A Proposal for Criteria of Safe and Functional Port: The Perspective of Seafarers

A B Sulistiyono¹, W Mutmainnah², F H Seputro³ and M Furusho⁴
¹Departement of General Civil 1, PT. Wijaya Karya (Persero) Tbk, Jakarta, Indonesia
²Research & Development Division, Biro Klasifikasi Indonesia, Jakarta, Indonesia
³Marine Advisor, PT. Istpro Inti Nusa (Marine Division), Tangerang Selatan, Indonesia
⁴Graduate School of Maritime Sciences, Kobe University, Kobe, Japan

bambang.achmadi@wika.co.id

Abstract. Indonesia is the largest archipelagic state in the world with abundant natural resources and its geographical location. However, domestic connectivity is one of the major national issues that cause economic disparity among regions in Indonesia. The government is giving attention to maritime infrastructure development, especially port construction. Port construction process, applying other infrastructure construction standard in Indonesia, is started by setting an aim to get profit from the owner company. Then the owner company choose designer consultant to make a Detailed Engineering Design. After that, the tender process is conducted to select Construction Company. Finally, the chosen contractor start the construction. Seafarers, as the intense user of port facilities, have to accept the port condition as it is. Opinions from seafarers regarding the safety and functionality of ports would make the port acceptable for seafarer and could improve working performance at ports and support better-living conditions in the surrounding areas. Thus, the objectives of the paper are to find the criteria of the safe and functional port, to find the safest and most functional port standards from seafarers’ point of view, and to propose the recommendation program to improve the level of safety and functionality of the port, especially in Tanjung Perak Port as case study. The discussion will be focused on passenger terminal and RoRo ship, so the seafarers who are onboard the Roro ships are targeted as respondent. Safety of port and functionality of port are defined using 4M Overturned Pyramid (MOP) model. Seven points of criteria of the safe and functional seaport have been obtained. The questionnaire is then created to approach the seafarers’ opinion regarding the safety and functionality of the port. The port that durable in all-weather condition (strong wind, wave height, tide, temperature) is chosen as the safest and most functional port by seafarers.

1. Introduction
Indonesia is the largest archipelagic state in the world with abundant natural resources and strategically located along the world’s shipping routes between Pacific and Indian oceans. Although this assets give Indonesia some advantages, they still have a way to go. With more than 17,000 islands, domestic connectivity and regional development are major national issues in every presidency era [1]. Illegal fishing and ocean borders with neighboring countries are also serious issues needing attention. Lack of domestic connectivity causes economic disparity among regions in Indonesia, especially between the Western Region (IWR) and the Eastern Region (IER). For 30 years (1983-
2013) the contributions of IWR’s Gross Regional Domestic Product (GRDP) has been dominant and constant, not less than 80% of Indonesia’s Gross Domestic Product (GDP) [2].

Planes or ships are the best possible choices to solve this connectivity problem, but in terms of cost and capacity, ships are seen to be the most favorable choice. Unfortunately, the current infrastructure of seaports, navigational aids, and ship safety in Indonesia are insufficient to support domestic ship connectivity. The government of Indonesia is now focusing on the development of the maritime sector, especially maritime infrastructure. Regulations have been eased to boost development. At least 13 ports construction projects are now underway as part of the National Development Plan [3].

Port construction process, applying other infrastructure construction standard in Indonesia, is started by setting an aim to get profit from the owner company. Then the owner company choose designer consultant to make a Detailed Engineering Design. After that, the tender process is conducted to select Construction Company. Finally, the chosen contractor start the construction with supervision from management consultant [4]. The owner’s main considerations are the loading and unloading capacity, road accessibility, social impact, and other aspects of land ownership. The fact that seafarers are the intense user of port facilities is sometimes forgotten. With no opportunity to make recommendation regarding port construction to make it safer, seafarers have had to accept port condition as they are. Opinions from seafarers regarding the safety and functionality of ports would make port more seafarers friendly and could improve working performance at ports and support better living conditions in the surrounding areas.

These opinion are discussed further using 4M (man, machine, media, management) factor approach. The definition of 4M in MOP Model analysis are redefined from the original definition that used for accident analysis, become new definition for improvement. All aspects of safety in navigation and port functionality are analyzed. Tanjung Perak port in Surabaya, Indonesia was used as a case study for this research. Interviews with experts and experienced seafarers questionnaires are used for the main data. The objective of this paper are to find the criteria of the safe and functional port as well as to find the safest and most functional port criteria from seafarers’ perspective.

