragu antara 3 dan 5 maka pilih skala 4 dan seterusnya

KPI (Key Performance Indicator) adalah ukuran keberhasilan dari suatu tujuan dan sasaran strategis operasional. Setiap perusahaan atau instansi wajib memiliki KPI sebagai suatu prioritas untuk mencapai sasaran atau tujuan dari perusahaan atau lembaga terkait dan menjadi bahan evaluasi untuk kinerja perusahaan/lembaga dalam mengembangkan sasaran.

KPI pada SMS (Safety Management System) atau SMK (Sistem Management Keselamatan) diperlukan untuk memantau kinerja dari pelaksanaan SMK yang relevan. Pemantauan yang dilakukan dari penilaian KPI pada SMK, akan memberikan hasil evaluasi perbaikan atas kejadian kecelakaan kapal yang terjadi di pelabuhan Tanjung Perak, Surabaya.

Berikut ini adalah deskripsi KPI untuk mengukur kefektifitas dari SMK implementasi pada kapal ROPAX (Ro-ro Passenger) yang beroperasi di pelabuhan penyeberangan Merak. Deskripsi KPI ini didapat melalui sumber dari Akyuz & Celik (2014).

1. KPI_1 – Jumlah dari defisien diatas kapal

   Defisien mengacu pada kurangnya persyaratan & lingkungan diatas kapal dan berkaitan pada persyaratan regulasi. Defisien harus dicatat dan diidentifikasi minimal sekali dalam setahun.

   Kategori utama dari defisien kapal, diamati dari PSC (Port State Control) seperti :

   - Sertifikat dan dokumentasi (contoh sertifikat pengawakan)
   - Kondisi kedap air (jalan, gang untuk penyelamatan penumpang
   - Peralatan penyelamatan hidup (contoh, inventaris lifeboat)
   - Pencegahan polusi (contoh, control dari pembuangan oli)

2. KPI_2 – Angka dari pemberian pelatihan diatas kapal

   Tujuannya untuk memberikan peningkatan kesadaran awak terhadap persyaratan keselamatan & lingkungan. DPA mengirimkan persyaratan pelatihan ke otoritas kapal terkait

untuk meningkatkan persyaratan kompetensi. Oleh karena itu,, jumlah pelatihan sebisanya dapat dilakukan dalam setahun.

3. KPI_3 – Jumlah ketidak-sesuaian yang utama

   Ketidak-sesuaian yang utama di definisikan menjadi ancaman serius yang mungkin mengakibatkan kegagalan vital untuk kesalamatan kru, kapal atau lingkungan yang memerlukan tindakan perbaikan sesegera mungkin. Dalam level operasional, pegawai PSC (Port State Control) melakukan survei diatas kapal. Jika pegawai menemukan ketidak-sesuaian yang utama selama pemeriksanaan, hal tersebut harus diperbaiki sebelum kapal berangkat. Misalnya, belum adanya Sertifikat Manajemen Keselamatan dan kru baru yang harus sesuai dengan tugasnya masing-masing.

4. KPI_4 – Jumlah dari penahanan

   Jika prosedur tindakan perbaikan tidak dilakukan pada ketidak-sesuaian yang utama, kapal tidak diperbolehkan untuk berlayar. Ini disebut dengan penahanan.

5. KPI_5 – Jumlah dari *near-miss*

   Hal ini didefinisikan sebagai kejadian yang tidak terduga yang tidak mengakibatkan hilangnya nyawa atau luka tetapi potensial menuju bahaya tetap ada. *Near-miss* adalah rekaman di atas kapal untuk melihat kejadian yang hampir mengakibatkan bahaya di kapal untuk mencegah terjadinya kembali.

6. KPI_6 – Jumlah dari tes psikometri untuk kru

   Menurut peraturan maritim, setiap perusahaan harus menyediakan kapal dengan pelaut yang berkualitas dan sehat secara medis. Untuk memenuhi persyaratan ini, DPA menerapkan tes psikometri untuk kru. Tes ini memiliki cara objektif untuk memantau kinerja fisik dan mental pelaut.

7. KPI_7 – Jumlah kru yang cedera di atas kapal

   Kru cedera adalah isu yang paling umum diatas kapal dan kru kapal selalu menghadapi resiko tersebut. Di ISM Code dijelaskan, memastikan keselamatan di laut, pencegahan dari cedera manusia atau hilangnya nyawa diklasifikasikan sebagai salah satu tujuan utama. Karena itu, catatan jumlah cedera awak kapal harus disimpan dan dilaporkan ke DPA.

8. KPI_8 – Pertimbangan DPA audit internal

   Tanggung jawab DPA didefinisikan dalam ISM Code adalah sebagai monitoring keamanan dan pencegahan polusi di kapal. DPA hadir di atas kapal untuk melakukan audit internal secara teratur untuk memastikan bahwa praktek SMK telah baik.

9. KPI_9 – Pertimbangan manajer HSEQ (Health, Safety, Environment and Quality)

   Audit Dalam suatu perusahaan, terdapat departemen HSEQ, dibentuk untuk meningkatkan keselamatan, kualitas dan kinerja lingkungan dalam pengelolaan kapal dan operasi. Departemen HSEQ berkonsenterasi dalam adposi prinsip kualitas pertimbangan kesehatan, keselamatan dan lingkungan.

Contoh :
Nilai keefektivitas dari Safety Management System berdasarkan KPI (Key Performance Indicator)

No	Kriteria (A)	Skala									Skala								Kriteria (B)
		9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
1	KPI_1																		KPI_2

Jika anda memberi tanda cek (**v**) di skala 7 di kolom kriteria (A), maka artinya adalah kriteria (A) dalam contoh ini **KPI_1** sangat lebih penting dibanding dengan kriteria (B) **KPI_2**. Maka pengisian kolomnya adalah sebagai berikut :

No	Kriteria (A)	Skala									Skala								Kriteria (B)
		9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
1	KPI_1			**v**															KPI_2

Nilai keefektivitas dari Safety Management System berdasarkan KPI (Key Performance Indicator) pada ROPAX wilayah operasi Pelabuhan Merak, Banten

No	Kriteria (A)	Skala									Skala								Kriteria (B)
		9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
1	KPI_1																		KPI_2
2	KPI_1																		KPI_3
3	KPI_1																		KPI_4
4	KPI_1																		KPI_5
5	KPI_1																		KPI_6
6	KPI_1																		KPI_7
7	KPI_1																		KPI_8
8	KPI_1																		KPI_9

Nilai keefektivitas dari Safety Management System berdasarkan KPI (Key Performance Indicator) pada ROPAX wilayah operasi Pelabuhan Merak, Banten

No	Kriteria (A)	Skala									Skala								Kriteria (B)
		9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
1	KPI_2																		KPI_3
2	KPI_2																		KPI_4
3	KPI_2																		KPI_5
4	KPI_2																		KPI_6
5	KPI_2																		KPI_7
6	KPI_2																		KPI_8
7	KPI_2																		KPI_9

Nilai keefektivitas dari Safety Management System berdasarkan KPI (Key Performance Indicator) pada ROPAX wilayah operasi Pelabuhan Merak, Banten

No	Kriteria (A)	Skala									Skala								Kriteria (B)
		9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
1	KPI_3																		KPI_4
2	KPI_3																		KPI_5
3	KPI_3																		KPI_6
4	KPI_3																		KPI_7
5	KPI_3																		KPI_8
6	KPI_3																		KPI_9

Nilai keefektivitas dari Safety Management System berdasarkan KPI (Key Performance Indicator) pada ROPAX wilayah operasi Pelabuhan Merak, Banten

No	Kriteria (A)	Skala									Skala								Kriteria (B)
		9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
1	KPI_4																		KPI_5
2	KPI_4																		KPI_6
3	KPI_4																		KPI_7
4	KPI_4																		KPI_8
5	KPI_4																		KPI_9

Nilai keefektivitas dari Safety Management System berdasarkan KPI (Key Performance Indicator) pada ROPAX wilayah operasi Pelabuhan Merak, Banten

No	Kriteria (A)	Skala									Skala								Kriteria (B)
		9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
1	KPI_5																		KPI_6
2	KPI_5																		KPI_7
3	KPI_5																		KPI_8
4	KPI_5																		KPI_9

Nilai keefektivitas dari Safety Management System berdasarkan KPI (Key Performance Indicator) pada ROPAX wilayah operasi Pelabuhan Merak, Banten

No	Kriteria (A)	Skala									Skala								Kriteria (B)
		9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
1	KPI_6																		KPI_7
2	KPI_6																		KPI_8
3	KPI_6																		KPI_9

Nilai keefektivitas dari Safety Management System berdasarkan KPI (Key Performance Indicator) pada ROPAX wilayah operasi Pelabuhan Merak, Banten

No	Kriteria (A)	Skala									Skala								Kriteria (B)
		9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
1	KPI_7																		KPI_8
2	KPI_7																		KPI_9

Nilai keefektivitas dari Safety Management System berdasarkan KPI (Key Performance Indicator) pada ROPAX wilayah operasi Pelabuhan Merak, Banten

No	Kriteria (A)	Skala									Skala								Kriteria (B)
		9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
1	KPI_8																		KPI_9

ATTACHMENT 2 : AHP Calculation

Respondent(s) Judgments on KPIs

Respondent 1

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	8	8	0,1429	0,1111	0,1111	0,1111	0,1111	0,1111
KPI_2		1	7	7	7	7	7	7	7
KPI_3			1	0,1667	0,1667	0,2	0,1111	0,1429	0,125
KPI_4				1	7	7	7	7	7
KPI_5					1	0,1667	0,1667	0,125	0,1111
KPI_6						1	7	7	7
KPI_7							1	0,125	0,1429
KPI_8								1	7
KPI_9									1
Total	3	9	16	8,3095	15,278	15,478	22,389	22,504	29,49

