

# Emergence of Emergency Logistics Centre (ELC): Humanitarian Logistics Operations at the Straits of Malacca

Jagan Jeevan, Nurul Haqimin Mohd Salleh, Rudiah Md Hanafiah, Abdul Hafaz Ngah

Despite the apprehension of certain parties, the demand for maritime emergency logistics has emerged following the occurrence of maritime accidents around the world while trading activities are performed. The requirement of Emergency Logistics Centre (ELC) is crucial as part of the maritime disaster preparedness at the Straits of Malacca (SOM). The ELC prevents massive losses, should any disaster occur in the rough ocean. Based on unforeseen situations at sea, this paper explores the contributing factors of the ELC in proposing and improving strategies for Kuala Linggi seaport as an ELC. The Exploratory Factor Analysis (EFA) has been employed to achieve the objectives of this paper. The outcome of this paper indicates that resource availability, risk management, and geographical factors are the three key attributes that are substantially required to transform Kuala Linggi seaport into an ELC. Furthermore, disaster preparedness, ELC supply-chain management system, and safety procedures are the crucial components to enhance the operational efficacy at this seaport as an ELC. The findings of this research may contribute to the safety of the maritime route and disaster preparedness at the SOM.


## KEY WORDS

~ Emergency Logistics Centre  
~ Straits of Malacca  
~ Malaysia

University of Malaysia Terengganu, Faculty of Maritime Studies, Malaysia

e-mail: jagan@umt.edu.my

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## 1. INTRODUCTION

Maritime disasters have occurred throughout the ages and have caused significant damages to the environment, society, and trade activity. For example, the shipwreck of the *Oriental Star* in 2015, the Exxon Valdez oil spill in 1989, and the notorious sinking of the *Titanic* in the North Atlantic Ocean in 1912 indicate a substantial need for this ELC. Over the past few years, numerous incidents have occurred, and these catastrophes have been classified as either natural disaster or man-made disaster. Disaster is defined as a situation or event causing widespread damage which is difficult or beyond human ability to control (Timoleon, 2012). Disasters occur frequently in various parts of the world and normally bring enormous consequences such as human death and injury, property loss, pollution, and others. Maritime disaster is a man-made disaster, as classified by the International Civil Defence Organisation. It has received considerable attention due to the enormous property damage, casualties and serious environmental impact that it potentially brings (Yan et al., 2017). Although there is low probability of its occurrence, maritime disaster is a serious disaster with grave consequences such as loss of human life, damage to the economy, and the environment (Yan et al., 2009). Therefore, maritime disasters have motivated decision-makers and researchers to initiate the ELC in order to serve the victims. The ELC plays an important role in providing effective and efficient rescue procedures to save human life, assets, and the environment (Cozzolino, 2012).

In general, maritime disasters usually occur in a confined area such as a strait or channel where the density of vessel traffic is high (Akten, 2006). Operating an ELC will be pointless if the

execution process is not timely. Therefore, the emergency relief must be delivered to the affected area as swiftly as possible with minimum time access to constitute effective rescue operation after the occurrence of a disaster (Ji and Zhu, 2012). Since the Straits of Malacca (SOM) is one of the vital shipping routes in the world with a high potential of ship accident, quick emergency operation response in the event of maritime disaster is very important to reduce the disaster impact at the location.

Every year, the number of vessels navigating along this strait keeps increasing. According to a report from the Marine Department of Malaysia (2017), deep-draft vessels, tanker vessel, LNG carrier, cargo vessel, container vessel, bulk carrier, Ro-Ro, passenger vessel, livestock carrier, tugboats, government vessel, and fishing vessel are all major types of fleets that actively navigate along the SOM. In addition, the volume of the vessels also indicates a progressive pattern from 2009 until 2016. For example, in 2009, the number of vessels recorded to be navigating along this strait was 71,359, and in 2010 the number went up to 74,133. In 2011, the number further increased to 73,528 vessels. Between 2012 and 2019, a smooth rise has been witnessed whereby the number of vessels climbed up from 75,477 to 83,740 within the seven-year period.

The SOM experiences high-density vessel traffic; therefore, it is a busy area with a high potential for collisions (Zaman et al.,

2015). More than 80,000 vessels pass through the SOM annually. Managing the narrow SOM that caters for a large number of international maritime vessels is one of the significant issues in this region. Maritime accidents such as collision and explosion at the straits can cause traffic obstruction, environmental degradation, loss of revenue, and damage to the economy (Rusli, 2012). A maritime accident will affect the economy, environment as well as the performance of trade activities. Consequently, the existence of the ELC is required to provide efficient and effective emergency response procedures especially at the SOM.

There are five types of maritime disasters recorded at the SOM. These are collision, sinking of a ship, fire on board, grounding of a ship, and others. Other types of disasters are flooding, capsizing, hijacking, man overboard, crew injuries, as well as engine failure. Among these, collisions, ship sinking, vessel on fire, and vessel grounded are the main maritime catastrophes that have occurred at the SOM. From 2006 to 2016, there were 35 cases of collision, 28 cases of ship sinking, 23 cases of vessel on fire, 13 cases of vessel grounded, and 19 cases under the category of 'others' that were recorded at the SOM.