2. Indonesia Maritime Vision

Global geo-economy presents both opportunities and threats to Indonesia’s economy. One positive aspect of this global situation is the movement of the focus of the global economy from mainly Europe and America to the Asia Pacific region. This movement is expected to occur, as developing countries experience rapid growth and become the driving force of the global economy. Accordingly, the Indonesian government’s medium and long-term national development plans take the global situation into account. As stated in the National Medium-term Development Plan (RPJMN) for 2015–2019, one of the general policy of national development focuses on with maritime identity. The policy and strategy to accomplish these objectives are embedded in the Indonesia’s Global Maritime Fulcrum (IGMF) concept. This concept guides the development of all aspects of the maritime sector. The vision of the IGMF is to rebuild Indonesian maritime culture, maritime resources management, maritime infrastructure and connectivity including tourism, maritime diplomacy, and the maritime defence forces [5] under collaboration of relevant stakeholders to realize better domestic connectivity. The aim of this vision is to make economic growth between Indonesia’s Western Region (IWR) and Indonesia’s Eastern Region (IER) equal and sustainable. The IWR consists of Sumatra and the Java-Bali region, while the IER consists of the region of Kalimantan, Sulawesi, Nusa Tenggara, Maluku, and Papua. Region classification is made in terms of the ease of region recognition, it simplifies thousands of islands within 34 provinces into seven big regions. Based on the population census of 2010, Indonesian population was 237,641,326 with 50.34% being male and 49.66% female. This places Indonesia 4th in terms of population after China, India, and the United States. The relation of population on the big islands of Indonesia to the total area of Indonesia is shown in table 1 [6].

From the table, we can see that more than half of Indonesia’s population live on Jawa island, which is a small island compared to Sumatra, Kalimantan, and Papua. This distribution of population in some way explain the economic disparity that exist between IWR and IER through the unbalanced distribution of human resources. The population of Jawa island itself is growing rapidly, and is further increase by immigration from other islands.
Table 1. The Percentage of Island’s Area and the Population.

| Island   | Percentage of island’s area compared to the total area of Indonesian (%) | Population (%) |
|----------|--------------------------------------------------------------------------|-----------------|
| 1. Sumatra | 25.2                                                                     | 21.3            |
| 2. Jawa    | 6.8                                                                      | 57.5            |
| 3. Kalimantan | 28.5                                                                   | 5.8             |
| 4. Sulawesi | 9.9                                                                     | 7.3             |
| 5. Maluku  | 4.1                                                                      | 1.1             |
| 6. Papua   | 21.8                                                                     | 1.5             |

2.1. Domestic Connectivity

The main focus of the regional development agenda is to overcome the disparities in economic growth across regions. For 30 years (1983-2013) the contributions of IWR’s Gross Regional Domestic Product (GRDP) has been dominant and constant, not less than 80% of Indonesia’s Gross Domestic Product (GDP) [2]. To improve equality, the government has set a specific agenda to boost the development of IER while maintaining economic growth momentum in IWR [7].

Zaman, in his research also stated that the disparities between IWR and IER is caused by the lack of connectivity [8]. Port development in IER will benefit from the construction of Hub Ports which will increase the connectivity among regions. For maximum results, domestic connectivity must be well thought out. The themes of Regional Development are prioritized based on the region’s potential natural resources, geographical conditions, human resources, advanced technology, and in consideration with the National Spatial Plan and Regional Spatial Plan.

According to Government Decree No. 61 of 2009 on Seaports, several ports classifications are stipulated to realize domestic connectivity, to support domestic and international trade, and to create regional development [9]. Hierarchically, ports in Indonesia are classified into three, inter alia:

- Main Port. A port with main functions to serve domestic and international transportation activities in large volumes, as the place of origin of passengers and/ goods, and a ferry system with the scope of service between the provinces.
- Collector Port. A port with main functions to serve domestic activities in medium quantities, as the place of origin of passengers and/ goods, and a ferry system with the scope of service between the provinces.
- Feeder Port. A port with main functions to serve domestic transportation activities in limited quantities, as a feeder for main port and collector port, and as the place of origin of passengers and/ goods, and a local ferry system.

In terms of service that can provide for enterprises, ports are classified into:

- Commercial ports. Ports deliberately organized to provide facilities required by ships entering, berthing, loading and unloading, and other activities until leaving the port. This kind of port is equipped with facilities to service ships and cargo, and subject to required payment.
- Non-commercial ports. Ports which are just places for ships or boats without any facilities provided by the port.

Commercial ports, include Main ports that are now managed by Pelabuhan Indonesia or Indonesia Port Corporation (Pelindo). While non-commercial ports are applied to small-scale ports. The Indonesian government evaluates the development of non-commercial ports, to see if they are capable of becoming commercial ports, if they are, their status will change in the future. Non-commercial ports are located in remote areas, especially in IER. From a total of 758 public ports in Indonesia, 112 ports are commercial ports and 646 are non-commercial ports.