Respondent 2

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	5	0,2	5	5	5	5	5	5
KPI_2		1	5	5	5	5	5	5	5
KPI_3			1	5	5	5	5	5	5
KPI_4				1	0,2	5	0,2	0,2	0,2
KPI_5					1	5	5	5	5
KPI_6						1	0,2	0,2	0,2
KPI_7							1	4	4
KPI_8								1	0,2
KPI_9									1
Total	1	6	6,2	16	16,2	26	21,4	25,4	25,6

Respondent 3

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	0,11111	7	6	0,1111	0,1429	0,1429	7	0,1111
KPI_2		1	0,1111	7	7	0,1111	0,1111	0,1111	7
KPI_3			1	7	7	7	7	7	7
KPI_4				1	0,1111	0,1111	7	0,1111	0,1111
KPI_5					1	0,1111	7	7	7
KPI_6						1	0,1111	0,1111	0,1111
KPI_7							1	0,1111	0,1111
KPI_8								1	7
KPI_9									1
Total	1	1,11111	8,1111	21	15,222	8,4762	22,365	22,444	29,444

Respondent 4

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	0,2	4	0,25	0,125	0,2	0,125	0,1667	0,125
KPI_2		1	6	6	0,125	5	5	4	0,125
KPI_3			1	4	0,125	0,3333	0,1429	0,25	0,125
KPI_4				1	0,125	5	0,125	0,25	0,125
KPI_5					1	8	8	8	4
KPI_6						1	6	0,2	0,125
KPI_7							1	8	8
KPI_8								1	0,1429
KPI_9									1
Total	1	1,2	11	11,25	1,5	19,533	20,393	21,867	13,768

Respondent 5

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	7	1	0,1429	0,1429	0,1111	7	7	7
KPI_2		1	0,1429	0,1429	0,1111	1	0,1111	1	1
KPI_3			1	0,3333	0,1111	7	0,1111	5	5
KPI_4				1	0,2	7	0,1429	7	7
KPI_5					1	7	1	9	9
KPI_6						1	0,1111	1	1
KPI_7							1	9	9
KPI_8								1	1
KPI_9									1
Total	1	8	2,1429	1,619	1,5651	23,111	9,4762	40	41

Respondent 6

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	5	5	0,2	6	0,1429	0,1667	0,2	0,2
KPI_2		1	0,2	0,2	0,2	0,2	0,2	0,2	0,2
KPI_3			1	5	0,2	0,2	0,2	0,2	0,2
KPI_4				1	0,2	5	0,2	0,1667	0,1667
KPI_5					1	6	0,2	5	0,2
KPI_6						1	0,2	0,2	0,2
KPI_7							1	5	5
KPI_8								1	0,2
KPI_9									1
Total	1	6	6,2	6,4	7,6	12,543	2,1667	11,967	7,3667

Respondent 7

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	7	0,2	0,125	5	1	0,2	0,1111	1
KPI_2		1	0,1429	0,1111	0,1429	1	0,1667	0,2	0,1667
KPI_3			1	1	2	1	2	3	1
KPI_4				1	5	1	1	3	2
KPI_5					1	0,2	3	1	3
KPI_6						1	1	2	1
KPI_7							1	0,3333	1
KPI_8								1	1
KPI_9									1
Total	1	8	1,3429	2,2361	13,143	5,2	8,3667	10,644	11,167

Respondent 8

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	0,14286	0,125	0,1429	0,1429	0,125	0,1667	7	7
KPI_2		1	8	8	8	0,1429	8	8	7
KPI_3			1	8	7	0,125	0,125	8	8
KPI_4				1	0,125	0,125	0,125	0,125	0,125
KPI_5					1	9	0,1111	9	9
KPI_6						1	0,1111	0,125	0,125
KPI_7							1	8	8
KPI_8								1	8
KPI_9									1
Total	1	1,14286	9,125	17,143	16,268	10,518	9,6389	41,25	48,25

Respondent 9

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	7	0,1111	6	0,1111	7	3	6	0,1429
KPI_2		1	0,1667	0,1429	0,125	6	5	5	0,1429
KPI_3			1	7	7	6	6	6	7
KPI_4				1	0,125	6	0,125	6	6
KPI_5					1	8	8	7	6
KPI_6						1	6	5	0,1667
KPI_7							1	7	7
KPI_8								1	0,1667
KPI_9									1
Total	1	8	1,2778	14,143	8,3611	34	29,125	43	27,619

Respondent 10

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	5	7	4	8	2	3	6	9
KPI_2		1	7	6	8	4	9	6	5
KPI_3			1	9	7	5	8	6	4
KPI_4				1	3	5	7	6	8
KPI_5					1	8	7	6	5
KPI_6						1	5	6	7
KPI_7							1	8	5
KPI_8								1	6
KPI_9									1
Total	1	6	15	20	27	25	40	45	50

Respondent 11

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	7	6	5	8	7	9	4	5
KPI_2		1	7	6	8	5	4	2	9
KPI_3			1	3	5	4	7	8	2
KPI_4				1	3	6	8	7	5
KPI_5					1	9	7	8	6
KPI_6						1	0,3333	0,2	0,5
KPI_7							1	7	8
KPI_8								1	6
KPI_9									1
Total	1	8	14	15	25	32	36,333	37,2	42,5

Respondent 12

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	6	4	7	5	9	0,125	0,25	3
KPI_2		1	4	6	0,25	0,1429	8	0,125	0,125
KPI_3			1	5	0,2	0,2	0,1429	6	0,25
KPI_4				1	7	0,1667	0,125	6	0,25
KPI_5					1	6	0,25	0,2	0,1667
KPI_6						1	5	6	7
KPI_7							1	0,2	0,2
KPI_8								1	0,2
KPI_9									1
Total	1	7	9	19	13,45	16,51	14,643	19,775	12,192

Respondent 13

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	8	0,1429	6	7	8	5	4	0,125
KPI_2		1	0,125	7	0,1667	7	5	0,125	0,1111
KPI_3			1	7	0,1429	0,25	5	0,125	0,1111
KPI_4				1	0,1667	0,2	0,1667	0,125	0,1111
KPI_5					1	7	0,1429	0,125	0,125
KPI_6						1	0,1667	0,125	0,1111
KPI_7							1	0,1667	0,1429
KPI_8								1	0,125
KPI_9									1
Total	1	9	1,2679	21	8,4762	23,45	16,476	5,7917	1,9623

Respondent 14

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	6	4	5	1	3	0,5	2	0,3333
KPI_2		1	6	1	3	0,5	2	0,5	1
KPI_3			1	5	4	3	2	4	1
KPI_4				1	5	4	6	1	3
KPI_5					1	5	4	2	5
KPI_6						1	6	4	1
KPI_7							1	5	4
KPI_8								1	3
KPI_9									1
Total	1	7	11	12	14	16,5	21,5	19,5	19,333

Respondent 15

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	7	7	7	5	7	7	7	7
KPI_2		1	8	3	1	6	9	0,1111	9
KPI_3			1	6	6	3	9	4	3
KPI_4				1	0,3333	1	3	0,5	1
KPI_5					1	3	0,1111	3	3
KPI_6						1	0,3333	6	1
KPI_7							1	3	4
KPI_8								1	3
KPI_9									1
Total	1	8	16	17	13,333	21	29,444	24,611	32

Respondent 16

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	7	7	3	7	7	7	7	7
KPI_2		1	0,1429	0,1429	5	9	9	9	9
KPI_3			1	5	4	7	3	3	4
KPI_4				1	0,25	0,3333	0,125	1	1
KPI_5					1	3	3	3	3
KPI_6						1	0,3333	0,5	0,5
KPI_7							1	4	3
KPI_8								1	0,25
KPI_9									1
Total	1	8	8,1429	9,1429	17,25	27,333	23,458	28,5	28,75

Respondent 17

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	5	1	3	3	2	3	4	3
KPI_2		1	3	2	1	0,5	0,25	3	3
KPI_3			1	4	3	3	2	3	3
KPI_4				1	0,3333	0,3333	1	0,3333	0,5
KPI_5					1	6	2	3	2
KPI_6						1	0,3333	0,2	0,5
KPI_7							1	6	5
KPI_8								1	5
KPI_9									1
Total	1	6	5	10	8,3333	12,833	9,5833	20,533	23

Respondent 18

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	0,33333	0,3333	2	0,5	0,25	0,5	0,5	0,5
KPI_2		1	3	3	2	0,5	3	0,5	2
KPI_3			1	3	2	0,5	2	0,3333	2
KPI_4				1	0,5	0,3333	0,3333	0,3333	0,5
KPI_5					1	0,3333	2	2	0,5
KPI_6						1	2	2	2
KPI_7							1	0,3333	0,5
KPI_8								1	2
KPI_9									1
Total	1	1,33333	4,3333	9	6	2,9167	10,833	7	11

Respondent 19

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	3	0,3333	3	3	3	0,5	0,3333	3
KPI_2		1	0,3333	2	3	3	0,3333	1	3
KPI_3			1	3	3	3	2	0,3333	3
KPI_4				1	0,5	1	0,3333	0,3333	2
KPI_5					1	2	0,3333	0,3333	2
KPI_6						1	0,3333	0,3333	1
KPI_7							1	0,5	3
KPI_8								1	3
KPI_9									1
Total	1	4	1,6667	9	10,5	13	4,8333	4,1667	21