The SOM is about 180 nautical miles long from One Fathom Bank (Choke point 1) off the coast of Port Klang to Tanjung Piai (Choke point 3) in the south and west entrance to the Strait of Singapore (see Figure 1). Choke point 1 is about 3,582 meters

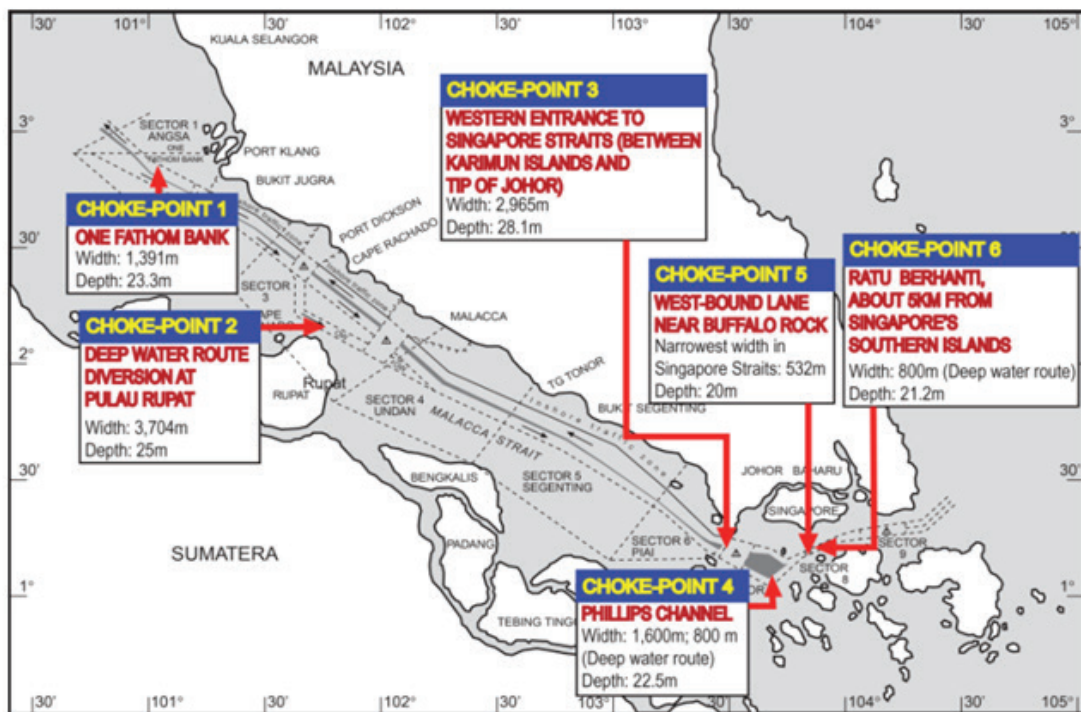


Figure 1. Major choke points along the SOM. Source: Adapted from IRGC (2011).

wide and Choke point 3 is about 2,965 meters wide (Awaludin and Abu, 2017). Limited space for vessel navigation and accessibility has labelled Choke point 1 and Choke point 2 as two major chokepoints with limited depth for safe navigation and vulnerable navigation points along the SOM. The traffic flow will be severely affected and could cause a 'shut down' if any casualties occur at the SOM, especially at the two major chokepoints. Unfortunately, according to Awaludin and Abu (2017), with the current emergency capability along this strait, it will take several months for the strait to be re-opened for navigation. This will affect the sustainability of the SOM in the respective regions especially in Indonesia, Singapore, Thailand, and Brunei.

Due to the limitations of the humanitarian services provided by the Marine Department and the Malaysian Maritime Enforcement (MME), it was seen as suitable for Kuala Linggi seaport to be proposed as the ELC to maintain the efficiency of the SOM and enhance the productivity of Malaysian seaports. Conversely, limited availability of research on the ELC at the SOM is the main motivation for this paper. Very few studies have been carried out on the topic of the ELC compared to business logistics, which has a reasonable amount of literature involved (Caunhye et al., 2012). Most of the research on the ELC discusses disasters at inland via 'humanitarian logistics' rather than disasters at foreland, especially in terms of maritime disasters. Therefore, this paper will examine two main questions, i.e. the factors contributing to the development of Kuala Linggi Port as an ELC on the west coast of Peninsular Malaysia, and the improvement strategies for the performance development of the ELCs on the west coast of Peninsular Malaysia. The outcome of this paper may reduce the gap in the academic research that occurred between maritime disasters and business logistics.

Owing to the limited academic research into the functions of the ELC at the SOM, this paper seeks to provide a clear depiction of the development and operation of the ELC at this particular location through an online survey with important stakeholders. The paper starts by addressing the motivation and basic requirements for the ELC operations. Development factors explored and strategies suggested by respondents to cope with the challenges of operational efficiency at the SOM are discussed in Section 2. The methodological approach applied will be explained in Section 3. Section 4 reveals the key outcome of this paper, while Section 5 discusses the application of inland terminals in the ELC operations. The conclusions reached will be presented in Section 6 of the paper.

## **2. EMERGENCE OF THE ELC IN THE SOM: REVIEW OF THE LITERATURE**

This section elaborates two main components of this research, which include the reason for ELC development and

strategies to improve the performance of ELC. The outcome of this section will be utilised for questionnaire development to ease the data collection procedure and analysis.