2.2. Tanjung Perak Port

The discussion of port development is focused on the passenger terminal including Ferry Ro-Ro. As the successful example is one of Pelindo III managed area, Tanjung Perak Port. The revitalization of the Gapura Surya Nusantara (GSN) passenger terminal shows a lot of good improvement. Before the
revitalization, GSN had a lot in common with other passenger terminals in Indonesia: dirty, hot, dangerous, and uncomfortable, but now everything is changed dramatically. GSN was rebranded and launched a port-based maritime tourism attraction, Surabaya North Quay (SNQ).

Located in Surabaya city, Tanjung Perak port is one of Indonesia’s main ports. It acts as the center for the collection and distribution of goods to IER. Supported by the hinterland of East Java, Tanjung Perak port became one of the busiest ports in Indonesia. General port facilities, for example the channel, pilotage, bunker, passenger terminal, container yard, and cranes are all in good condition to serve port activities. It serves all available modes of shipping transportation and trade, including bulk carriers, containers, cargo, passenger, etc. It has 13 wharfs with a total length 10.067 km with various depths from -2.5 to -10.5 m [10].

2.3. Ro-Ro Ships
Maritime transportation is necessary for a country made up of thousands of islands like Indonesia. The need for fast, reliable, and safe transportation is in high demand. Ferry operation is considered as the best solution since it is able to provides outstanding performance based on time and distance, as well as flexibility in operation. Ferry operation in Indonesia, is synonymous with Ro-Ro ships (Roll On Roll Off) as its provides superior transportation for goods and passengers at the same time. In addition, Ro-Ro ships also provide the opportunity to reach both inhabited and remote islands spread across the country, as well as inland waterways that require low draft ships. The Ro-Ro ship type is considered to be the most appropriate transport mode for Indonesia, since it can operate with low fares and has basic, economic technology. In conclusion Ro-Ro ships are important in enhancing domestic connectivity.

Based on land transportation statistical data, there are a total of 217 ferry lanes across the country that are consists of 48 commercial lanes and 169 lanes under the subsidiary of local municipalities or under the management of the central government as part of a pioneer service program. In terms of distance, the shortest ferry lane covers 530 Nm [11]. In terms of transport productivity, Indonesia domestic ferry transport has achieved a significant outcome. Nurwahyudi in his comparison research stated that in 2013, the domestic Ro-ro ships indicate a significant increment of 20% compared to the previous year of 2012 regarding passenger transported. Vehicle transport activity also increased by 30% in 2013 compared to data from 2012 [11].

3. Safety and Functionality of Port
Safety is a common word that all the people in the world know about its definition. Several definitions are stated from literature, for example Leveson defines that safety is freedom from accidents or losses”. According to Redmill et al. safety is a state, and that a safe state is a state where the perceived risk is acceptably low (and may include unperceived risk). Even though there are several acceptable definitions of safety, they all have in common the aspects of being free from something undesired, unwanted or unacceptable. A standard definition of safety is defined by ISO and IEC is "freedom from unacceptable risk" [12]. Summarized from literature and context adjustment with this study, the definition of the safety of port, as well as functionality of port are defined for the clarity of this study, the definitions are:

- Safety of port: The state of being protected from the occurrence of an accident or risk that leads to injury, danger situation, or loss in port area.
- Functionality of port: The quality of being suited to serve and assist seafarers in enhancing their performance in port area.

Discussing about safety, accident is one of indicator in term of safety assessment. The safer the operation, the less accident happen. In order to find the safety of port operation, once we analyzed the characteristic of accident in ports. Five main ports in Japan are the case study of the accident analysis. The accident investigation report from 2008 through 2013 re-analyzed using 4M Overturned Pyramid (MOP) model analysis. The explanation of MOP model analysis will be in the next section. The result is stated that Japan’s five major ports has 113 failures in 28 reported accidents. 54 of these failures resulted from the man factor, followed by 32 of management-related failures, 15 media-related
failures, and 12 machine-related failures. These numbers indicate that the man factor is the leading factor responsible for failures [13].

The characteristics of accidents in Japan’s five major ports have been discussed and the result is as follows. The highest causative factor is found to be the man factor, in the form of the man-machine relationship. Based on this research, there is one recommendation for the ports’ authorities regarding building/structure that may help overcome “contact” accidents. Almost all contact accidents were caused by “strong winds”, a media factor that cannot be controlled by humans, and this accident results in collision between the ships and the ports’ structures. If this is happened periodically, the safety of the port would be at risk. Therefore, it would be beneficial to install robust fenders, either rubber or plastic, to protect the ports’ structures and prevent future “contact” accidents.

In order to find the functionality of port operation, we use the functional approach from Marina that consist of two main function, first one is the people oriented function, and the second is vehicle-oriented function. Identical analogy can be used in term of port development. Since port also a place that accessible by land and by water, including berths, roadways, places for visitors and seafarers, personal welfare facilities, and loading/ unloading activity. Thus, the working area of port classified into:

- Water area. This area covers the approaching of the ships until berthing, including pilotage, towing or pushing barge. The area includes fairway, anchorage, turning basin.
- Berthing area. This area covers loading unloading activity
- Land area. This area covers stevedoring, cargo shifting, passenger transfer, personal welfare facilities.