Respondent 20

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	4	3	4	4	4	3	0,5	4
KPI_2		1	0,25	1	2	3	0,25	0,3333	3
KPI_3			1	4	3	4	1	0,3333	3
KPI_4				1	0,3333	3	0,25	0,25	2
KPI_5					1	3	0,3333	0,25	3
KPI_6						1	0,25	0,3333	0,5
KPI_7							1	0,3333	4
KPI_8								1	4
KPI_9									1
Total	1	5	4,25	10	10,333	18	6,0833	3,3333	24,5

Respondent 21

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	0,25	0,3333	2	3	3	0,3333	0,25	4
KPI_2		1	0,5	4	4	4	1	0,3333	4
KPI_3			1	4	4	4	0,3333	0,3333	4
KPI_4				1	0,3333	3	0,25	0,25	4
KPI_5					1	3	0,3333	0,3333	3
KPI_6						1	0,25	0,25	0,5
KPI_7							1	0,3333	4
KPI_8								1	4
KPI_9									1
Total	1	1,25	1,8333	11	12,333	18	3,5	3,0833	28,5

Respondent 22

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	0,25	2	4	3	3	3	0,2	4
KPI_2		1	4	3	4	3	3	0,3333	4
KPI_3			1	3	0,5	4	0,333333	0,25	3
KPI_4				1	0,333333	2	0,25	0,25	3
KPI_5					1	3	1	0,3333	3
KPI_6						1	0,333333	0,25	3
KPI_7							1	0,25	3
KPI_8								1	5
KPI_9									1
Total	1	1,25	7	11	8,833333	16	8,916667	2,8667	29

Respondent 23

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	3	3	3	4	3	3	4	3
KPI_2		1	0,333333	3	1	3	2	2	3
KPI_3			1	3	2	4	3	3	3
KPI_4				1	0,333333	1	0,25	0,3333	2
KPI_5					1	3	0,25	0,25	3
KPI_6						1	0,25	0,3333	3
KPI_7							1	2	3
KPI_8								1	3
KPI_9									1
Total	1	4	4,333333	10	8,333333	15	9,75	12,917	24

Respondent 24

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	0,333333	0,25	0,5	0,333333	0,5	0,25	0,25	3
KPI_2		1	0,333333	3	1	3	0,333333	0,25	4
KPI_3			1	4	3	4	2	0,5	0,25
KPI_4				1	0,333333	1	0,25	0,25	2
KPI_5					1	3	3	0,3333	3
KPI_6						1	0,333333	0,25	2
KPI_7							1	0,5	3
KPI_8								1	4
KPI_9									1
Total	1	1,333333	1,583333	8,5	5,666667	12,5	7,166667	3,3333	22,25

Respondent 25

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	0,333333	0,333333	1	0,333333	1	0,333333	0,25	2
KPI_2		1	0,333333	3	3	3	0,5	0,3333	3
KPI_3			1	3	3	3	1	0,3333	4
KPI_4				1	0,333333	1	0,333333	0,25	2
KPI_5					1	3	0,333333	0,3333	3
KPI_6						1	0,333333	0,25	2
KPI_7							1	0,3333	4
KPI_8								1	3
KPI_9									1
Total	1	1,333333	1,666667	8	7,666667	12	3,833333	3,0833	24

Respondent 26

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	0,333333	0,333333	3	3	2	3	0,25	3
KPI_2		1	0,5	3	1	3	2	3	3
KPI_3			1	3	3	4	3	3	3
KPI_4				1	0,333333	0,5	0,333333	3	3
KPI_5					1	3	0,333333	0,3333	3
KPI_6						1	0,333333	0,25	0,5
KPI_7							1	2	3
KPI_8								1	3
KPI_9									1
Total	1	1,333333	1,833333	10	8,333333	13,5	10	12,833	22,5

Respondent 27

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	3	0,25	3	3	3	3	3	3
KPI_2		1	3	3	0,5	2	0,333333	0,3333	3
KPI_3			1	3	2	4	0,333333	3	3
KPI_4				1	0,25	0,5	0,333333	0,3333	0,5
KPI_5					1	4	0,333333	3	3
KPI_6						1	4	0,3333	3
KPI_7							1	0,25	4
KPI_8								1	4
KPI_9									1
Total	1	4	4,25	10	6,75	14,5	9,333333	11,25	24,5

Respondent 28

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	5	0,333333	4	2	4	0,333333	0,3333	4
KPI_2		1	3	4	0,5	4	0,25	0,25	3
KPI_3			1	4	0,333333	3	0,5	0,25	3
KPI_4				1	0,333333	1	0,25	0,2	0,3333
KPI_5					1	3	0,333333	0,25	3
KPI_6						1	0,25	0,2	2
KPI_7							1	0,3333	3
KPI_8								1	4
KPI_9									1
Total	1	6	4,333333	13	4,166667	16	2,916667	2,8167	23,333

Respondent 29

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	5	0,5	3	2	4	3	0,25	3
KPI_2		1	0,25	3	3	3	0,5	0,25	3
KPI_3			1	3	4	3	0,333333	0,3333	3
KPI_4				1	0,333333	0,5	0,25	0,2	0,3333
KPI_5					1	3	0,333333	0,25	3
KPI_6						1	0,25	0,25	0,5
KPI_7							1	0,25	3
KPI_8								1	3
KPI_9									1
Total	1	6	1,75	10	10,33333	14,5	5,666667	2,7833	19,833

Respondent 30

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1	3	0,25	5	4	5	0,5	3	4
KPI_2		1	0,25	3	3	3	0,333333	4	4
KPI_3			1	4	4	4	4	3	4
KPI_4				1	0,333333	0,5	0,333333	0,3333	2
KPI_5					1	3	0,333333	1	3
KPI_6						1	0,25	0,3333	3
KPI_7							1	0,3333	3
KPI_8								1	3
KPI_9									1
Total	1	4	1,5	13	12,33333	16,5	6,75	13	27

Table comparison between criteria geometric mean

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9
KPI_1	1,000	2,0775	0,9811	1,8664	1,5405	1,5976	1,006409	1,070782	1,688365
KPI_2	0,4813	1,000	0,964	2,0955	1,3287	1,9131	1,265411	0,840265	1,952343
KPI_3	1,0192	1,0373	1,000	3,3934	1,7083	2,009	1,179684	1,309237	1,807353
KPI_4	0,5358	0,4772	0,2947	1,000	0,4632	1,1596	0,467013	0,603133	1,043908
KPI_5	0,6491	0,7526	0,5854	2,159	1,000	2,8753	0,854215	1,194481	2,265536
KPI_6	0,6259	0,5227	0,4978	0,8623	0,3478	1,000	0,563867	0,53413	0,834958
KPI_7	0,9936	0,7903	0,8477	2,1413	1,1707	1,7735	1,000	1,057674	2,411681
KPI_8	0,9339	1,1901	0,7638	1,658	0,8372	1,8722	0,945471	1,000	1,771539
KPI_9	0,5923	0,5122	0,5533	0,9579	0,4414	1,1977	0,414649	0,564481	1,000
Total	6,8313	8,3599	6,4878	16,134	8,8377	15,398	7,696718	8,174184	14,77568

Normalised pair-wise comparison

Criteria	KPI_1	KPI_2	KPI_3	KPI_4	KPI_5	KPI_6	KPI_7	KPI_8	KPI_9	Priority	Percentage
KPI_1	0,14639	0,248512	0,151227	0,1156828	0,17431	0,10375	0,130758	0,131	0,1143	0,14621	14,62%
KPI_2	0,07046	0,119618	0,148594	0,129884	0,15034	0,12425	0,164409	0,1028	0,1321	0,12694	12,69%
KPI_3	0,1492	0,12408	0,154136	0,2103245	0,1933	0,13047	0,153271	0,16017	0,1223	0,15525	15,53%
KPI_4	0,07843	0,057082	0,045423	0,0619813	0,05241	0,07531	0,060677	0,07379	0,0707	0,06397	6,40%
KPI_5	0,09502	0,090029	0,090227	0,1338203	0,11315	0,18673	0,110984	0,14613	0,1533	0,12438	12,44%
KPI_6	0,09163	0,062524	0,076722	0,0534485	0,03935	0,06494	0,073261	0,06534	0,0565	0,06486	6,49%
KPI_7	0,14545	0,094529	0,130659	0,1327186	0,13246	0,11518	0,129926	0,12939	0,1632	0,13039	13,04%
KPI_8	0,13671	0,142357	0,11773	0,1027656	0,09473	0,12159	0,122841	0,12234	0,1199	0,12011	12,01%
KPI_9	0,0867	0,061269	0,085283	0,0593743	0,04994	0,07778	0,053873	0,06906	0,0677	0,06788	6,79%