### **2.1. Reasons for the ELC Development**

This section explains the motivation of ELC developed at SOM which includes ship accident, hazardous substance spills, tsunami, unpredictable weather conditions, and the demand for seaport of refuge on this coast.

#### **2.1.1. Ship accident**

The increasing number of ships navigating through the SOM has caused a concern for domestic and international users. The growing of ships' traffic and the narrow path of the SOM led to the increasing of navigational hazards (Khalid, 2013). The responsibility carried out by the SOM accommodating one-third of the world trade needs to be secured by an effective support system such as the ELC. Shipping accident is the term used in an accident that resulted in the loss of either life or property, or both. Shipping activity is one of the risky activities, which can lead to maritime accidents (International Maritime Organisation, 2005). Between the years of 2000 and 2010, maritime collision represents the largest fraction of casualty in the Strait of Malacca (Rusli, 2012).

#### **2.1.2. Hazardous substance spills**

Ship traffic at the SOM is contributing to the potential hazard disastrous to the environment (Ibrahim and Khalid, 2007). As oil transportation worldwide continues to increase, many communities are at risk of oil spill disasters and must anticipate and prepare for it (Chang et al., 2014). One of the factors that cause marine oil spill is the accidents of marine oil tankers or freighters (Mei and Yin, 2009). For example, the wreck of the MV Rena off the northeast coast of New Zealand is one of the worst maritime disasters resulting in the pollutant combination of oil and dangerous goods debris in a dynamic oceanic environment (Schiel et al., 2016). Hence, the ELC is urgently needed to execute the maritime emergency operation effectively to save human life and the environment.

#### **2.1.3. Tsunami**

Emergency logistics planning during the 2004 Indian Ocean tsunami was conducted manually without logistics experts, which caused a significant inefficiency during the procedure (Fritz Institute, 2005). A systematic emergency logistics procedure is crucial for disaster response to provide an effective reaction. The tsunami case proves that the effectiveness of the emergency aid response hinges on logistics speed and efficiency (Pettit et al., 2011).

#### **2.1.4. Unpredictable weather condition**

Regions around the SOM including Malaysia, Singapore, and Indonesia experience high humidity with a considerable amount of rainfall, and the wind velocity is reported to be light along the length of the waterways (Ibrahim et al., 2008). The movement of the sea current at the southern part of the SOM is unstable compared to the northern part of the strait (Rusli, 2012). The currents in this part of the Strait form large sand waves, sandbanks and shallow shoals along the waterway, which is vulnerable for commercial vessels (George, 2008).

#### **2.1.5. Demand for the port of refuge**

The port of refuge has become a relief node for the vessels in distress because of the several notorious maritime disasters such as the Erika (1999), the Castor (2000), the Prestige (2002), the Napoli (2007), and the Flaminia (2012) (EMSA, 2017). When a ship gets into difficulties, one of the main options of the owner or master is to seek a relief space where the difficulties can be remedied or minimised before proceeding on the voyage (Morrison, 2011). In this critical situation, a ship can use a port of refuge to unload its cargo of fuel oil or to carry out repairs so that the situation does not become worse and prevents pollution to the environment (Yang, 2006).

### **2.2. Strategies for ELC Performance Improvement**

This section discusses how the performance of the ELC can be improved to perform as relief node to victims at the SOM. Hence, several components will be considered such as infrastructure supports, unified command and network coordination, contingency plan, procurement management, warehousing, collaboration among the parties involved, disaster preparedness, application of information system in the ELC, technological advancement and implementation as well as a comprehensive logistics training programme.

#### **2.2.1. The infrastructure support**

The infrastructure support includes transportation network, storage structure and information exchange etc. (Ji and Zhu, 2012). Insufficient infrastructure will affect the accessibility of the emergency logistics to the affected area and may raise the uncertainties, complexity and difficulty of the emergency logistics operation (Sheu, 2007). In order to respond during a maritime disaster, the difficulties and challenges to respond to the affected area depend on the state of the sea and the disaster/s. A well-designed transportation network and storage infrastructure could make the distribution operation to the affected areas faster (Ji and Zhu, 2012).

#### **2.2.2. Unified command and network coordination**

The unified command and network coordination refer to integrated network and the coordination of capacities, devise the relief distribution plan and organise the dispatch commands. In a massive disaster, unified command is important to ensure response and recovery in an immediate and orderly manner (Ji and Zhu, 2012). Furthermore, unified command and coordination are crucial while dealing with the victims from different nationalities or backgrounds.

#### **2.2.3. Contingency plan**

Contingency planning aims to prepare an organisation to respond well to an emergency and its potential humanitarian impact. A contingency plan comprises the hardware such as relief service models, relief reserve funds, infrastructures and goods as well as the software including expert teams, volunteers, exchange of information and contingency measures (Ji and Zhu, 2012). The management of logistics for the emergency operation is part of contingency planning that needs a special attention and focus (Amna, 2013).

