ABSTRACT

The research on dry bulk terminal improvement is currently limited and lacks focus, despite the increasing global demand for dry bulk cargo which has necessitated terminal expansion to accommodate this demand. The primary aim of this paper is to propose a design for enhancing dry bulk terminal operations and identify a significant factor for improving dry bulk terminal performance through the utilization of the Quality Function Deployment (QFD) method. The fundamental concern in QFD pertains to determining the customer’s desires and formulating an effective strategy to address the identified challenges. These two elements are of utmost importance and are considered essential components within the House of Quality (HOQ) matrices. This study employed systematic procedures that utilized inferential statistics, specifically factor analysis and Spearman correlation, within the context of QFD method. Factor analysis is employed in the process of identifying and selecting the optimal set of unutilized items. The Spearman correlation coefficient was employed to examine and enhance the association between the elements. The findings indicate that there exist significant variables and items that contribute to the enhancement of dry bulk terminal. A study revealed that there exists a moderate and statistically significant correlation between loading time and both labor and machine factors. Additionally, the analysis reveals a substantial correlation between the provision of quality services and the size of the berth. Finally, the analysis reveals a moderate correlation between vehicle control and the operation of lorries. The strategy proposed in this study can be employed by port management to effectively identify solutions in the context of dry bulk terminals.

KEYWORDS

Quality Function Deployment, Dry Bulk Terminal, House Of Quality, Port Performance

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INTRODUCTION

Seaports serve as crucial infrastructural nodes that facilitate the seamless integration of maritime and terrestrial transportation systems, enabling the efficient movement of goods across various modes of transport (Shahrokni et al., 2015; Wasesa et al., 2017). The system facilitates the transfer of import or export cargo from ships to land transportation modes such as roads or railways as needed. Seaports play a crucial role as trading gateways worldwide. In light of increasing competition and escalating operational expenses; seaports are undergoing a transformation from their conventional function of solely providing storage or transit capabilities. Seaports are currently recognized and regarded as significant participants within the entire supply chain. Consequently, a significant amount of capital is allocated towards the development of infrastructure with the aim of improving operational effectiveness. The port industry in Malaysia has a significant role in fostering the growth and development of the national economy. According to the Maritime Institute of Malaysia (2020), it was estimated that seaborne transportation constitutes approximately 95% of international trade in Malaysia. Furthermore, it is worth noting that the port of Malaysia holds a position among the top 20 busiest ports globally. As reported by Bernama (2013), the seaport industry in Malaysia experiences a significant economic impact. Consequently, there exists a significant need for the expansion of the port sector due to the substantial growth observed within this particular industry. Dry bulk cargo represents the most substantial commodity in terms of tonnage traded within the realm of international maritime commerce. According to UNCTAD (2008) the global seaborne trade comprises various categories, with dry bulk accounting for 38% of the total, followed by oils at 34%, and containerized cargo at 28%. The trade in question can be further categorized into two distinct groups, namely large dry bulk and small dry bulk. Approximately one-third of the total volume of large dry bulk commodities is attributed to iron ore, which accounts for 844 million tons. Coal follows closely behind with 815 million tons, while grain constitutes 323 million tons. Bauxite and alumina contribute 84 million tons, whereas phosphate and rock make up 32 million tons. Moreover, the trading industry for small dry bulk encompasses a diverse array of cargoes, albeit on a smaller scale, yet remains significant in its own right. According to UNCTAD (2008), the Minor bulk dry category consists of 265 million tonnes, the forest product category consists of 176 million tonnes, the bulk fertilizer category consists of 83 million tonnes, the cement and clinker category consists of 120 million tonnes, and the crude sugar category consists of 519 million tonnes.