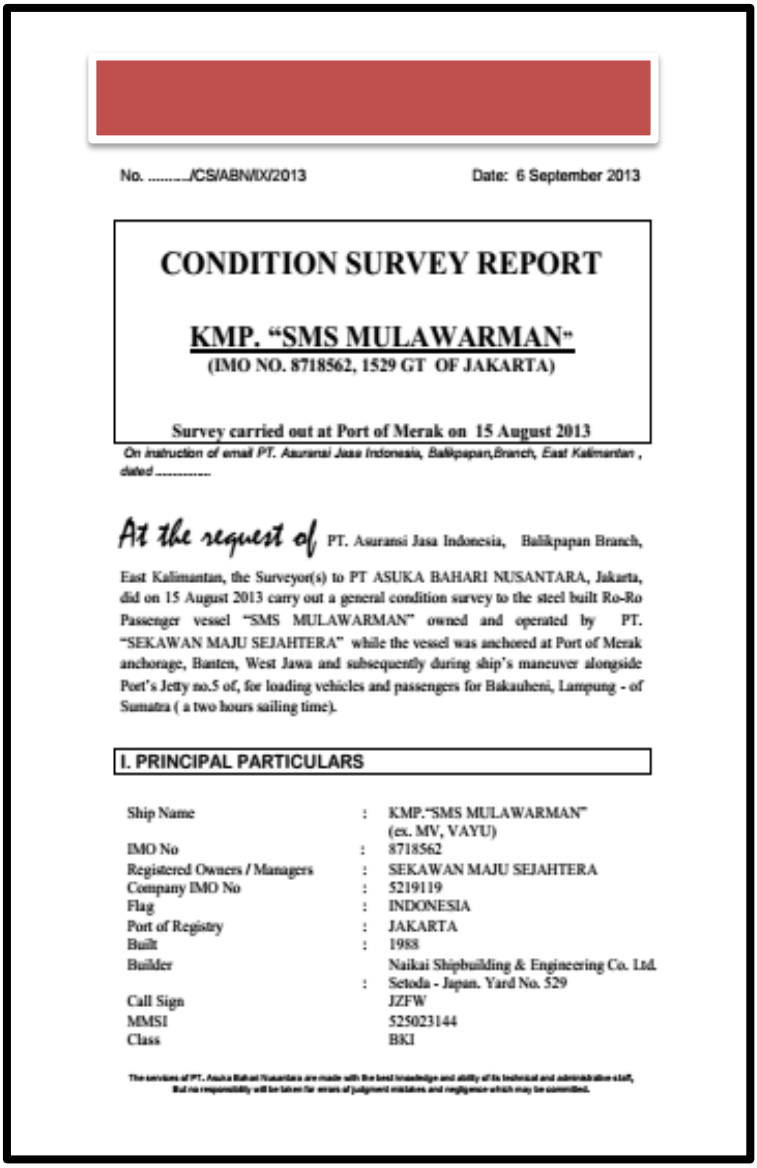
Consistency ratio calculation

Criteria	Total per column	Criterion/priority weight	Result
KPI_1	6,83126	0,1462	0,9988
KPI_2	8,35995	0,1269	1,0612
KPI_3	6,48778	0,1553	1,0072
KPI_4	16,1339	0,064	1,0321
KPI_5	8,8377	0,1244	1,0992
KPI_6	15,398	0,0649	0,9987
KPI_7	7,69672	0,1304	1,0036
KPI_8	8,17418	0,1201	0,9818
KPI_9	14,7757	0,0679	1,003
Total			**9,1857**

λ maks	=	9,1857
CI	=	0,0206
CR	=	0,0142

ATTACHMENT 3 : Condition Survey Reports

1. KMP. SMS Mulawarman



No. ...../CS/ABN/IX/2013 Date: 6 September 2013

CONDITION SURVEY REPORT

KMP. "SMS MULAWARMAN"

(IMO NO. 8718562, 1529 GT OF JAKARTA)

Survey carried out at Port of Merak on 15 August 2013

On instruction of email PT. Asuransi Jasa Indonesia, Balikpapan,Branch, East Kalimantan , dated ----------

At the request of PT. Asuransi Jasa Indonesia, Balikpapan Branch, East Kalimantan, the Surveyor(s) to PT ASUKA BAHARI NUSANTARA, Jakarta, did on 15 August 2013 carry out a general condition survey to the steel built Ro-Ro Passenger vessel "SMS MULAWARMAN" owned and operated by PT. "SEKAWAN MAJU SEJAHTERA" while the vessel was anchored at Port of Merak anchorage, Banten, West Jawa and subsequently during ship's maneuver alongside Port's Jetty no.5 of, for loading vehicles and passengers for Bakauheni, Lampung - of Sumatra (a two hours sailing time).

I. PRINCIPAL PARTICULARS

Ship Name	:	KMP."SMS MULAWARMAN" (ex. MV, VAYU)
IMO No	:	8718562
Registered Owners / Managers	:	SEKAWAN MAJU SEJAHTERA
Company IMO No	:	5219119
Flag	:	INDONESIA
Port of Registry	:	JAKARTA
Built	:	1988
Builder	:	Naikai Shipbuilding & Engineering Co. Ltd. Setoda - Japan. Yard No. 529
Call Sign		JZFW
MMSI		525023144
Class		BKI

The services of PT. Asuka Bahari Nusantara are made with the best knowledge and ability of its technical and administrative staff, But no responsibility will be taken for errors of judgment mistakes and negligence which may be committed.

No : .../CS/ABN/IX/2013
Date : 06.09.2013

Ship type	:	Ro-Ro Cargo Ferry, Passengers & Vehicles
GT		1529 *)
DWT	:	803 Metric tons
LOA x B x D	:	88.4 x 14.5 x 10.30 meters
Draft Maximum	:	3.814 meters
Decks	:	2 (Upper and Lower Vehicle Decks)
Main Engines	:	2 x DAIHATSU 6DLM-32, 2 x 2876 kW *)
Aux Engines / Generators		2 x YANMAR 2 x 480 kW / 450 V-60Hz
Bow Thruster		1 x Electric motor driven CPP
Propellers & shafts		2 x FPP through Clutches, Flexible couplings
	:	and Reverse / Reduction Gear boxes
Last Dry-docking Survey		29 July 2013
Next Dry-docking Survey		29 July 2014
Last Special Survey		----------
	:	

***) See notes on Chapter III. RECOMMENDATION, Para F-MISCELENOUS**

II. SURVEY

A. ATTENDANCE

A Hull and Machinery (H & M) Condition survey satisfactorily completed on 15 August 2013, from 09.00 to 16.00 hours while the vessel was anchored at Port of Merak anchorage and subsequently during ship's maneuvering alongside Jetty no.5 of Port of Merak, Banten - Jawa, for loading vehicles and passengers for Bakauheni, Lampung - of Sumatra (a two hours sailing time).

B. CONDITION OF VESSEL

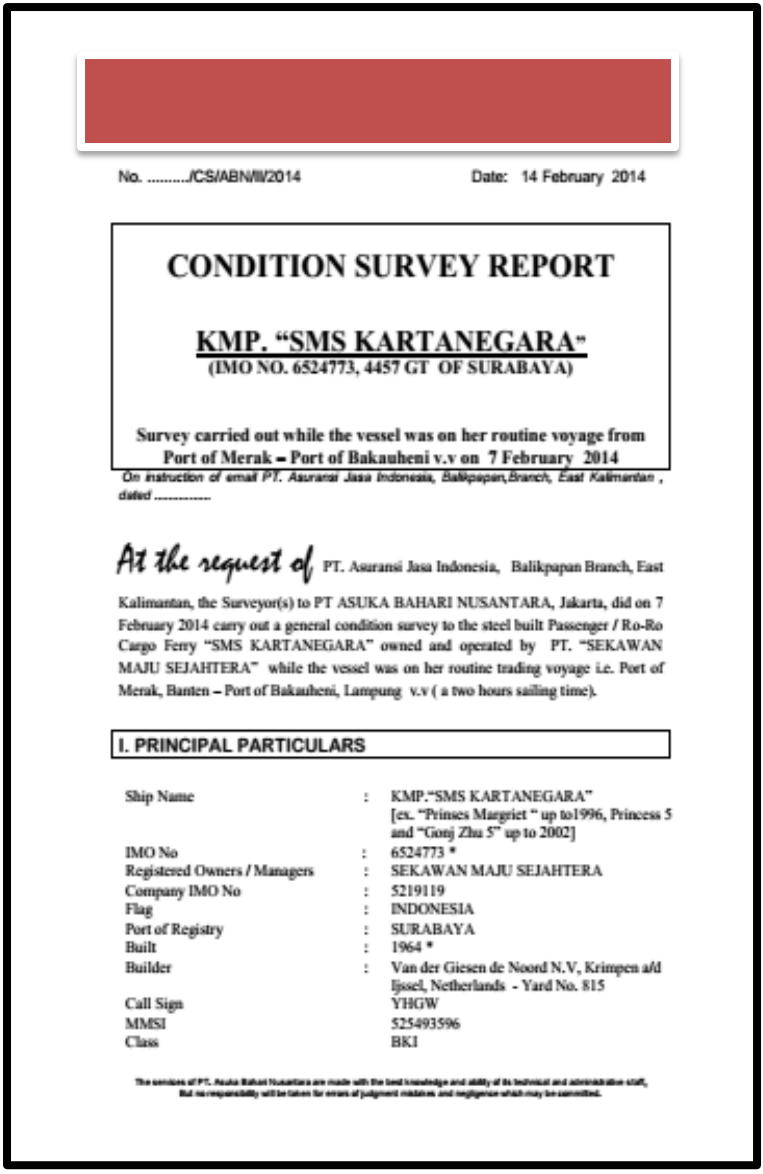
1 HULL & MACHINERIES

Physically Hull & Machinery and Equipment are generally found in satisfactory condition. Important machineries and equipment items for operational purposes tested and found satisfactorily functioning, except certain fire dampers / flaps and self closing fire doors .

2 DEFICIENCES

The following deficiencies were found and noted:

2. KMP. SMS Kartanegara



No. ...../CS/ABN/II/2014 Date: 14 February 2014

CONDITION SURVEY REPORT

KMP. "SMS KARTANEGARA"

(IMO NO. 6524773, 4457 GT OF SURABAYA)

Survey carried out while the vessel was on her routine voyage from Port of Merak – Port of Bakauheni v.v on 7 February 2014

On instruction of email PT. Asuransi Jasa Indonesia, Balikpapan,Branch, East Kalimantan , dated .....

At the request of PT. Asuransi Jasa Indonesia, Balikpapan Branch, East Kalimantan, the Surveyor(s) to PT ASUKA BAHARI NUSANTARA, Jakarta, did on 7 February 2014 carry out a general condition survey to the steel built Passenger / Ro-Ro Cargo Ferry "SMS KARTANEGARA" owned and operated by PT. "SEKAWAN MAJU SEJAHTERA" while the vessel was on her routine trading voyage i.e. Port of Merak, Banten – Port of Bakauheni, Lampung v.v (a two hours sailing time).