#### **2.2.4. Procurement management**

Procurement management considers the need for supplies, competitive price for supplies and eventuality arrangements if the shortages occur (Bozorgi et al., 2012). The purpose of the procurement management is to ensure the supplies of the emergency operation resources are provided timely in the right amount, good quality and at a reasonable price (Sunyoto and Wismadi, 2008). The supplies for emergency operation come from different sources, either from disaster relief organisation, donation from the national or international community or loans (Timoleon, 2012). The delay of the procurement is one of the most important factors that can result in the slow delivery of the emergency operation supplies after the disaster occurs (Holguín et al., 2007).

#### **2.2.5. Warehousing**

Warehousing is a key component for disaster relief where the emergency aid resources that will be pre-positioned properly to minimise the response time and allow for better procurement planning while improving distribution cost (Bozorgi et al., 2012). Every resource needs to be placed in an appropriate storage, and the significance of the warehousing is to ensure the quality and quantity of the resources is in a good condition during the process of the emergency response (Sunyoto and Wismadi, 2008). The purpose of the logistics warehouse is to facilitate the management of the efficient emergency logistics operation to the affected area (Ariyanti, 2013).

### 2.2.6. Collaboration plan

The collaboration includes government institutions, both at the central and regional levels, donor institutions and countries, volunteer groups, military, non-government organisations, the private sector and academics (Sunyoto and Wismadi, 2008). The collaboration between all the parties involved shall be mobilised with proper communication, cooperation and coordination, and shall be united in the same objective, examples like providing help and aids to reduce the victims' sufferings. According to the Yan et al. (2017), the emergency responses for the maritime accident are very complex, and all the experts from a different organisation should be involved in this process.

### 2.2.7. Disaster preparedness

Disaster preparedness is the process of building up and prepare the emergency response capacities before a disaster situation prevails in order to reduce impacts (Sena and Michael, 2006). Improved disaster preparedness may save life, reduce the suffering of survivors, and enable communities to restart normal life more quickly (Wisetjindawat et al., 2014). Wassenhove (2006) pointed out that disaster preparedness consists of five key elements, which are human resources, knowledge management, operations and process management, financial resources and community.

### 2.2.8. Application of information system in ELC

Emergency aid information system provides a better flow of emergency operation information and increases the efficiency of the emergency logistics supply chain (Koseoglu and Yildirimli, 2015). Furthermore, with the information system, the information flows, which integrated logistics unit and the non-logistics unit, will be more efficient to overcome unpredictable disasters (Howden, 2009).

### 2.2.9. Technological advancement and implementation

It is easy to manage disasters, either natural or man-made disasters, in the era of technology. The role of technology in disaster emergency operation is to connect, inform, and ultimately save the lives of the victims (Holdeman, 2014). Sufficient technology can contribute to a better and appropriate connectivity during the disaster operation. For example, space technology plays an important role in minimising the disaster impact by providing the information about the disaster to telecommunications, global navigational satellite systems, geographic information system and web technology which can be used for disaster prevention, relief, recovery, warning and monitoring the various phase of disaster management (Subbarao et al., 2014). With the enhancement in information technology, the capability to carry logistical operations timely and deliver the required inventory to the victims has been efficient (Amna, 2013).

### 2.2.10. A comprehensive logistics training program

According to the Holguín et al. (2007), based on the Katrina disaster case, most of the emergency logistics staff does not have an adequate training to respond to the extreme circumstances. This is because the effectiveness of the emergency response and recovery operations are based on the knowledge and skills possessed by the staffs working at the disaster sites (Schaafstal et al., 2001) and their ability to practice them when the disaster occurs (Sinclair, 2012). Hence, the emergency logistics operation training is very important towards providing effective and efficient emergency response with a good skill level to handle critical supply chain (Holguín et al., 2007).

## 3. METHODOLOGICAL PROCEDURE

An exploratory factor analysis (EFA) has been carried out in this research to investigate the influential factors and improvement strategies of ELC development in this region especially at the SOM. A list-based stratified sampling technique has been employed to enhance the sample's statistical efficiency rather than just a simple random sampling and is appropriate for the survey when the respondents' organisations are dispersed (Cooper and Schindler 2014). A list-based stratified sampling strategy is used to gather sufficient data to analyse the multiple subpopulations. It is effective for studying certain population's characters, their points of view or their standing on certain issues (Creswell and Amanda, 2008). The target respondents are key stakeholders of seaports in Malaysia.

The population of this research are experts from Kuala Linggi Port Operator (10 participants), Malaysian Marine Department (25 participants), Ministry of Transport (25 participants), and Malaysian Maritime Enforcement (10 participants). Top and middle-level managers from the above mentioned subpopulations who are directly involved in the ELC, managing intermodal terminals, seaports, humanitarian aid, policy makers and related logistics operations have been invited to participate due to their experience and knowledge in the ELC and humanitarian logistics operations. They are expected to contribute with their viewpoints or opinions on the major contributing factors to the development of the ELC at the SOM and strategies to improve the ELC performance at the SOM.

The survey in the form of a questionnaire was distributed online. The instrument was structured using five-point Likert scale ranging from "strongly agree", "agree", "neutral", "disagree" to "strongly disagree". The questionnaires were distributed to the key experts in each organisation to ensure the validity and appropriateness of the outcome. There are three sections in the questionnaire, namely Section A (the demographic profile of the participant), Section B (contributing factors to the development



of Kuala Linggi Port as an ELC), and Section C (improvement strategies for Kuala Linggi Port as an ELC). This questionnaire was designed based on the outcome in the literature review. The literature review in this paper has focused on the aim of the research. Therefore, the outcome has been critically reviewed and shortlisted based on the influencing factors and improvement strategies of the ELC.