The increasing global demand for dry bulk cargo has necessitated a significant expansion of terminal capacities, thereby placing substantial pressure on these facilities. The expansion and increased capacity of dry bulk terminals worldwide are primarily driven by the significant demand for energy and mineral resources (Kusumawati, 2009; Lodewijks et al., 2007). The dry bulk trading industry encompasses a vast array of terminal services that are operational on a global scale. According to the DCI report from 2010, there are a grand total of 1,003 seaports spanning over 120 countries. These seaports collectively manage 1,525 terminals that facilitate the trade of dry bulk commodities. Among these terminals, 317 are specifically designated for the production of iron ore, 458 are dedicated to handling large quantities of fertilizers, and 628 are primarily utilized for coal transportation. Therefore, prioritizing efficiency is crucial to the delivery of its services. In order to improve their performance, it is necessary for current terminals to undertake the task of enhancing all aspects of dry bulk terminals and examining areas of weakness that could be
enhanced (Mohd Rozar et al., 2023; Rozar et al., 2018). One example of a primary objective in enhancing terminal efficiency is the reduction of time spent at anchorages, sedans, and stockpiles (Razik et al., 2015).

Nonetheless, ports face many complex functions and the complexities of their port facilities in delivering their services to customers. In particular, this refers to the bulk terminal where cargoes have different physical dimensions and weights. This causes congestion and further worsens the situation during loading and unloading because of the inefficiency in terminal installations. The congested yard actually triggers instability of the entire terminal activities, such as the anchorage, berth and stock pile (Razik et al., 2015; Rozar et al., 2018). In addition, not enough space for berths often leads to a longer queue of vessels waiting for served, increasing the turn-off period for the vessel. From a liner operator's viewpoint, it is important to reduce terminal costs by reducing vessel turnaround time (duration of spent in the dry bulk terminal). If the terminal does not deliver its service effectively and efficiently, congestion problems can seriously affect the terminal operations and damage the reputation of the terminal. Congestion will also lead to shipping lines exploring alternate routings or preferring other adjacent ports (Cheng et al., 2010).

A dry bulk terminal unable to handle massive cargo volumes and service large vessels is not only likely to lose its customers, but is also at risk of extinction (Razik et al, 2015). In addition, previous literature showed that Dry Bulk Terminal Improvement research, particularly in Malaysia, is still less oriented and scarce (Rozar et al., 2018). Henceforth, the objective of this paper is to: (i) To propose a design of Dry Bulk Terminal Improvement; (ii) To recognize an impacting variable for Dry Bulk Terminal Improvements.

LITERATURE REVIEW

2.1 Seaports in Malaysia

In Malaysia, ports are categorized as either Federal or State Ports, each falling under the jurisdiction of their respective governments. The management and oversight of ports and jetties are entrusted to the maritime department, while fishing ports and jetties are under the purview of the Fisheries Development Authority. Additionally, petroleum-related activities are facilitated through the establishment of specialized ports maintained by the relevant authorities (Maritime Institute of Malaysia, 2020). The establishment of the Federal ports has occurred as a result of their designation as Federal Statutory Bodies. Penang Port was established in accordance with the Penang Port Commission Act of 1955, the Bintulu Port Authority Act of 1981, and other federal ports as stipulated by the Port Authorities Law of 1963. The Port Privacy Law of 1990 governs the operations of federal ports and privatized private operators. Under this law, port agencies have assumed the responsibility of regulating private operators as they transition into the role of private operators themselves. Presently, there are seven prominent federal ports, specifically Port Klang, Penang Port, Johor Port, Tanjung Pelepas Port, Kuantan Port, Kemaman Port, and Bintulu Port, all of which possess contemporary infrastructure (Faris Indriya Himawan, 2018).

The economic growth of Malaysia had a significant impact on the transportation services sector in Malaysia. The large number of ports and road transports demanded greatly. In addition, in the last decade there has been a rapid growth in maritime activity. Almost 95% of Malaysia's foreign trade is estimated to be maritime based trade (Jagan et al., 2011) (Maritime Institute of Malaysia, 2020). In 2012, Malaysian seaports handled total cargo of about 480 million tonnes, out of a total of 505.26 million tonnes (RM 127,66 trillion) (Razik, 2015). It is also predicted to grow as per solid and sustainable relationship among Asian countries. Additionally, there has been a reformation and significant changes of port industry in Malaysia within this decade (Nik Azli et.
Abdurrahman Faris Indriya Himawan, Mohamad Hazeem Sidik, Muhammad Ashlyzan Razik, Md Zaki Muhamad Hasan, Bayu Wijayantini