I. PRINCIPAL PARTICULARS

Ship Name	:	KMP."SMS KARTANEGARA" [ex. "Prinses Margriet " up to1996, Princess 5 and "Gonj Zhu 5" up to 2002]
IMO No	:	6524773 *
Registered Owners / Managers	:	SEKAWAN MAJU SEJAHTERA
Company IMO No	:	5219119
Flag	:	INDONESIA
Port of Registry	:	SURABAYA
Built	:	1964 *
Builder	:	Van der Giesen de Noord N.V, Krimpen a/d Ijssel, Netherlands - Yard No. 815
Call Sign		YHGW
MMSI		525493596
Class		BKI

The services of PT. Asuka Bahari Nusantara are made with the best knowledge and ability of its technical and administrative staff, But no responsibility will be taken for errors of judgment mistakes and negligence which may be committed.

No : .../CS/ABNM/2014
Date : 14.02.2014

Ship type	:	Double-ended Ro-Ro Cargo Ferry, Passengers & Vehicles
GT		4457 *)
DWT	:	673 Metric tons
LOA x B x D	:	101.99 x 18.01 x 5.29 meters
Draft Maximum	:	4.83 meters
Car decks	:	2 (Upper and Lower Vehicle Decks)
Propulsions		2 x 1600 HP Reversible DC Electric motor (300V) each respectively directly driving Forward sc. shaft & FPP and Aft sc. shaft & FPP.
Main Generator Engines	:	4 x 750 kW MAN G8V 30/45ATL at 400 rpm
Aux Generator Engines		3 x 150 kW MAN G6V 17.5/22.5 A at 750 rpm

Last Dry-docking Survey		28 August 2012
Next Dry-docking Survey		28 August 2013 **
Last Special Survey, Classification		20 September 2012
Next Special Survey, Classification	:	22/November 2017

***) See notes in Section F - Miscellenuous of Part IV - Recommendations.**

II. SURVEY

A. ATTENDANCE

A Hull and Machinery (H & M) Condition survey satisfactorily completed on 07 February 2014, from 12.30.00 to 18.30 hours while the vessel was on her routine trading voyage from Port of Merak, Banten to Port of Bakauheni, Lampung v.v, a two hours sailing time).

B. CONDITION OF VESSEL

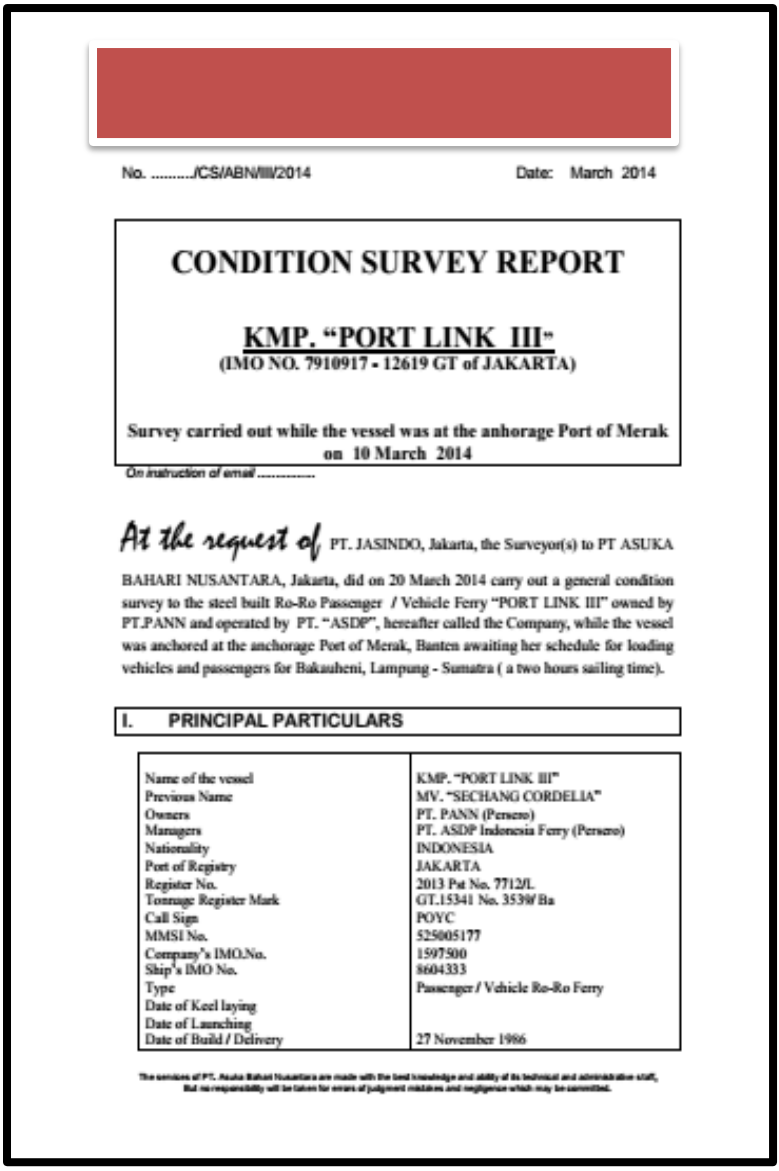
1 HULL & MACHINERIES

Physically Hull & Machinery and Equipment are generally found in satisfactory condition. Important machineriy items found operational and functioning normally, except the followings

2 DEFICIENCES

The following deficiencies were noted:

3. KMP. Port Link III



No. ...../CS/ABN/III/2014 Date: March 2014

CONDITION SURVEY REPORT

KMP. "PORT LINK III"

(IMO NO. 7910917 - 12619 GT of JAKARTA)

Survey carried out while the vessel was at the anhorage Port of Merak on 10 March 2014

On instruction of email .....

At the request of PT. JASINDO, Jakarta, the Surveyor(s) to PT ASUKA BAHARI NUSANTARA, Jakarta, did on 20 March 2014 carry out a general condition survey to the steel built Ro-Ro Passenger / Vehicle Ferry "PORT LINK III" owned by PT.PANN and operated by PT. "ASDP", hereafter called the Company, while the vessel was anchored at the anchorage Port of Merak, Banten awaiting her schedule for loading vehicles and passengers for Bakauheni, Lampung - Sumatra (a two hours sailing time).

I. PRINCIPAL PARTICULARS

Name of the vessel	KMP. "PORT LINK III"
Previous Name	MV. "SECHANG CORDELIA"
Owners	PT. PANN (Persero)
Managers	PT. ASDP Indonesia Ferry (Persero)
Nationality	INDONESIA
Port of Registry	JAKARTA
Register No.	2013 Pst No. 7712/L
Tonnage Register Mark	GT.15341 No. 3539/ Ba
Call Sign	POYC
MMSI No.	525005177
Company's IMO.No.	1597500
Ship's IMO No.	8604333
Type	Passenger / Vehicle Ro-Ro Ferry
Date of Keel laying	
Date of Launching	
Date of Build / Delivery	27 November 1986

The services of PT. Asuka Bahari Nusantara are made with the best knowledge and ability of its technical and administrative staff, But no responsibility will be taken for errors of judgment mistakes and negligence which may be committed.

No : .../CS/ABNMI/2014
Date : 03.2014

Builders	Shin Kurushima Co.Ltd - JAPAN
	Yard No.
Classification	BKI
LoA x Bmld x Dmld	150.88 x 25.00 x 13.30 meters
Max.Draft (Tropical)	5.47o meters
GT / NT	15341 / 4603
DWT	10,340 Metric Tons
Vehicle decks / capacity	2 (Main deck and Upper deck – 80 cars, 40 Trucks / Buses and 12 Trailers)
Total capacity of Passengers (Unberthed)	900 persons
Capacity of Fresh Water	
Capacity of Fuel Oil	260 tonnes
Capacity of Ballast Water	
Fuel Consumption / trip (ME + AE)	
Propulsion	2 x MAN-Mitsubishi 8L 58/68 @ 12000 HP at 428 RPM driving P & S Shaft Generators and CPPs through Reduction Gear Boxes.
Diesel Generators	2 x Daihatsu Ltd. - 6 DLB-26 @ 1300 HP at 720 RPM
Harbour Generator	1 x Daihatsu Ltd. – 6 DL 16 -300 HP at 900 RPM
Bow Thruster	1 x Electric Motor driven
Stern Thruster	1 x Electric Motor driven
Last Dry-docking Survey	31 July 2013
Next Dry-docking Survey	31 July 2014
Initial Survey /Change of Class to BKI	25 March 2013
Next Special Survey (SS)	-

II. SURVEY

A. ATTENDANCE

A Hull and Machinery (H & M) Condition survey satisfactorily completed on 20 March 2014, from 10.00 to 16.30 hours while the vessel was at anchorage Port of Merak, Banten, waiting for her next routine sailing schedule to Port of Bakauheni, Lampung v.v.

B. CONDITION OF VESSEL

1 HULL & MACHINERIES

Physically Hull & Machinery and Equipments are generally found in satisfactory condition. Important machinery items & equipment seen operational and functioning normally, except the following

2 DEFICIENCES

4. KMP. HM. Baruna 1

No. ...../CS/ABN/III/2014 Date: March 2014

CONDITION SURVEY REPORT

KMP. "HM BARUNA 1"

(IMO NO. 8518039 - 4432 GT OF JAKARTA)

Survey carried out while the vessel was on her routine voyage from Port of Merak – Port of Bakauheni v.v on 3 March 2014

On instruction of email .....