Participants were then instructed to respond according to their degree of agreement with the statements contained in the instrument. An EFA has been used for decision-making process to assess the contribution factor of the ELC development at the SOM and to validate the appropriate strategy to improve the performance of the ELC at the location. The aim of the EFA is to reveal any latent variables and to reduce data to a smaller set of summary variables. Besides, it is also intended to explore the underlining theoretical structure of the phenomena and to identify the relationship structure between the variable and the respondent. The broad purpose of the EFA is to summarise the existing data so that relationships and patterns can be easily interpreted (Yong and Pearce, 2013). Moreover, they argue that the main role of the EFA is to assist researchers to reduce a large dataset that consists of several variables by observing 'groups' of variables. In this paper, the factors that influence the ELC development and appropriate strategies to enhance the ELC performance will be classified accordingly, based on the views of Malaysian seaports.

Interpretation is an important aspect of the EFA, which requires pragmatic, theoretical, and subjective procedures to develop meaningful latent factors to answer the proposed research questions. A labelling procedure should reflect the conceptual and theoretical intent (Tabachnick and Fidell, 2000). Inputs to develop all items for the questions in the questionnaire were derived from a reliable data collection instrument developed from an extensive literature review. These procedures were utilised to generate significant insights for latent interpretation and labelling. In this paper, the above-mentioned interpretation and labelling procedures have been employed to generate three themes on the influencing factors for the ELC development in Malaysia, and other three themes for the strategies to improve the ELC performance in this region. The ELC (1) has been proposed in Malacca seaport due to its close proximity with Choke points 1, 2, and 3. This will be the most critical location with risk of maritime disasters. However, the ELC (2) has been proposed in the northern region of Peninsular Malaysia in order to provide comprehensive benefits to the users of the SOM.

#### 4. FINDINGS

A total of 40 people responded out of 70 potential participants, which brings the response rate to 57.14 per cent. Among the respondents, 67.5 per cent of them have working

experience of more than six years. In terms of academic qualifications, 50 per cent of the respondents are bachelor degree holders. About 15 per cent of the responses were received from seaport operators, 35 per cent from the Marine Department, and 50 per cent from the Ministry of Transport and the MME (see Table 1).

While reviewing the literature, very limited researches on the ELC were found. It is evident from very few variables identified as influencing factors of the ELC development at the SOM (9 variables) and improvement strategies of the ELC at the SOM (11 variables). Hence, to avoid over extraction and under extraction, all variables were used to answer both research questions. There is no standard rule to determine the optimum loading values in the EFA. However, Comrey and Lee (1992) offered a guideline for interpreting the loading values as follows: 0.71 = excellent, 0.63 = very good, 0.55 = good, 0.45 = fair, and 0.32 = poor. They indicated that variables with loading value of more than 0.5 assist the researcher in drawing a definite conclusion about the component. Hence, in this paper, factor loading of more than 0.55 has been implemented to gain significant outcome to meet the research objectives of the paper. The outcome of this analysis has been re-labelled to fit the newly developed variables in the research frame.

##### 4.1. Influencing Factors of ELC Development at SOM

Kaiser-Meyer-Olkin (KMO) measures sampling adequacy (MSA) and Bartlett's Test of Sphericity are part of the main method to test the appropriateness of factor analysis. The KMO value should always be above 0.50 before proceeding with factor analysis while the Bartlett's Test is significant when lower than 0.05 (Hair et al., 2010 and Bertsch, 2012). The sampling adequacy and appropriateness of the result in this paper are aligned with the requirements as proposed. The KMO result of the contributing factors to the development of the ELC at the west coast of Peninsular Malaysia is 0.581, which is barely acceptable for the sampling adequacy (see Table 2). The results of the EFA indicate that there are three major factors influencing the ELC development at the SOM including resources availability, risk, and geographical factor with a 66.5 per cent total variance.

The first component is resources availability, which has five variables, i.e. adequate port facilities and infrastructure (0.887), sufficient human resources (0.834), adequate transportation and distribution infrastructure (0.799), role of the port as a port of refuge (0.673), and strategic location (0.548). The Cronbach alpha value for this component is 0.791 (see Table 3). The Port of Linggi in Malacca has been proposed to be a regional centre for the ELC because this particular seaport is well equipped to execute a safe and efficient operation. Additional resources are strategically located at this seaport to ensure optimum operation readiness and fast response besides fulfilling commercial

**Table 1.**

Demographic characteristics of the respondents.