al., 2011). In Malaysia, port industry is characterized as a public sector as most of ports are governed by public entities (Indriya, 2018). To boot, some of the main port are practicing commercial management to prepare better services to the customer. In 1986, the privatization of port terminal began and some of the ports are privatized such as Klang Port in 1986, followed by Johor Port and Bintulu Port in 1993. Even though the existing ports are being expanded and enlarged, Government still built up a new port in order to meet up with the growing of port traffic. Tanjung Pelepas is one of the port in Johor Area which is only half an hour away from the busiest shipping lanes in the world and it is entirely accessible within Malaysia water (Razik, 2015).

RESEARCH METHOD

3.1 Research Design

The research commences by employing a survey methodology. The survey method is employed to gather data pertaining to the necessary enhancements for dry bulk terminal facilities. The research is being conducted at all 18 ports in Malaysia that are engaged in the operation of dry bulk cargo. Past research has shown that a survey approach has played a significant role in many port outcomes to boost terminals efficiency and effectiveness (APEC Transportation Working Group, 2002, 2003, 2004, 2005, 2006, 2008). It is indeed the most cost-effective way of collecting large groups of data (Moser 1967). The data collected for the survey are further analyzed using QFD. A case study is the basis of the approach taken for this research. The case study approach is to analyze in more depth WHAT and HOW. A variety of qualitative data collection methods include interviews, evaluation, simulation and document review. This is in line with tonnes of previous researchers that also used the same methods (Zhu et al., 2012). Then the items are analyzed using factor analysis to determine the vital items for further analysis in QFD as already published in Rozar et al. (2018). There are 18 ports in Malaysia that are accounted for 98% cargo volumes (Chen et al., 2016). Kuantan Ports is selected for this study and the analysis will use QFD methods within the organization.

3.2 QFD Process

The QFD method is divided into three phrases: design of quality, comprehensive design and process implementation (Razik, 2015). Using a QFD matrix as an instrument is effectively defines a range of issues relevant to the planning process, achieves any stage of implementation or interpretation (Govers, 2001, 1996). The QFD process begins with the desires and needs of our consumers as well as of themselves frequently known as the "customer's voice". Various ways are done to get this "voice" such as surveys and interviews to consumer research, user reviews and product screening (Razzaly, 2000). This voice is classified in logical terms, after which it is interpreted to produce the customer's wishes as soon as it has been collected. These are the internal company specifications which are usually the characteristics of global product to the degree that the product is sufficiently implemented to satisfy customer needs. In order to achieve fundamental functions, the global design specifications must then be translated into particular elements and essential features (Razzaly, 2000. Indriya, 2018). By focusing on key aspects of the product being developed, relationships between the indefinite number of requirements, which are the requirements and the requirements, are established through the use of the planning matrix. With this information, the next interpretation can be generated as inputs after requirements have been established, including target values and key relationships.