At the request of PT. Duyin Mitra, Jakarta, the Surveyor(s) to PT ASUKA BAHARI NUSANTARA, Jakarta, did on 3 March 2014 carry out a general condition survey to the steel built Ro-Ro Passenger / Vehicle Ferry "HM Baruna 1" owned and operated by PT. "Hasta Mitra Baruna" while the vessel was on her routine trading voyage i.e. Port of Merak, Banten – Port of Bakauheni, Lampung v.v (a two hours sailing time).

I. PRINCIPAL PARTICULARS

Name of the vessel	KMP. HM BARUNA 1
Owners / Managers	PT. HASTA MITRA BARUNA
Nationality	INDONESIA
Port of Registry	JAKARTA
Register No.	1986.Ba No. 7398 / L
Tonnage Register Mark	GT.4432 No.2180 / Ba
Call Sign	YDYP
IMO No.	8518039
Type	Passenger / Vehicle Ro-Ro Ferry
Date of Keel laying	20 March 1985
Date of Launching	15 March 1986
Date of Build / Delivery	02 June 1986
Builders	Southern Ocean Shipyard Co Pte, Singapore Yard No. SON 161
Classification	BKI – Class Notation +100A1 ⊕ P and +SM
LoA x Bmld x Dmld	90.60 x 17.60 x 5.00 meters

The services of PT. Asuka Bahari Nusantara are made with the best knowledge and ability of its technical and administrative staff, But no responsibility will be taken for errors of judgment mistakes and negligence which may be committed.

No : .../CS/ABN/III/2014
Date : 03.2014

Max.Draft (Tropical)	4.233 meters
GT / NT	4432 / 2408
DWT	600 Metric Tons
Vehicle decks / capacity	3 (Main deck - 55 units, Lower deck - 50 units and Upper deck – 48 units.
Total capacity of Passengers (Unberthed)	708
Capacity of Fresh Water	200 M/T
Capacity of Fuel Oil	471.40 M/T
Capacity of Ballast Water	1381.29 M/T
Fuel Consumption / trip (ME + AE)	0.55 M/T
Propulsion	2 x YANMAR Z-280 ST @1600 HP at 650 RPM driving P & S FPP through Reduction Gear Boxes.
Diesel Generators	3 x YANMAR 8 LAAL DTN @ 400 HP at .... RPM
Emergency Generator	1 x YANMAR
Bow Thruster	1 x driven through a gear box by a YANMAR diesel engine.
Last Dry-docking Survey	20 January 2014
Next Dry-docking Survey	20 January 2015
Last Continuous Special Survey (6th SS)	1 December 2010 (after several postponement from 1 July 201O)
Next Continuous Special Survey	1 July 2015 (the validities of Hull & Machinery and Load Lines Certificates)

Notes: Visa no.5 & no.7, the back pages of both Classification Certificates of Hull & Machinery have notation that class had been reinstated on two occasions. These are indications that the class had been not maintained during two periods i.e. from ..... to 2 December 2012 and from ..... 20 January 2014.

II. SURVEY

A. ATTENDANCE

A Hull and Machinery (H & M) Condition survey satisfactorily completed on 03 March 2014, from 12.00 to 20.30 hours while the vessel was on her routine trading voyage from Port of Merak, Banten to Port of Bakauheni, Lampung v.v, a two hours sailing time).

B. CONDITION OF VESSEL

1 HULL & MACHINERIES

Physically Hull & Machinery and Equipments are generally found in satisfactory condition. Important machinery items seen operational and functioning normally, except the following

5. KMP. Example II

KMP."EXAMPLE II"

(EX. MV. MEMORY)

IMO NO. 7116846

5227 GT OF CIREBON

H&M CONDITION SURVEY – PRELIMINARY REPORT

H & M Condition survey completed on 18 March 2012, from 13.30 to 22.30 hours while the vessel was on her routine trading voyage Merak - Banten to Bakauheni - Lampung V V.

SHIP PARTICULARS:

Name	:	EXAMPLE - II (Ex. MEMORY)
IMO No.	:	7116846
Port of Registry	:	Cirebon
Owners / Operators	:	PT.Angkutan Penyeberangan Laut (APL)
Built	:	1971
Builder	:	ANKER LOKKEN VERFT FLORO A/S DENMARK
Class	:	BKI (Built to LR Class)
Ship type	:	Ro-Ro Passenger & Vehicle Ferry
GT / NT	:	5527 / 1569
Capacity	:	120 trucks and cars + 953 passengers
Last Drydocking Survey	:	9 October 2012
Next Drydocking Survey	:	8 October 2013
Last Special Survey	:	(no record)
Main Engines	:	2 x Pielstick 8PC-2V 400 – 2x4000HP at 520 RPM
Aux Engines / Generators	:	2 x Caterpillar D-379 @ 720 HP at 1500 RPM / 415V-50Hz 1 x Cummins KTA 38-G3 980 HP at 1800 RPM /415V-50Hz
Bow Thrusters	:	1 x Electric motor driven
Propellers & shafts	:	2 x CPP through gear boxes

1 - 10

ATTACHMENT 4 : KPI Scoring

1. KMP. Example II

KPI number	KPI Descriptions	Details	Number	Information
KPI_1	Number deficiency observed onboard ship (-)	Fire doors on board, notably accesses to the Engine room and to the Upper / Lower Car deck were in poor condition or missing altogether or kept open, which render fire containment highly improbable in case of fire.	1	-
		No display of "No Smoking" signs.	1	
		Fire hose boxes found mostly empty	1	
		The ship was also provided with an emergency generator of adequate power, but stated not functioning any longer. No record available on board as when this generator stopped functioning	1	
		Lifebuoys, not fitted with retroreflected tapes and lifelines as required by SOLAS.	1	

		No evidence or records of maintenance of safety equipments as required by SOLAS was made available.	1	
		Effectiveness and function of watertight doors separating main engines room, auxilliary engines room and bow thrusters room were found doubtful due to obstructions and absence any testing evidence. Confirning fire and/or water ingress would therefore be highly improbabble.	1	
		It was stated that the engine room is protected by Halon fixed system, while the Upper and Lower car decks are protected by Splinkler system, however their effectiveness were not proven, since there was no evidence of any fire drills involving these equipments and also due to the condition that the engine room cannot be made air tight.	1	

		No evidence of safety drills schedule having been prepared and / or practised could be shown.	1	
		The fire hoses & hydrants in Upper / Lower car deck were not readied for use in case of fire, lighting in these spaces found inadequate.	1	
		The engine room bilges were not emptied, dirty and covered with soot and oil, loose gears were left laying around unsecured. The Engine Room space was shrouded by oil mist and felt uncomfortably hot, estimated in the 40s degree Celcius which is a clear evidence of lack of ventilation.	1	
Total number			11	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI2	Judgement of completed training on board ship (+)	1	Condition survey reports : ISM Code does not implemented, although the ship has valid DOC and SMC. There are no records of implementation with regards to training and drills in the use of Life saving and Fire Extinguishing Appliance
		1	
		2	
Total judgments number		1,25992105	

KPI number	KPI Descriptions	Details	Number	Information
KPI3	Number of major non-conformity observed on board ship (-)	Specific prosedures for preventing and extinguishing fire in each of the following spaces i.e engine room, bow thruster room and upper & lower car deck are to be established, included in the ship's SMS and practiced through regular / periodic safety drills as required by SOLAS.	1	-

		All access weathertight closing appliances / doors on the lower deck (which is also a main deck) to spaces below the deck i.e engine room, bowthruster room and steering gear room are to be closed all the times while the ship is underway, and is to be confirmed by including this activity in a ship's departure checklist / ship's SMS.	1	
		"No Smoking" signs of appropriate sizes and colour to be displayed through out the vessel, particularly in upper & lower car deck and Engine & Bow Thruster rooms. Conspicuous notices ordering passengers to leave their vehicles while the vessel is underway are to be displayed in the upper & lower car deck.	1	
		Weathertightness of the aft and side ramdoors to be improved	1	

		The capacity of drainage bilge water on lower car deck to be verified by fully testing water spraying system for at least one hour.	1	
		Compliance of the existing fire detecting and alarms system to SOLAS requirements to be checked and reported. Procedure for testing of this system is to be established and practiced and listed as part of critical equipments which required to be tested periodically.	1	
		Access fire doors to the following compartments i.e engine room, bow thruster room and lower car deck to be closed all the times and to be checked and included in the departure check list.	1	

		Approved Fire Control Plans indicating symbols / locations and capacities of 2 sets of Main Fire Pumps and Emergency Fire Pump and all other fire equipments i.e hydrants & fire hose boxes, fixed & portable fire extinguishing systems, SCBA & EEBD, fire doors, fire-alarms etc., are to be provided and displayed as per SOLAS requirements.	1	
Total number			8	

KPI	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI4	Judgement of detention reported (+)	1	Independent maritime surveyor statements : "Never detention for ROPAX vessel on the shipping domestic. There must be changes here"
		1	
		2	
Total judgments number		1,25992105	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI5		1	Condition survey reports : ISM Code does not
		1	

	Judgement of near-misses reported by ships (+)	2	implemented, although the ship has valid DOC and SMC. There are no records of implementation with regards to near-misses reported
Total judgments number		1,25992105	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI6	Judgement of successful psychometric test applied for officer reported by ships (+)	1	NTSC ship accident investigator statements : "Usually crew recruitment based on experience and rating"
		1	
		2	
Total judgments number		1,25992105	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information

KPI7	Judgement of crew injury observed & reported onboard ships (+)	1	Independent maritime surveyor statements : "Officer should record the number of crew injuries on board so quickly able to handle the crew if need special treatment"
		1	
		2	
Total judgments number		1,25992105	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI8	Judgement of DPA internal audit (+)	1	Condition survey reports : Revising SMS by including above procedures and other procedures relating to safety equipments have yet to be established as mentioned in previous paragraph to make the SMS more specific to the vessel by DPA
		1	
		2	
Total judgments number		1,25992105	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information