The criteria regarding safety and functionality of port is needed in order to improve the condition of port which also can improve the performance of the seafarers in performing their job.

3.1. 4 M (Man, Machine, Media, Management) Factor

The 4M factor is a multifaceted approach that is widely used in the investigation of accidents, with an emphasis on human error. Discovered by the United States National Transportation Safety Board (NTSB), many researchers have used 4M factor analysis and have modified it into new analysis models. 4M4E, the IM model, and the 4M overturned pyramid (MOP) model are examples of the development of 4M factor analysis [14] [15] [16]. The MOP model, developed by Mutmainnah & Furusho, is a three-dimensional model configured as a three-sided inverted pyramid. This inverted pyramid is an unstable geometry and is vulnerable to failure, representing maritime transportation’s susceptibility to error. The four corners represent the 4M factors, with the man factor always located at the bottom of the pyramid. The model has two analyses, namely, corner analysis and line relation analysis that can describe each corner of the 4M factors and the corner-corner relationships.

The 4M factors are not just Man-Machine-Media-Management; they have broad meanings and specific definitions. The usage of 4M factors can be expanded to analyze the improvement case, not only to analyze accident like the original aim of its creation. The authors have already utilized the MOP model for the analysis of maritime tourism improvement. The application is in choosing which Entry and Exit Ports (EEP) should be the priority to be improved first, so it can make the usage of time and budget right on target.

The 4M factor analysis uses a specific definition for each factor. The definition of each 4M factor is defined in the MOP model, but some modifications must be applied in order to utilize this model in terms of improvements [16] [17]. In the case of analyzing the right development plan, for example port development, the definitions and examples must be redefined to obtain the best result. Table 2 explain the definition and example of each Man, Machine, Media, and Management.

| Table 2. The Definition and Example of Each 4M. |
|-----------------------------------------------|
| 4 M Factors  | Definition (Example) |
| Man          | All elements that affect people’s preparedness and will for an improvement (knowledge, education, skills, abilities, welfare, experience, sense of belonging, alertness, etc.). |
Table 2. The Definition and Example of Each 4M.

| 4 M Factors | Definition (Example) |
|-------------|----------------------|
| Machine     | All elements, including technology, that help people to complete their tasks (information and communication technology, equipment, design, infrastructure, construction, etc.). |
| Media       | All environmental factors that affect the system and/or people (geographical location, climatic/weather conditions, economic conditions, social politics, culture, etc.). |
| Management  | All elements that can control the system and/ or people (communication among stakeholders/ government, regulatory activities, procedures, rules, maintenance, etc.). |

3.2. Questionnaire Construction

To pursue the opinion of individual in research field, questionnaire is one of the effective way that be utilized. Questions are design to get the maximum opinion from the respondents. As the aim of this study, the constructed questions are addressed to seafarers. The questionnaire is consist of four parts, first is profile question, this part the question regarding respondent`s profile data will be asked, of course their data will be not used for another purpose except for this research only. The second part is regarding the safest and most functional port from seafarer` point of view. Third is the question regarding to the satisfaction level of seafarers at Tanjung Perak port. The last is additional comments from seafarers regarding the criteria of the safety and functionality of port, regarding the questionnaire, etc.

This questionnaire is constructed in free online media basis that have several advantages. It is low cost, real time access data, easy to operate, easy to spread to unlimited place and time in the world, and more important thing is paper less which is environmental friendly.

4. Result

4.1. The Criteria of the Safe and Functional Port

There are a lot of resources in determining the criteria of the safest and most functional ports. Literature study and expert interview are done to find the best possible criteria for this study. From literatures study, Ji-Yeong Pak et.al stated that port safety criteria are mainly affected by two main categories; Environmental factors and Non-environmental factors [18]. Environmental factors includes weather condition and channel condition, while non-environmental factors includes the volume of traffic inside the ports, and vessel size. Another criteria studied by Hsu, stated that the criteria consist of Vessel Traffic Service (VTS), marine pilot, fairy traffic, navigational aid, and ship berthing [19].

Another study that can be used is the criteria of marina. Neslihan Parker summarized the criteria of good marina in featuring its easy access to the city, prompt contact facilities to emergency point, individual activity opportunities, accommodation facilities, cleanliness, service quality, infrastructure quality, and security against external threat. Other researchers also stating almost the same aspects that can be the criteria of the safest and the most functional port [20].