| Items  | Frequency | Per cent (%) |
|--|-----------|--------------|
| <b>Years of experience</b>                   |           |              |
| <b>Below 1 year</b>                          | 5         | 12.5         |
| <b>2-5 years</b>                             | 8         | 20.0         |
| <b>6-9 years</b>                             | 16        | 40.0         |
| <b>Above 10 years</b>                        | 11        | 27.5         |
| <b>Total</b>                                 | 40        | 100          |
| <b>Education background</b>                  |           |              |
| <b>Diploma</b>                               | 5         | 12.5         |
| <b>Certificate</b>                           | 5         | 12.5         |
| <b>Bachelor Degree</b>                       | 20        | 50.0         |
| <b>Others</b>                                | 10        | 25.0         |
| <b>Total</b>                                 | 40        | 100          |
| <b>Organisation of the respondent</b>        |           |              |
| <b>Malaysia Marine Department</b>            | 14        | 35           |
| <b>Malaysian Maritime Enforcement Agency</b> | 10        | 25           |
| <b>Seaport operator</b>                      | 6         | 15           |
| <b>Ministry of Transport</b>                 | 10        | 25           |
| <b>Total</b>                                 | 40        | 100          |

**Table 2.**

The KMO and Bartlett's Test.

|   |                    |             |
|---|--------------------|-------------|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy |                    | <b>.581</b> |
| Bartlett's Test of Sphericity                   | Approx. Chi-Square | 114.601     |
|   | Df                 | 36          |
|   | Sig.               | .000        |

needs. For example, this seaport possesses ship-to-ship transfer facilities (STS) and oil-spill response equipment. This equipment is crucial for salvaging human life, cargo as well as protecting the environment.

Resources availability refers to sufficient human resources to execute emergency logistics procedures effectively. Professional human resources play a vital role in disaster preparedness in implementing an organisation's emergency disaster plan. According to Thompson (2015), having well trained personnel is crucial to ensure that all the pieces are in place to mount an efficient and effective response.

Currently, search-and-rescue procedures would be handled by the MME. However, the procedure to execute ship-to-ship transfer requires special skills and experience. Cooperation between the MME and Kuala Linggi seaport will be an appropriate combination to provide humanitarian services via the ELC in this region. Besides the MME, Kuala Linggi seaport may collaborate with the relevant disaster management organisations including Malaysian Red Crescent Society (MRCS), National Disaster Relief Fund, Malaysian Meteorological Service, Special Malaysia Disaster Assistance and Rescue Team, and Malaysia Social Welfare Department in providing comprehensive humanitarian

services to victims. These disaster management organisations are designed to provide accurate information, supplies, relief funds, search and rescue services, space for evacuations, registration of disaster victims for purposes of rehabilitation, as well as post-trauma counselling (MDMRH, 2016). This indicates that the infusion of inland facilities and comprehensive cooperation from various dimensions are required to provide effective services to

the victims at the SOM instead of solely depending on seaports to provide all the facilities, services, and additional aid. Examples of additional aid include rehabilitation, counselling services, search and rescue services, space for evacuations, in-situ and ex-situ oil debris cleaning services, cargo salvaging, finding a connecting vessel to carry the remaining cargo and continuing the navigation to the seaport of destination.

**Table 3.**

Contributing factors to the development of the ELC at the SOM.

| <b>Components</b>   | <b>Resource availability<br/>*0.791</b> | <b>Risk management<br/>*0.598</b> | <b>Geographical factor<br/>**0.886</b> |
|---|---|-----------------------------------|--|
| Adequate port facilities and infrastructure   | <b>.887</b>                             | -.100                             | .019                                   |
| Sufficient human resources for the ELC operations   | <b>.834</b>                             | .238                              | -.197                                  |
| Adequate transportation and distribution infrastructure   | <b>.799</b>                             | .002                              | -.152                                  |
| The role of Kuala Linggi Port as a port of refuge   | <b>.673</b>                             | .071                              | .378                                   |
| The port strategically located at the SOM   | <b>.548</b>                             | -.397                             | .393                                   |
| Ship accident threat at the SOM   | .041                                    | <b>.813</b>                       | -.016                                  |
| The increasing volume of ship traffic at the SOM  | .217                                    | <b>.744</b>                       | .118                                   |
| Disaster caused by dangerous goods or noxious and hazardous substance spills from the ship at the SOM | -.141                                   | <b>.649</b>                       | .008                                   |
| Unpredictable weather and geographical conditions   | -.108                                   | .103                              | <b>.886</b>                            |

*Note: Extraction Method: Principal Component Analysis  
Rotation Method: Varimax with Kaiser Normalisation  
\*\*Estimated/\*Cronbach alpha value*

Without a proper transportation system, not all resources for emergency aid can reach the affected location. Adequate transportation and distribution infrastructure constitute the third component in resources and availability, which contributes to the development of the ELC. Places of refuge play a vital role in the provision of rapid and effective assistance to distressed ships (Yang, 2006). The ELC is very important as a hub to facilitate the emergency resources so that it may play a role in emergency relief aid such as collecting, transporting, storing, and assigning the materials needed (Wang and Zhu, 2015).

The second component that affects the ELC development is risk, which involves three variables, i.e. threat of a ship accident (0.831), numbers of ship traffic at the SOM (0.744), and disasters due to dangerous goods or noxious and hazardous substance spills (0.649). The Cronbach alpha value for this component is 0.598.

The growing volume of ship traffic and the narrow path have led to increasing navigational hazards causing risks of accidents and pollution in the sea lane. This can affect the performance of seaports and shipping along the SOM as well as the interests of domestic and international users. Shipping is one of the high-

risk activities that is highly exposed to maritime accidents or casualties which commonly happen in constricted waters such as the SOM (International Maritime Organisation, 2005).