3.3 The House of Quality
The House of Quality is the basic tool for developing QFD projects (Ding, 2009). The house of quality is a form of conceptual map that provides inter-functional communication between matrixes. Design priorities can be modified by anyone with variant problems and accountability to reach the solution that they desired while referring to evidence on the patterns of the house grids. The customer demands are recognized and determined qualitatively. Then, the room of House of Quality are established which also known as WHATs room. WHATs room is the amalgamation of customer voices which comprise of what they want and what they need (Dale et. al, 1998). Then the voices of customer/ WHATs room is being categorize and prioritize where consumer importance or weighing and market analysis is listed from the most importance to lesser in order to create a strong basis in the customer's voice. To proceed into comprehensive next step, the list of WHATs is enhanced by listing one or more HOWs for each WHAT so that consumer requirements are converted into global product features or design requirements. Then, the relationships between the WHATs and the HOWs is determined. By filling up the room known as "Relationship Matrix," relationships are established in a matrices structure to deal with these complicated connections’ problems. Relationship strength can be categorized as strong, medium, or weak, into three categories. The measurements are derived from the measurement of knowledge, practice, statistical and experimental analysis. Next, the correlational matrix is established. The correlations are classified as Positive, Strongly Positive, Strong Negative and etc. In the end, the last step is to take action where the aim of this step is to identify which issues are most critical in improving the overall customer satisfaction with the product resulting from the data organized. The critical elements are those which are either new, challenging or momentous. Most of them are the items to be unraveled or improved by the inter-functional teamwork of the organization. This analysis involves a series of seven steps to effectively construct the HOQ for the improvement of dry bulk Terminal (DBTI), as illustrated in the accompanying Figure. 1. The initial step involves compiling a comprehensive list of customer requirements (WHATs) in Room 1. 2. In Room 2, the subsequent step entails creating a list of technical descriptors (HOWs) that correspond to the identified customer requirements. 3. Room 3 is dedicated to constructing a relationship matrix that illustrates the connections between the customer requirements and technical descriptors. 4. Moving on to Room 4, an interrelationship matrix is developed to establish the interdependencies among the technical descriptors. 5. Similarly, in Room 5, an interrelationship is established between the customer requirements to further understand their interdependencies. 6. Room 6 is dedicated to conducting a technical competitive assessment to evaluate the competitiveness of the technical descriptors. 7. Finally, in Room 7, priorities for improvement are determined based on the findings from the previous steps.
Figure 1: the model of House of Quality

Figure 2: The Proposed Model of Dry Bulk Terminal Improvements (DBTI)
Figure 2 above depicts the proposed model in this study in order to improve Dry Bulk Terminal. For a more systematic analysis, WHAT and HOW item distributions are shown according to the following Table 1, Table 2 and Table 3:

### Table 1: The List and Abbreviations for WHATs (X) Group

<table>
<thead>
<tr>
<th>WHAT</th>
<th>ABBREVIATIONS</th>
<th>Primary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loading cost reduction</td>
<td>Xa1</td>
<td></td>
</tr>
<tr>
<td>Trucking efficiency improvement</td>
<td>Xa2</td>
<td></td>
</tr>
<tr>
<td>Loading Work-in-process reduction</td>
<td>Xa3</td>
<td></td>
</tr>
<tr>
<td>Material Handling facility efficiency improvement</td>
<td>Xa4</td>
<td></td>
</tr>
<tr>
<td>Stockpile location improvement</td>
<td>Xb1</td>
<td></td>
</tr>
<tr>
<td>Labour improvement</td>
<td>Xb2</td>
<td>Infrastructure</td>
</tr>
<tr>
<td>Flexibility (loading) improvement</td>
<td>Xb3</td>
<td></td>
</tr>
<tr>
<td>Loading Processing time reduction</td>
<td>Xc1</td>
<td></td>
</tr>
<tr>
<td>Loading Lead time reduction</td>
<td>Xc2</td>
<td>Time performance</td>
</tr>
<tr>
<td>Service quality (loading) improvement</td>
<td>Xc3</td>
<td></td>
</tr>
</tbody>
</table>

### Table 2: The List and Abbreviations for WHATs (Y) Group

<table>
<thead>
<tr>
<th>WHAT</th>
<th>ABBREVIATIONS</th>
<th>GROUP NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reasonable cost operation</td>
<td>Y1</td>
<td></td>
</tr>
<tr>
<td>Port planning capability</td>
<td>Y2</td>
<td></td>
</tr>
<tr>
<td>High loading/unloading flexibility</td>
<td>Y3</td>
<td></td>
</tr>
<tr>
<td>Smooth gate systems</td>
<td>Y4</td>
<td></td>
</tr>
<tr>
<td>Transporting service level of connecting road systems</td>
<td>Y5</td>
<td>Operation Improvement</td>
</tr>
<tr>
<td>Shortest processing time</td>
<td>Y6</td>
<td></td>
</tr>
<tr>
<td>Control of vehicles, all modes, entering and leaving port</td>
<td>Y7</td>
<td></td>
</tr>
</tbody>
</table>