Another source for criteria seeking is from expert interview. The experts are consist of port management consultant, experienced seafarers, and also lecturer. The features of port facilities as well as environmental condition are all included in experts` opinion. The addition point is the ability of port worker in doing berthing and other port related work, so they can gives the services to port user maximally. The combination of previous studies and expert opinion regarding the safe and functional port`s criteria results in the seven important criteria for this study. These criteria are used in the questionnaire to get know which criteria is the most important thing based on seafarers` opinion. The seven criterias are shown in table 3 below.
Table 3. The Criteria of The Safe and Functional Port

| No. | Criteria of The Safe and Functional Port (Example)                                |
|-----|----------------------------------------------------------------------------------|
| 1.  | Durable in all-weather condition (strong wind, wave height, tide, temperature)  |
| 2.  | Have the best quality and sufficient infrastructure (bollard, fender, navigational aid, channel’s depth and width) |
| 3.  | Have the best performance of Vessel Traffic Service to provides better information (traffic, inquiries from seafarers, and geographical features of port) |
| 4.  | Have the best ship service quality (pilotage, berthing, mooring, unloading)      |
| 5.  | Eco friendly (clean, hygiene, low emission)                                       |
| 6.  | Have sufficient public service for seafarers (accommodation, restaurant, internet, fuel, water, electricity) |
| 7.  | Safe and secure against external threat in port (thief, logging, extortion)       |

4.2. Questionnaire Analysis

4.2.1. Respondent Data. The questionnaire has been spread for two weeks to get the respondent and author received, in total, 25 respondents. All of the respondents are male. Here are several identifications of the respondents from the first part of the questionnaire. More than half of respondents or 52% are at the range of 30-39 years old, followed by the range of 40-49 years old with 32%. While the youngest ages range 18-29 years old is the fewer respondent with 16% percentage.

Figure 1 shows the educational and/or Certificate of Competence (COC) record of respondents. Indonesia ratify the International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers (STCW) 1978 and its amendment since 1986 stated in Presidential Decree 60 of 1986. Thus, all of standards regarding training and certification is referring to STCW. Every seafarers must have COC as the requirement to do on-board ship. In Indonesia, there are specific maritime school academy that has the license from the MOT to organize educational and training program to create seafarers. After graduated, the student needs to participate in competency test to gain the COC. After gaining specific COC, seafarers can upgrade their COC to obtain higher position on-board by participating in competency test held by the government.

The words ANT, ATT, will be explained in Table 4, the definitions are adopted from Ministerial Decree 70 of 2013 on Education and Training, Certification, and Watchkeeping [21]. It show the COC and its position on-board in Indonesia term lined with English term. While JHS is the abbreviation of Junior High School, SHS is Senior High School, VHS is Vocational High School, and D3 means Diploma Degree. The people who are graduated from general school also could be seafarers, with the provision of pass the competency test.
Table 4. Definition of COC and its Position On-board in Indonesian term and English Term.

| Certificate of Competence (COC) | Position on Board (Indonesia Term) | Position on Board (English Term) |
|---------------------------------|------------------------------------|----------------------------------|
| A. Deck Crew                    |                                    |                                  |
| 1. Ahli Nautika Tingkat I (ANT I) | Nahkoda                            | Master                           |
| 2. Ahli Nautika Tingkat II (ANT II) | Mualim I                           | Chief Officer                    |
| 3. Ahli Nautika Tingkat III (ANT III) | Mualim II                          | 2nd Officer                      |
| 4. Ahli Nautika Tingkat IV (ANT IV) | Mualim III                         | 3rd Officer                      |
| 5. Ahli Nautika Tingkat V (ANT V) | Mualim Jaga                        | Officer                          |
| 6. Sertifikat Rating Dinas Jaga Navigasi dan Kemudi (Sertifikat Juru Mudi) | Juru Mudi                         | Able Bodied (A/B)                |
| 7. Sertifikat Pelaut Terampil Bagian Dek | Kelasi                            | Ordinary Seaman                  |
| B. Engineer Crew                |                                    |                                  |
| 1. Ahli Teknika Tingkat I (ATT I) | Kepala Kamar Mesin                 | Chief Engineer                   |
| 2. Ahli Teknika Tingkat II (ATT II) | Masinis II                         | 1st Engineer                     |
| 3. Ahli Teknika Tingkat III (ATT III) | Masinis II                         | 2nd Engineer                     |
| 4. Ahli Teknika Tingkat IV (ATT IV) | Masinis Jaga                       | 3rd Engineer                     |
| 5. Ahli Teknika Tingkat V (ATT V) | Masinis Jaga                       | Engineer                         |
| 6. Sertifikat Rating Dinas Jaga Mesin (Juru Minyak) | Juru Minyak                       | Oiler                            |
| 7. Sertifikat Pelaut Terampil Bagian Mesin (Able Seafarer Engineer) | Kelasi Mesin                      | Wiper                            |
| 8. Sertifikat Electro-Technical Officer | Juru Listrik                    | Electrician                      |
| 9. Sertifikat Rating Teknik Elektro (Electro Technical Rating) | Kelasi Listrik                   | Electrician                      |
| 10. Sertifikat Operator Radio GMDSS | Markonis                        | Radio Officer                    |