KPI9	Judgement of HSEQ Manager audit (+)	1	Condition survey reports : ISM Code does not implemented, although the ship has valid DOC and SMC. There are no records ship operational procedures to ensure safety, bunkering process, list of fire watch/patrol.
		1	
		2	
Total judgments number		1,25992105	

2. KMP. HM Baruna 1

KPI number	KPI Descriptions	Details	Number	Information
KPI_1	Number deficiency observed onboard ship (-)	All weather tight closing arrangements (except fore & aft ram doors) to main deck (as an enclosed car deck) and access doors to spaces below were found to have been kept opened while the vessel was underway. No instructions as for closing all those openings on the main deck while the ship is sailing	1	-
		The ship has no contingency plan or Procedures for responding / fighting fire in Engine Room and Main /Upper / Lower vehicle decks	1	
		No evidence that the efficiency of the scuppers / drainage on lower car deck have been tested. The draining system is recommended to be checked / verified or tested by operating the water drenching system for at least an hour and effectiveness confirmed and reported.	1	
		Last Tonnage Cerificate	1	

		Ship to be provided with a Minimum Safe Manning Certificate	1	
		STCW 1995 requires that qualifications of both Chief Engineer and 2nd Engineer in a vessel with propulsion 3000 kW and above to be minimum of Managerial levels (A III/2).	1	
Total number			6	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI2	Judgement of completed training on board ship (+)	1	Condition survey reports :No evidence or record that training on safety matters i.e. fire fightings using the above fixed fire fighting systems have ever been carried out nor has a schedule for safety drills been prepared.
		1	
		2	
Total judgments number		1,25992105	

KPI number	KPI Descriptions	Details	Number	Information
KPI3	Number of major non-conformity observed on board ship (-)	Access fire doors to the following compartments i.e. engine room, bow thruster room and lower car deck to be closed all the times when sailing	1	-
		Conspicuous notices ordering passengers to leave their vehicles while the vessel is underway are to be displayed in the main, upper & lower car decks.	1	
		Fire Control Plan on board to be revised according to the latest condition of the vessel.	1	
Total number			3	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI4	Judgement of detention reported (+)	1	Independent maritime surveyor statements : "Never detention for ROPAX vessel on the shipping domestic. There must be changes here"
		1	
		2	
Total judgments number		1,25992105	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI5	Judgement of near-misses reported by ships (+)	1	Condition survey reports : The Master / Ship Safety Officer (2nd Officer) could not show ship's SMS manual. There are no records of implementation with regards to near-misses reported. The company has a valid short term DOC and full time SMC
		1	
		1	
Total judgments number		1	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI6	Judgement of successful psychometric test applied for officer reported by ships (+)	1	NTSC ship accident investigator statements : "Usually crew recruitment based on experience and rating"
		1	
		1	
Total judgments number		1	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI7	Judgement of crew injury observed & reported onboard ships (+)	1	Independent maritime surveyor statements : "Officer should record the number of crew injuries on board so quickly able to handle the crew if need special treatment"
		1	
		2	
Total judgments number		1,25992105	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI8	Judgement of DPA internal audit (+)	1	Condition survey reports : ISM Code does not implemented, DPA could not show SMS as well as records of ISM Code activities on board.
		1	
		1	
Total judgments number		1	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI9	Judgement of HSEQ Manager audit (+)	1	Condition survey reports : ISM Code does not implemented. No effort of the company to make internal safety auditor to fix this issue
		1	
		2	
Total judgments number		1,25992105	

3. KMP. Rajakarta

KPI number	KPI Descriptions	Details	Number	Information
KPI_1	Number deficiency observed onboard ship (-)	Fire doors on board, notably accesses to the Engine were found being kept open, which render fire containment highly improbable in case of the fire	1	-
		Contingency plan as part of the SMS on board, shall be further developed as to include procedures for responding / fighting fire in Engine Room and in the Upper / Lower vehicle decks or other ulnerable places on board specific to the ship as required by SOLAS and to be incl;uded in the periodic safety drills	1	

		Contingency plan as part of the SMS on board, shall be further developed as to include procedures for responding / fighting fire in Engine Room and in the Upper / Lower vehicle decks or other ulnerable places on board specific to the ship as required by SOLAS and to be incl;uded in the periodic safety drills.	1	
		Man Overboard or MOB lifebuoys on Port and Starboard Bridge wings to be placed as per SOLAS requirements i.e in a quick relelease manner.	1	
		Ship is provided with 25 of 25 persons capacity and 1 of 20 persons capacity inflatable liferafts. At time of survey all containers raft were still tied by straps as temporary securing arrangement. Ship's officer has been advised that the straps must be cut, in order to enable the rafts to self inflate	1	

		Engine room is protected by CO2 fixed system, while the Upper and Lower car decks are protected by fixed water drenching system, however their effectiveness were not proven.	1	
		The ship's departure check list should be used to cofirm that all equipment for safe operation of ship are in order prior to departures	1	
		No evidence that the efficiency of the scuppers on lower car deck have ever been tested, it is recommended tha the effectiveness of these draining systems to be verified or tested by operating the drenching system for at least an hour and reported.	1	
		During theloaded voyage, The fire hoses & hydrants in Upper / Lower car deck to be standby for use in case of fire, .	1	
		Class and Load Line certificates issued by BKI	1	

		"No Smoking" signs and wiritten warning / informations containing restriction for passengers / truck drivers not to remain in the upper / lower car deck during the voyage to be displayed in conspicuous places	1	
Total number			11	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI2	Judgement of completed training on board ship (+)	1	Condition survey reports : ISM Code does not implemented, although the ship has valid DOC and SMC. There are no records of implementation with regards to training and drills in the use of Life saving and Fire Extinguishing Appliance
		1	
		2	
Total judgments number		1,25992105	

KPI number	KPI Descriptions	Details	Number	Information
KPI3	Number of major non-conformity observed on board ship (-)	To further develop the plan as part of the SMS on board, as to include procedures for responding / fighting fire in Engine Room and in the Upper / Lower vehicle decks or other vulnerable places on board specific to the ship as required by SOLAS and include them in the periodic safety drills.	1	-
		To make ready for use in Upper / Lower car decks during loaded passages	1	
		CO2 fixed fire extinguishing system in Engine room, fixed water drenching system on the Upper and Lower car decks.	1	
		To ensure and record that on placing back on board after service, the temporary lashing straps of the containers are cut to enable the rafts to self inflate when required.	1	

		Steering gears and the navigation lights' visual/audible alarm indicators. To check proper functioning of steering gears and navigation lights' visual/audible alarm indicators as per SOLAS requirements and record them prior to each ship departure or at least daily.	1	
		To check proper functioning of steering gears and navigation lights' visual/audible alarm indicators as per SOLAS requirements and record them prior to each ship departure or at least daily	1	
		To prove effectiveness and include them in the periodic fire drills and reported upon.	1	
Total number			7	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI4	Judgement of detention reported (+)	1	Independent maritime surveyor statements : "Never detention for ROPAX vessel on the shipping domestic. There must be changes here"
		1	
		1	
Total judgments number		1	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI5	Judgement of near-misses reported by ships (+)	1	Condition survey reports : ISM Code does implemented, need to practicing procedures for reporting any near miss occurrences and recording work and rest periods for individual seamen on board.
		1	
		2	
Total judgments number		1,25992105	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI6	Judgement of successful psychometric test applied for officer reported by ships (+)	1	NTSC ship accident investigator statements : "Usually crew recruitment based on experience and rating"
		1	
		2	
Total judgments number		1,25992105	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI7	Judgement of crew injury observed & reported onboard ships (+)	1	Independent maritime surveyor statements : "Officer should record the number of crew injuries on board so quickly able to handle the crew if need special treatment"
		1	
		2	
Total judgments number		1,25992105	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI8	Judgement of DPA internal audit (+)	1	Condition survey reports : DPA doesn't implementation ISM Code in this ship
		1	
		1	
Total judgments number		1	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI9	Judgement of HSEQ Manager audit (+)	1	Condition survey reports : To ensure that Contingency plans which include safety instructions / procedures specific to the ships are developed.
		2	
		2	
Total judgments number		1,587401052	

4. KMP. SMS Kartanegara

KPI number	KPI Descriptions	Details	Number	Information
KPI_1	Number deficiency observed onboard ship (-)	The ship has no Contingency plan or any Procedures for responding / fighting fire in Engine Room and Upper / Lower vehicle decks	1	-
		Ship to be provided with a Minimum Safe Manning Certificate	1	
		STCW 1995	1	
		Tonnage Certificate	1	
		The ship has no Muster List for Emergency Situations	1	

		Main Generator Engines' room / Auxiliary Generator Engines' room and Fore & Aft Electric propulsion & Shaft tunnel are all separate spaces connected by watertight doors. Main Generator Engines' room and Auxiliary Generator Engines' room were not provided with any fixed fire extinguishing system as required by SOLAS	1	
		Access doors to Engine room were always left opened and found not airtight as should be.	1	
		No evidence that all weather tight closing arrangement of hatches / access to spaces below the main deck were closed while the vessel was underway	1	
		No evidence that the remote control for closing the watertight door in engine room located on main deck have ever been tested.	1	
Total number			9	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI2	Judgement of completed training on board ship (+)	1	Condition survey reports : ISM Code does not implemented, although the ship has valid DOC and SMC. There are no records of implementation with regards to training and drills in the use of Life saving and Fire Extinguishing Appliance
		1	
		2	
Total judgments number		1,25992105	