### Table 3: The List and Abbreviations for HOWs (Z) Group

<table>
<thead>
<tr>
<th>HOW</th>
<th>ABBREVIATIONS</th>
<th>Primary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor</td>
<td>Za1</td>
<td>Utilisation</td>
</tr>
<tr>
<td>Machine</td>
<td>Za2</td>
<td></td>
</tr>
<tr>
<td>Berth Size</td>
<td>Zb</td>
<td>Berth</td>
</tr>
<tr>
<td>Bucket Wheel Loading</td>
<td>Zc1</td>
<td></td>
</tr>
<tr>
<td>Clamshell Grabs</td>
<td>Zc2</td>
<td></td>
</tr>
<tr>
<td>Loading Spouts</td>
<td>Zc3</td>
<td></td>
</tr>
<tr>
<td>Mobile Harbor Cranes</td>
<td>Zc4</td>
<td>Materials Handling Facilities</td>
</tr>
<tr>
<td>Conveyors</td>
<td>Zc5</td>
<td></td>
</tr>
<tr>
<td>Conventional Labor Oriented</td>
<td>Zc6</td>
<td></td>
</tr>
<tr>
<td>Pipelines</td>
<td>Zc7</td>
<td></td>
</tr>
</tbody>
</table>

Harnessing Quality Function Deployment And The House Of Quality Principle For Malaysia’s Dry Ports
RESULTS AND DISCUSSION

Figure 3 displays the coefficient symbols and scale used to describe the relationships. Therefore, the study result in Figure 3 could be interpreted.

Figure 3: Scale of QFD

<table>
<thead>
<tr>
<th>Coefficient Value (Spearman)</th>
<th>QFD Symbols (Relationship)</th>
<th>QFD Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>No Relationship (or Weak)</td>
<td>0</td>
</tr>
<tr>
<td>0.71</td>
<td>Low</td>
<td>+1</td>
</tr>
<tr>
<td>0.9</td>
<td>Moderate</td>
<td>+3</td>
</tr>
<tr>
<td>1.0</td>
<td>Strong</td>
<td>+9</td>
</tr>
</tbody>
</table>
Figure 4: The Relationship Matrix Between WHATs VS HOWs

Harnessing Quality Function Deployment And The House Of Quality Principle For Malaysia’s Dry Ports
Figure 5: The Complete Roof correlation matrix between DBTE (HOWs vs HOWs)
<table>
<thead>
<tr>
<th>LE</th>
<th>Port Competitive Assessment</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Kotakin Port</td>
<td>Lahu Port</td>
</tr>
<tr>
<td>Loading cost reduction</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Trucking improvement</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Loading Work-in-process reduction</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Material Handling facility efficiency improvement</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Stockpile location improvement</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Labour improvement</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Flexibility (loading) improvement</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TP</th>
<th>Port Competitive Assessment</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Kotakin Port</td>
<td>Lahu Port</td>
</tr>
<tr>
<td>Loading Processing time reduction</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Loading Lead time reduction</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Service quality (loading) improvement</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OE</th>
<th>Port Competitive Assessment</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Kotakin Port</td>
<td>Lahu Port</td>
</tr>
<tr>
<td>Reasonable cost operation,</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Port planning capability</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>High loading/unloading flexibility</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Smooth gate systems</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Transporing service level of connecting road systems</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Shortest processing time</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Control of vehicles, all modes, entering and leaving port</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