Figure 2 shows the position on board ship of respondents that already translated in English term (refer to Table 4). In the figure, there is HRD word mentioned, it is abbreviation of Human Resource Development, the data from HRD is not used as they do not have any competency of seafarers. Mualim is the highest position who give the feedback of this questionnaire. Mualim here including Mualim II, III, and Mualim Jaga.
Figure 3 shows the Certificate of Proficiency (COP) that respondents already obtained. The explanation of COP abbreviation will be presented in Table 5 from the biggest percentage to small.

**Table 5. COP Abbreviation Explanation.**

| Abbreviation | Certificate of Proficiency (COP) |
|--------------|----------------------------------|
| 1. BST       | Basic Safety Training            |
| 2. MFA       | Medical First Aid                |
| 3. SCRIB      | Survival Craft & Rescue Boat     |
| 4. AFF       | Advanced Fire Fighting           |
| 5. MC        | Medical Care                     |
| 6. CCM       | Crowd and Crisis Management Training |
| 7. SAT       | Security Awareness Training      |
| 8. ORU/GMDSS | Operator Radio Umum/Global Maritime Distress and Safety System |
| 9. ECDIS     | Electronic Chart Display Information System |
| 10. ERM      | Engine Resource Management       |
| 11. SDSD     | Security Designated for Safety Duties |
| 12. SSO      | Ship Security Officer            |

From the feedback information, we can understand that the biggest COP of respondents is the basic safety training, which is the basic skill that must be mastered by seafarers. Another COP imply that the respondents are the seafarers of passenger (ro-ro) ship, proven by the CCM proficiency that are required for passenger ship. In case of Dead Weight (DWT) of ship that respondents operated, both 2000 – 3500 DWT and more than 5000 DWT is the highest value with 40 % percentage, and then DWT less than 2000 with 20% percentage. As of 2016, Indonesia fleet number is 7,843 ships with the DWT 18,117,000 DWT [22].
4.2.2. Questionnaire Result. Seven criteria of the safe and functional port (refer to table 3) is used to get the information which criteria is the most suitable in their opinion as the most important criteria. This is the result of second part of the questionnaire. Seafarers are given seven criteria that obtained and ask the rating of each criteria. Figure 6 shows the percentage of importance based on seafarers’ average opinion, 100 % is the maximum value of percentage of importance. It also give the information regarding the highest percentage of importance criteria. The questionnaire’s result shows that criteria number one is categorized as extremely important from the 86% seafarers, while 9% seafarers rate it as very important, and 5% seafarers rate it as moderately important. Thus, the average percentage of importance is 97%.

From the figure above, we can understand that criteria number one is the most important criteria based on the seafarers’ opinion. Followed by criteria number two, three, four, seven, six, and five. If the criteria listed as the result of the questionnaire, the criteria of safe and functional port for seafarers is:

Table 6. The Criteria of The Safe and Functional Port Based on Seafarers’ Opinion.

| No. | Seafarers’ Criteria of The Safe and Functional Port (Example) |
|-----|---------------------------------------------------------------|
| 1.  | Durable in all-weather condition (strong wind, wave height, tide, temperature) |
| 2.  | Have the best quality and sufficient infrastructure (bollard, fender, navigational aid, channel’s depth and width) |
Figure 7 is the result of questionnaire to seafarers which priority should Tanjung Perak port operator do to improve their port based on percentage of importance. The improvement program are based on seven criteria of the safe and functional port. Table 7 shows the order of recommendation program to improve Tanjung Perak Port based on seafarers’ opinion.

Table 6. The Criteria of The Safe and Functional Port Based on Seafarers’ Opinion.

| No. | Seafarers’ Criteria of The Safe and Functional Port (Example) |
|-----|-------------------------------------------------------------|
| 3.  | Have the best performance of Vessel Traffic Service to provides better information (traffic, inquiries from seafarers, and geographical features of port) |
| 4.  | Have the best ship service quality (pilotage, berthing, mooring, unloading) |
| 5.  | Safe and secure against external threat in port (thief, logging, extortion) |
| 6.  | Have sufficient public service for seafarers (accommodation, restaurant, internet, fuel, water, electricity) |
| 7.  | Eco friendly (clean, hygiene, low emission) |