KPI number	KPI Descriptions	Details	Number	Information
KPI3	Number of major non-conformity observed on board ship (-)	Specific procedures for preventing and extinguishing fire in each of the following spaces i.e. engine room and upper & lower car decks are to be established and included in the ship's SMS and practiced through regular / periodic safety drills as required by SOLAS	1	-

		Engine rooms are to be retrofitted with a Fixed Fire Fighting System as required by SOLAS (Ch.II-2, Reg.10.4.1.1 & 10.5.2.1).	1	
		Access fire doors to the following compartments i.e. engine room, bow thruster room and lower car deck to be closed all the times and to be checked and included in the departure check list.	1	
		"No Smoking" signs in Indonesian language of appropriate size and color to be displayed throughout the vessel, particularly in upper & lower car deck and Engineroom. Conspicuous notices ordering passengers to leave their vehicles while the vessel is underway are to be displayed in the upper & lower car decks	1	
Total number			4	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI4	Judgement of detention reported (+)	1	Independent maritime surveyor statements : "Never detention for ROPAX vessel on the shipping domestic. There must be changes here"
		1	
		2	
Total judgments number		1,25992105	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI5	Judgement of near-misses reported by ships (+)	1	Condition survey reports : no record of near-miss
		1	
		2	
Total judgments number		1,25992105	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI6	Judgement of successful psychometric test applied for officer reported by ships (+)	1	NTSC ship accident investigator statements : "Usually crew recruitment based on experience and rating"
		1	
		2	
Total judgments number		1,25992105	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI7	Judgement of crew injury observed & reported onboard ships (+)	1	Independent maritime surveyor statements : "Officer should record the number of crew injuries on board so quickly able to handle the crew if need special treatment"
		2	
		2	
Total judgments number		1,587401052	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI8	Judgement of DPA internal audit (+)	1	Condition survey reports : ISM Code does not implemented, No record of internal verification audit was available on board. No record of interim / initial external verification audit was available on board.
		1	
		2	
Total judgments number		1,25992105	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI9	Judgement of HSEQ Manager audit (+)	1	Condition survey reports : There are no development of SMS in this ship.
		1	
		2	
Total judgments number		1,25992105	

5. KM. Port Link III

KPI number	KPI Descriptions	Details	Number	Information
KPI_1	Number deficiency observed onboard ship (-)	Several access doors from lower car deck to main engines room, and aux. generators room, and from lower car deck to bow bow / stern thruster room and steering gear room are provided with hinged weather tight doors, which should always be kept closed during ship operations were left open.	1	-
		Lower and upper car decks (on the main deck and the deck above the main deck respectively) were protected against fire by a set of fixed water drenching system	1	
		Spaces below main deck containing port and stbd. main engines, aux. generating engines, aux. boiler and shaft generators were protected against fire by a set of fixed CO2 system. In addition to CO2 fixed system main engines, aux. engines and aux. boiler were also provided individually by water mist local fixed fire extinguishing systems	1	
		Accommodation spaces (including crew cabins and navigation bridge) located on two decks above the lower car deck were protected against fire by a set of fixed automatic water sprinkler system.	1	

		No evidence that the ship has prepared a voyage / passage plan prior departures	1	
		No evidence that the efficiency of the scuppers / drainage on lower car deck have been tested	1	
		No evidence that the remote or local controls for closing all hydraulically activated watertight sliding doors in main & aux. engine rooms and spaces located below main deck have been tested / recorded.	1	
		No evidence that a fire patrol system or procedures / instructions to carry out this activities has been established / implemented.	1	
		The ship contingency / emergency response plan does not contain procedures for responding to fighting fires in Engine Room and Upper / Lower vehicle decks and other spaces mentioned above specific to the ship	1	
		All weather tight closing arrangements (except fore & aft ramp doors) to lower car deck (as an enclosed car deck) and access doors to spaces below were found to have been kept opened while the vessel was underway.	1	

		No detailed procedures/ instructions for closing all those openings on the lower deck prior each departure is available.		
Total number			10	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI2	Judgement of completed training on board ship (+)	2	Condition survey reports : ISM Code does not implemented, d. The ship was not provided with any of the following documents i.e. SOLAS Training Manual and Fire Safety Operational Booklet specific to the ship in a language understood by all crew i.e. Indonesian as required by SOLAS. e. No evidence or record that training on safety
		2	

		2	matters i.e. fire fighting using the above fixed fire fighting systems and testing of fire dampers / fire detecting system has ever been carried out nor has a proper schedule for safety training / drills been prepared.
Total judgments number		2	

KPI number	KPI Descriptions	Details	Number	Information
KPI3	Number of major non-conformity observed on board ship (-)	Access fire doors to the following compartments i.e. engine room, bow thruster room and lower car deck to be closed at all times when sailing.	1	-
		Proper functioning of all load-line items i.e. the closing of weather-tight openings / doors to be checked and included in the departure check list.	1	
		All access weather tight closing appliances / doors on the lower deck (which is also a main deck) to spaces below the deck i.e. engine room, bow-thruster room and steering gear room are to be closed at all times while the ship is underway, and is to be confirmed by including this activity in the ship's departure checklist / ship's SMS.	1	

		Procedures for testing of the existing fire detecting and alarm system is to be established and practiced and listed as part of critical equipments which required to be tested periodically and recorded.	1	
		Specific procedures for preventing and extinguishing fire in each of the following spaces i.e. engine room, upper & lower car decks and accommodation spaces are to be established and included in the ship's SMS and practiced through regular / periodic safety trainings / drills as required by SOLAS.	1	
		Conspicuous notices ordering passengers to leave their vehicles while the vessel is underway are to be displayed in the main, upper & lower car decks.	1	
		Proper functioning of all load-line items i.e. the closing of weather-tight openings / doors to be checked and included in the departure check list	1	

		Remote control / actuator for watertight sliding doors, quick closing valves of fuel tanks and Emergency stop switches for fuel pumps and blowers should at all times be made free of any obstruction and ready to be activated. These remote controls are part of critical safety equipment and therefore should be tested periodically and included in the list of critical equipment weekly tests as part of ship SMS.	1	
Total number			8	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI4	Judgement of detention reported (+)	1	Independent maritime surveyor statements : "Never detention for ROPAX vessel on the shipping domestic. There must be changes here"
		1	
		2	
Total judgments number		1,25992105	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI5	Judgement of near-misses reported by ships (+)	1	Condition survey reports : ISM Code does implemented, need to practicing procedures for reporting any near miss occurrences and recording work and rest periods for individual seamen on board.
		1	
		2	
Total judgments number		1,25992105	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI6	Judgement of successful psychometric test applied for officer reported by ships (+)	2	NTSC ship accident investigator statements : "Usually crew recruitment based on experience and rating"
		2	
		3	
Total judgments number		2,289428485	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI7	Judgement of crew injury observed & reported onboard ships (+)	2	Independent maritime surveyor statements : "Officer should record the number of crew injuries on board so quickly able to handle the crew if need special treatment"
		2	
		3	
Total judgments number		2,289428485	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI8	Judgement of DPA internal audit (+)	3	Condition survey reports : DPA always revision of the Safety Guide
		3	
		3	
Total judgments number		3	

KPI number	KPI Descriptions	Maritime experts judgments (scale)	Information
KPI9	Judgement of HSEQ Manager audit (+)	1	Condition survey reports : Revising the SMS by including procedures and
		2	
		2	

Total judgments number	1,587401052	other procedures relating to safety equipments have yet to be established as mentioned in previous paragraph to make the SMS specific to the vessel. Including the new statutory requirements in the existing SMS i.e. ISM Code 2008, STCW 2010 and ILMC 2006 by defining, establishing and practicing procedures for reporting any near miss occurrences and recording work and rest periods for individual seamen on board.

CHAPTER 5
CONCLUSION

5.1 Conclusion

Measure effectiveness SMS implementation based on KPIs using a hybrid decision making AHP-TOPSIS method provides to analyse about SMS practice on ROPAX vessel especially at ferry port authority branch Merak area which has the highest number of ferry ship trips in Indonesia. Monitoring implementation SMS practice on ROPAX vessel should be carried out in order to reduce number of accident in Indonesia. Moreover, this research should be consideration of shipping operator to revision safety management system (SMS) on their safety management operation.

This research has not entirely actual conditions because of limitation to obtain data on safety management system (SMS) report from ship operator. Therefore this research process to be challenging for authors. The main findings of the research show that ship detention (KPI_4) according to questionnaire survey from the respondents using AHP method and DPA internal audit (KPI_8) according to comparison five condition survey data ROPAX vessel using TOPSIS method at ferry port authority branch Merak operation area are the lowest effectiveness SMS based on KPIs model implementation.

Safety management system on ROPAX vessel at ferry port authority Merak operator area has not been implemented properly. Regulations about ship detention not fully implemented. Necessary firmness of the regulator regarding ship detention regulation to ensure implementation ISM Code on ROPAX vessel.All element in ISM Code does not impelementation well on ship.

DPA shipping has responsibility and assignment to implementation ISM Code on their safety management operation. Regulator also need to support by providing ISM Code training and supervisory function to implementation ISM Code on ROPAX vessel.

5.2 Recommendations for future research

In this research to measure effectiveness SMS based on KPI using to rate performance of implementation ISM Code on ROPAX vessel. The author used data from comparison condition survey reports in each ROPAX vessels to scoring KPI and calculating with AHP and TOPSIS. It is important to ensure that the safety standards has been fulfilled in accordance with ISM Code regulation. It is suggested that future studies should investigate topics such as :

- Measure effectiveness SMS based on another method in type of cargo ship (tanker ship or container ship) on the specific company.
- Provide a real solution using comparison model system on how to improved ship safety level standard in Indonesia so get a predicate ‘zero accident’
- Developing a system to making document (certificate or document) process easier and supervised properly.
- Need additional opinions from the manager level

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