**Figure 6**: Port Competitive Assessment
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**DISCUSSION**

The analysis in **Figure 4** shows the correlation \( r \) between each of the WHATs and HOWs items. It was found that loading time (Xc2) has moderate and significant relationship with labor (Za1) as conveyed by Kusumawati (2009) where the waiting time in a production system follows the philosophy of eliminating non-value-added activities, which can reduce costs and improve product quality. The production output increases as the level of product damage is minimized, while the input decreases due to the efficiency gained from eliminating non-value-added activities. This is due to Za1 is vital in order to ensure that Xc2 could run efficiently and effectively. The expertise, knowledge and real comprehension of every activity are thus indicators for the port functioning process. Apart from that, loading time (Xc2) also has a moderate relationship with machine (Za2). This is indicating that machine is also vital and crucial in ensuring port operation can run smoothly apart from labor. Additionally, the analysis shows that quality services (Xc3) would have a moderate relation to berth size (Zb). Therefore, it can be inferred that berth size is vital in terminal. The size of the berth plays an important role to ensure that large number of ships can be served. The bigger the size of the berth, the bigger the number of ships. Lastly, the analysis is also depicting that there is moderate relationship between control of vehicles (Y7) and lorry (Zd1). The lorry is an extensively used form of transport in ports for the carriage of the goods. The results of this analysis indicate that lorry is a highly correlated with vehicle control compared to railways and pipelines.

In addition, **Figure 4** also illustrates the weak relationship inside of the House of Quality, which are loading processing time (Xc1), loading lead time (Xc2), service quality (Xc3), reasonable cost operation (Y1), port planning capability (Y2), high loading flexibility (Y3), smooth gate system(Y4), transporting service level (Y5) and processing time (Y6). All these elements are correlated with lorry services (Zd1). Other than that, loading cost reduction (Xa1), materials handling facility (Xa4), stockpile location (Xb1), labor improvement (Xb2), flexibility in loading (Xb3), loading processing time reduction (Xc1), loading lead time (Xc2), service quality (Xc3), port planning capability (Y2), smooth gate system (Y4) and control of vehicles (Y7) are weakly correlated with upper 30 minutes for trucking (Ze3). Besides that, the empty row and column indicated that there is no significant correlation at all between WHATs and HOWs. Hence, the expectation of management fails to be attained. The empty column means that a different
WHATs does not impact the HOWs and can be withdrawn and omitted from the standard house after careful inspection.

The analysis in Figure 5 shows the complete roof of correlation matrix between HOWs. In this analysis, 24 items in technical descriptors correlate with each other using the correlation spearman. The symbols describe the direction of the correlation. In other words, a strong positive relationship would be nearly perfect positive correlation. This diagram allows the user to identify which technical descriptors support one another. In this roof, there are three items for the strong correlation with significant result. First, Za1 and Za2 which observe between labor and machine. Second, Zc2 and Zc3, observing the materials handling facility between spouts and grabs and third e1 and e2, trucking efficiency between less than 15 minutes and 15-30 minutes. The moderate correlation with significant results between elements in the technical descriptors; Zc1 and Zc2, Zc1 and Zc3, Zc4 and Zc5, Zd1 and Zd3. Zc1 represent Bucket wheel loading which correlate moderately with clamshell grabs (Zc2). Bucket wheel loading (Zc1) also shows moderate correlation with loading spouts (Zc3). Zc4 represent mobile harbor cranes have moderate correlation with conveyor (Zc5). Last, Zd1 which represent lorry has moderate correlation with railways (Zd3).

These five ports are Kuantan Port, Lumut Port, Johor Port, Kemaman Port and Penang Port (Figure 6). The elements involved in Port Competitive Assessment are the scale of customer’s requirements for each port involved in this study. The scale starts with the number 1 (least important) and ends with 5 (very important). In other words, the more important the DBTR, the higher the rating. The importance of ratings correlates the importance of DBTR and it represents the strength of each other. All of these are very useful for prioritizing efforts and making trade-off decisions. The QFD results indicate that the indicators that require top priority are those related to the competence of the personnel, particularly administrative staff. Therefore, the management’s recommendation is to create Standard Operating Procedures (SOPs) for each activity at the port specifically for administrative personnel (Bastian et al., 2018).