Table 7. The Order of Recommendation Program to Improve Tanjung Perak Port based on Seafarers’ Opinion

| No. | Recommendation Program to Improve Tanjung Perak Port (Example) |
|-----|--------------------------------------------------------------|
| 1.  | Improve the durability of port against all-weather condition (strong wind, wave height, tide, temperature) |
| 2.  | Improve port’s security against external threat (thief, logging, extortion) |
| 3.  | Improve the performance of VTS to provides better information (traffic, inquiries from seafarers, and geographical features of port) |
| 4.  | Improve public service for seafarers (accommodation, restaurant, internet, fuel, water, electricity) |
| 5.  | Improve infrastructure’s quality and quantity (bollard, fender, navigational aids, channel’s depth and width) |
| 6.  | Improve Eco-friendliness of the port (clean, hygiene, low emission) |
| 7.  | Improve ship service quality (piloting berthing, mooring, unloading) |
5. Consideration and Discussion
The criteria of the safe and most functional port that has been obtained and utilized for questionnaire. Each criteria also have the value of 4M factors. The detailed explanation discussed in this chapter.

5.1. Man Factor
The successful of port development, especially the safety work operation are depends on the quality and ability of provider to serve the user of port. In this term, “provider” is port operator and “user” is seafarers. To make the port become user friendly, the opinion from user can be used by provider to make it happen. If the current condition of port is user friendly enough, it is a good asset to be used as a benchmark for another port improvement. If not so good, even more need some improvement for the current port itself, the usage of user’s opinion could be the best way to practice.

For the provider, the opinion of user is a benefit in term of improvement. From seven criteria of the safe and functional port, criteria number three: Have the best performance of Vessel Traffic Service to provides better information (traffic, inquiries from seafarers, and geographical features of port), criteria number four: Have the best ship service quality (pilotage, berthing, mooring, unloading), and criteria number six: Have sufficient public service for seafarers (accommodation, restaurant, internet, fuel, water, electricity) considered as the criteria that included in man factor. All of these criteria indicates the service that provider give to user. Giving good services to user is a “must do” job for provider to support user’s comfortability and confidence in doing their job at port that can lead to their best performance and prevent any accident risk.

5.2. Machine Factor
Criteria number one: Durable in all-weather condition (strong wind, wave height, tide, temperature) and criteria number two: Have the best quality and sufficient infrastructure (bollard, fender, navigational aid, channel’s depth and width) are included in machine factor. These criteria has significant role to support the safety and functionality level of user in doing their working area. The resilience of port from natural forces as well as the completeness of navigational aid in port area is seen to be important by the user. Thus, the value of it has the highest number percentage of importance.

The result of the safest most functional port for seafarers is in line with the result of previous research of the author regarding the characteristics of accidents in Japan’s five Major Ports [13]. The highest causative factor is the Man factor, in the form of the Man-Machine relationship. Based on that research, port operator is recommended to overcome “contact” accidents which is almost all that accidents were caused by “strong winds”, a Media factor that cannot be controlled by humans. These accidents results in collision between the ships and the ports’ structures. If this is happened periodically, the safety of the port would be at risk. Therefore, robust fenders, good planning of breakwater can protect the ports’ structures and prevent future “contact” accidents.

5.3. Media Factor
Natural forces are seems to be the biggest obstacle for the user, thus the effort from provider to overcome the forces is expected to be done. Beside the natural force, environmental condition also must be keep in the best level. Criteria number five: Eco friendly (clean, hygiene, low emission) is the condition that must be improved to make the user as well as environment condition can perform their best performance level. However, based on the questionnaire’s result, the user seems to be not so interested with criteria number five, since they place it as the last in safety and functionality criteria. Maybe, this is the mindset of the people from developed country which prioritizes the productivity rather than the environmental condition.

5.4. Management Factor
Criteria number seven: Safe and secure against external threat in port (thief, logging, extortion) is the authority of provider, the user just can accept the situation on the field. If the user could not feel secure in their working area, it can affect their performance in doing their job. The good governance of the
provider must ensure that the user can feel safe and able to maintain the productivity and performance in their port.

6. Conclusion
All of the paper’s objectives are discussed and the conclusion are:

1. There are seven criteria of the safe and functionality port achieved from this study. These criteria are obtained from combination of literature studies, expert interviews, and 4 M factor consideration. The criteria of the safe and functionality port are:
   1. Durable in all-weather condition (strong wind, wave height, tide, temperature)
   2. Have the best quality and sufficient infrastructure (bollard, fender, navigational aid, channel’s depth and width)
   3. Have the best performance of Vessel Traffic Service to provides better information (traffic, inquiries from seafarers, and geographical features of port)
   4. Have the best ship service quality (pilotage, berthing, mooring, unloading)
   5. Eco friendly (clean, hygiene, low emission)
   6. Have sufficient public service for seafarers (accommodation, restaurant, internet, fuel, water, electricity)
   7. Safe and secure against external threat in port (thief, logging, extortion)
2. The safest and most functional port for seafarers is durable in all-weather condition (strong wind, wave height, tide, temperature).
3. The order of recommendation program for Tanjung Perak port operator to improve the level of safety and functionality of the port based on seafarers’ opinion are:
   1. Improve the durability of port against all-weather condition (strong wind, wave height, tide, temperature)
   2. Improve port’s security against external threat (thief, logging, extortion)
   3. Improve the performance of VTS to provides better information (traffic, inquiries from seafarers, and geographical features of port)
   4. Improve public service for seafarers (accommodation, restaurant, internet, fuel, water, electricity)
   5. Improve infrastructure’s quality and quantity (bollard, fender, navigational aids, channel’s depth and width)
   6. Improve Eco-friendliness of the port (clean, hygiene, low emission)
   7. Improve ship service quality (piloting berthing, mooring, unloading)