There is another conservative trade going on at the SOM besides commercial trade activities. Barter trade is actively taking place especially between Malaysia and Indonesia (Jeevan et al., 2018a). This trade activity involves a barter trade system between two nations with the involvement of a small amount of financial transactions. From 2004 to 2010, barter trade recorded 84,000 vessels in the SOM, which contributed approximately 18–24 per cent of the total trade to Malaysia (Dollah and Mohammad, 2010). In addition to Port Klang, Penang Port, and the Port of Tanjung Pelepas (PTP), Malacca port is also involved in barter trade between Thailand, the Philippines, and Indonesia (Rusli, 2012). This indicates that barter trade activity has been developed, and the number of vessels for this activity is almost equivalent to commercial vessels. Hence, it can be said that the SOM is overexposed to commercial and traditional shipping activities; therefore, a significant ELC needs to be set up to ensure the navigational safety at this location.



The third component affecting the ELC development is the geographical factor, namely the unpredictable weather and geographical conditions at the SOM (0.886). In the meantime, the estimated Cronbach alpha value for this component is 0.886. Vessel traffic will be severely affected due to the collisions in Choke points 1 and 3. This condition will have a significant impact on the seaports located along the Straits, including Port Klang, PTP, and Penang. If this condition is prolonged, the shipping lines will prefer to detour their navigation route through Indonesia via the Sunda Strait or the North Pole. The availability of these alternative routes will affect the competitiveness of Malaysian seaports and affect the performance of the Malaysian trade system in the long

run. To avoid this situation from occurring, an immediate ELC development with sufficient resources availability, prolific risk management, and advantages in terms of geographical factor need to be utilised to execute the ELC at the SOM.

#### 4.2. Improvement Strategies of the ELC at the SOM

The KMO result of the improvement strategies for the development of the ELC at the west coast of Peninsular Malaysia is 0.602, which is acceptable for the sampling adequacy (see Table 4).

**Table 4.**

The KMO and Bartlett's Test.

|  |                    |         |
|--|--------------------|---------|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. |                    | .602    |
| Bartlett's Test of Sphericity                    | Approx. Chi-Square | 157.721 |
|  | Df                 | 55      |
|  | Sig.               | .000    |

Three components have been validated as significant improvement strategies to enhance the performance of the ELC at the SOM. These three components make up a total of 61.467 per cent of the variance. The first group is labelled as disaster preparedness, which involves technology improvement and implementation (0.908), comprehensive emergency logistics training programme (0.805), application of information system (0.653), disaster preparedness (0.585), and collaboration among parties involved (0.582). The reliability value of this component is 0.791 (see Table 5). In this paper, the proposed improvement strategies are substantial to enhance the performance of this ELC particularly in Malaysia. Further, the ELC operation can be utilised as a benchmark for neighbouring regions including Indonesia, Thailand, Brunei, Philippines, to preserve the trade efficiency in the SOM and South China Sea. In addition, this improvement strategy emphasises the infusion of inland components in the ELC operation to produce a comprehensive emergency logistics services to the victims in both waters.

Technology plays an important role nowadays and it is able to ease the management of disasters. The role of technology in disaster emergency operation is to connect, inform, and ultimately save the lives of victims (Holdeman, 2014). In this case, the integration of air, sea, and land transportation is required to provide comprehensive recovery procedure to the victims. Advancement in drone technology can be utilised to capture real time situations and deliver urgent supplies such as medicine and communication devices to the victims. Moreover, Geographic Information System (GIS) needs to be updated to the Visual Information System (VIS) to preserve, manage, and disseminate

visual information to the response unit.

Although the effectiveness of the emergency response and recovery operations are based on technological advancement, the involvement of human factor is needed to improve the performance of the ELC. Therefore, a wide range of emergency-logistics training programmes is required to train the respective work force in Kuala Linggi seaport. Besides mastering the task of shipping and seaport operation, a sense of responsibility as humanitarian providers needs to be established among the workers at this seaport. For example, training needs to be provided for the workers on the application of the Fixed-Line Disaster Alert System (FLDAS) to promote awareness and disseminate early warnings to the public (shipping lines at the SOM), Government Integrated Radio Network (GIRN) providing radio communications between responders during emergencies or disasters, and the Malaysia Emergency Response System (MERS) as an efficient disaster reporting hotline. Apart from technological application training, the personnel in this seaport also needs to be equipped with disaster management skills and should be well versed with the concept of aero-mobility emergency services on foreland and overland. To ensure the effectiveness of the ELC, training is required for the participants from the neighbouring regions including Thailand, Indonesia and Singapore, and other shipping lines to ensure the flow of the procedure is well disseminated, especially in Southeast Asia. Therefore, collaboration among parties is substantial to ensure the fluidity of the traffic at the SOM as well as the safety of its users.

The second component is the ELC management system, which involves unified command and network coordination (0.900), infrastructure support system (0.834), and procurement management (0.526). The Cronbach alpha value for this second component is 0.652. In a massive disaster, unified command is important to ensure response and recovery in an immediate and orderly manner. According to the MDMRH (2016), the role of a unified command system is unlike the regimented order, but has been improved to cater for the need for humanitarian aid. This unified command is responsible to define clear roles and responsibilities within the organisation, provide information, and unite humanitarian and development groups within the organisation by introducing a common language. Hence, the collaboration between the players (neighbouring regions and shipping lines) is crucial to ensure that the orders are well provided and received during an emergency.