The rating was taken from the survey and interview from Dry Bulk Terminal Management Teams. There were 17 list of DBTR involved such as loading cost reduction (Xa1), trucking improvement (Xa2), loading work in process (Xa3), materials handling efficiency (Xa4), stockpile location improvement (Xb1), labor improvement (Xb2), loading/unloading improvement (Xb3), processing time reduction (Xc1), lead time reduction (Xc2), service quality (Xc3), reasonable cost operation (Y1), port planning capability (Y2), high loading/unloading flexibility (Y3), smooth gate systems (Y4), transporting service level (Y5), shortest processing time (Y6) and control of vehicles in all modes (Y7). The highest of PCA is loading cost reduction (Xa1) at Kemaman Port compared to Johor Port and Penang Port (3). Reasonable Cost Operation (Y1) in Penang Port also has high PCA compared to Kemaman Port and Johor Port (4). Finally the lowest of PCA is 2 and mostly were in Kuantan Port such as loading cost reduction (Xa1), trucking improvement (Xa2), materials handling efficiency (Xa4), materials handling efficiency (Xa4), smooth gate systems (Y4), transporting service level (Y5) and shortest processing time (Y6). Priority analysis consists of target value and scale up factor. Target value is what the Port management wants to remain in the DBTR, by improving or making it better than the competition. Scale up factor is the ratio of the target value to the rating given in PCA. The higher the number, the more effort is needed. Hence, higher efforts were required for three DBTR which are smooth gate systems (Y4), shortest processing time (Y6) and materials handling efficiency (Xa4).
Figure 7 shows room 7 or the technical competitive assessment (TCA). A total of 18 ports in Malaysia were used as an input and for TCA only 5 ports were involved as testing in QFD models. These ports were Kuantan Port, Lumut Port, Johor Port, Kemaman Port and Penang Port. The elements involve in TCA are the value of DBTE for each ports involved in this study. The TCA divide 2 groups of element; primary and secondary. Primary involves 5 groups; utilization; material handling facilities; transportation for moving cargo; trucking efficiency and storage location.

The 24 list element of DBTE were involved such as Labour (Za1), Machine (Za2), Berth size (Zb), utilization, Bucket wheel loading (Zc1), Clamshell grabs (Zc2), Loading spouts (Zc3), Mobile Harbor cranes (Zc4), Conveyor (Zc5), Conventional labour oriented (Zc6), Pipelines (Zc7), Grabs (Zc8), Hooper (Zc9), Cranes (Zc10) for material handling facilities, Lorry (Zd1), Truck (Zd2), Railway (Zd3) for transporation for moving cargo, Less than 15 minutes (Ze1), Between 15-30 minutes (Ze2), Upper than 30 minutes (Ze3) for trucking efficiency, Less than 1 km(Zf1), Between 1km-3 km (Zf2), 3km-5 km (Zf3),5 km-10 km(Zf4) and Upper than 10 km (Zf5) for storage location. The value in the list of DBTE was based on the survey and phone interview. The rating was obtained from Dry Bulk Terminal Management Teams. The Top five of TCA which must be prioritized are lorry ,Zd1 (24.2), labor, Za1 (20.3), machine, Za2 (20.3), upper than 30 minutes ,Ze3 (15.7) and truck, Zd2 (12.0). Its followed by Berth Size (9.0), 3km-5 km (5.8), pipelines (5.0) and conventional labor oriented (1.7). This is useful for the management to decide on which part of DBTE is in need of improvement.

CONCLUSION

Kuantan Port Consortium (KPC) is Malaysia's largest dry bulk terminal on the east Malaysia peninsula. Each year, cargo traffic, especially dry / breach bulk cargo and petrochemical products, have continuously increased. The port business keeps on boosting consistent with the development projects in the area. As traffic increased, KPC has expanded its facilities so that ship operators and cargo owners have a good quality of services. KPC's main aim is to provide effective services to enhance terminal operations, reduce ship time, increase facility use, mitigate traffic congestion and simultaneously decrease operational costs. This study has provided an empirical evidence with QFD method via House of Quality model where the main target is to improve the performance at Dry Bulk Terminal in Kuantan Port. The research models have strengthened understanding of the interactions between the various physical components of the port and port management policies. The process of developing the model and analyzing the interaction between these components has provided information on the various operating features of the port. The system analysis technique is not only useful to the modeler, but also benefits port operations officers, because it has a thorough knowledge of how the port is handled and also demonstrate how it is treated.
REFERENCES