7. References
[1] Uddin B. Sore and Sobirin 2017 Kebijakan Publik ed Dahan (Makassar: CV Sah Media) chapter 9 pp 187-189
[2] National Development Planning Agency (Bappenas) 2014 Rencana Pembangunan Jangka Menengah Nasional (RPJMN) 2015-2019, Book III Regional Development Agenda (Jakarta: Lingkup Strategis)
[3] President’s Staff Office 2016 Pembangunan Infrastruktur yang Komprehensif, Menciptakan Konektivitas Nasional dan Pertumbuhan Ekonomi (Available: www.kerjanya.id [access date: 12-05-2017])
[4] Indonesia Government 2000 Government Decree no. 29 of 2000 on Establishment of Construction Services (Available: https://tinyurl.com/pp29th2000 [access date: 14-06-2020])
[5] Indonesian Cabinet Secretary 2014 Pidato Presiden RI Joko Widodo Pada KTT ke-9 Asia Timur, di Nay Pyi Taw, Myanmar, 13 November 2014 (Available: http://tinyurl.com/Setkab-IGMF [access date: 23-07-2016])
[6] Indonesian Central Bureau of Statistics 2010 Indonesian Population Census 2010. (Available: http://sp2010.bps.go.id/ [access date: 12-07-2017])
[7] National Development Planning Agency (Bappenas) 2014 Rencana Pembangunan Jangka Menengah Nasional (RPJMN) 2015–2019, Book I National Development Agenda (Jakarta: Lingkungan Strategis)

[8] Zaman M B, Vanany I and Awaluddin D 2014 Proc. Int. Conf. on Ocean and Coastal Engineering, Environment, and Natural Disaster Management (Surabaya) pp 118-127.

[9] Indonesia Government 2009 Government Decree no. 61 of 2009 on Seaport (Available: https://tinyurl.com/GD-61-2009 [access date: 13-02-2017])

[10] Pelindo III, Tanjung Perak Branch 2017 Company Profile (Available: https://tinyurl.com/TanjungPerak-ComProf [access date: 12-07-2017])

[11] Nurwahyudi A 2014 CONTEMPORARY ISSUE IN DOMESTIC RO-RO PASSENGER FERRY OPERATION IN DEVELOPING COUNTRIES; Identification of Safety issues in domestic ferry operation based on accident investigation reports on ferry involved accidents in Indonesia waters, 2003-2013 (Malmo: World Maritime University)

[12] Rivai H 2014 Personal Identification (PIN) Safe Model to Analyze Unsafe Actions that Characterize Maritime Accidents (Japan: Kobe University)

[13] Sulistiyono A B, Mutmainnah W, and Furusho M 2016 J. Appl. Mechanics and Material 862 pp 214-219

[14] Takeshi C, Shinichi A and Takeshi K 2013 Special Edition Paper, JR EAST Review 5 pp 59-65

[15] Furusho M 2002 Proc. Inaugural General Assembly of IAMU (Turkey) pp 26-31

[16] Mutmainnah W, Furusho M 2014 Proc. Asia Navigation Conference (Xiamen: ANC) pp 1–10

[17] Sulistiyono A B, Mutmainnah W, Furusho M 2017 J. Appl Material Mechanic Journal

[18] Pak J -Y, Yeo G -T, Oh S -W, Yang Z 2015 J. Safety Science (Elsevier) 75 pp 172-181

[19] Hsu W-K K 2012 J. Safety Science (Elsevier) 50 pp 244-252

[20] Neslihan P and Ceren A V 2016 J. Touris Management 56 pp 156-171

[21] Ministry of Transportation 2013Ministerial Decree no. 70 of 2013 on Education and Training, Certification, and Watchkeeping (Available: https://tinyurl.com/MD-70-2013 [access date: 16-06-2017])

[22] United Nations Conference on Trade and Development 2017 UNCTADSTAT; Merchant Fleet by Country of Beneficial Ownership, ann (Available: https://tinyurl.com/UNCTAD-FL-DWT [access date: 09-06-2017])