In Malaysia, the infrastructure support system to cater for the requirements for the ELC is almost adequate. The road network connects all the states in this region; however, the development of rail network is still in progress. Initially, the rail

network only connects major cities in Peninsular Malaysia (not all cities). From an intra-region perspective, the rail connectivity is not comprehensive, as most of the small towns have no rail connection at all (Jeevan et al., 2018a). This indicates that the existing rail network will not be adequate to support the ELC in Kuala Linggi seaport. According to Sheu (2007), insufficient infrastructure will affect the transportability of the emergency logistics to the affected area and may raise uncertainties and difficulties during the execution of the emergency logistics operation. There are three major seaports located along the SOM: Penang Port, Port Klang, and PTP. In addition, there are four inland terminals: Padang Besar Cargo Terminal (PBCT), Ipoh Cargo Terminal (ICT), Nilai Inland Port (NIP), and Segamat Inland Port (SIP). These inland terminals are vertically located across Peninsular Malaysia from north to south (Jeevan et al., 2015; 2020). The incorporation of these facilities will provide an effective ELC to the victims both at sea and on land. The efficiency of ELC can be optimised after the connectivity between these nodes has been established. It is crucial to ensure fast response from the ELC to the disaster zone and vice versa.

**Table 5.**

Strategies to improve the ELC performance at the SOM.

| <b>Components</b>  | <b>Disaster preparedness<br/>*0.791</b> | <b>ELC Management system<br/>*0.652</b> | <b>Safety procedure<br/>*0.639</b> |
|--|---|---|------------------------------------|
| Technology improvement and implementation  | <b>.908</b>                             | .074                                    | -.109                              |
| Comprehensive emergency logistics training program   | <b>.805</b>                             | .128                                    | .008                               |
| Application of information system in the ELC.  | <b>.653</b>                             | .230                                    | .334                               |
| Disaster preparedness  | <b>.585</b>                             | .030                                    | .365                               |
| Collaboration among parties involved   | <b>.582</b>                             | .257                                    | .177                               |
| Unified command and network coordination   | .141                                    | <b>.900</b>                             | .005                               |
| Infrastructure support system  | .201                                    | <b>.834</b>                             | -.178                              |
| Procurement management   | .080                                    | <b>.526</b>                             | .357                               |
| Contingency plan   | .083                                    | .015                                    | <b>.801</b>                        |
| Emergency transportation channel   | .082                                    | -.049                                   | <b>.776</b>                        |
| Legal guarantee  | .313                                    | .456                                    | <b>.527</b>                        |
| Extraction Method: Principal Component Analysis<br>Rotation Method: Varimax with Kaiser Normalization<br>*Cronbach alpha value |   |   |                                    |

Procurement management is another dimension in the ELC that needs to be considered for performance enhancement. The aim of procurement management is to ensure that the supply of resources for emergency operation is provided in a timely manner, in the right amount, in good quality, and at reasonable prices (Sunyoto and Wismadi, 2008). In this regard, the transport facilities in this region need to be updated. Furthermore, the dry ports in this region need to be roped in for humanitarian purposes besides providing space, customs services, and transportation for freight. Currently, the United Nations Humanitarian Response Depot (UNHRD) is located in Subang, Malaysia. In this case, the integration of dry ports needs to be utilised by Kuala Linggi seaport in order to receive additional food, medical supplies, and other ancillary support throughout the region in an immediate and timely manner.

The third component is safety procedure, which involves contingency plan (0.801), development of emergency transportation channel (0.776), and legal guarantee (0.527). The Cronbach alpha value for this third component is 0.639. Contingency plan comprises several components such as infrastructures, goods, expert teams, and volunteers. Again, effective transportation system and unified command system become the main determinants of the performance of the ELC. Effective transportation system and a unified command system will ensure that the transformation of a contingency plan is well transferred from the point of origin to the point of destination. In order to execute a systematic contingency plan, collaboration between Kuala Linggi seaport, dry ports, Malaysian UNHRD, and transportation network needs to be synchronised. Other seaports aside from Kuala Linggi seaport need to be utilised by providing emergency transport channel to and from foreland. This situation could prevent an over-dependency on single nodes as the ELC at the SOM. Finally, the implementation of legal guarantees may assist towards recognising the rights and obligations of the victims, public and government, in order to maintain social stability in the affected zone.

## 5. DISCUSSION: A CASE STUDY ON THE COOPERATION OF THE ELC AND INLAND TERMINALS

With the ELC operating independently at Kuala Linggi seaport, other major seaports on the west coast such as Penang Port, Port Klang, and PTP can serve as back-up in case the initial ELC entity is unable to operate due to unavoidable reasons including issues on connectivity, limited options of multimodalism or incapability to handle modal shifting. This component is known as centre for disaster mitigation and preparedness. It involves human capacity, knowledge management, process management, resources, and community to mitigate and prepare for any disaster at the SOM.

The centre for disaster response and recovery will be based at the inland terminals. This centre will provide additional support system especially from inland to the seaports in order to respond and execute recovery procedure at the SOM through the ELC. The players at the centre will be all the Malaysian dry ports including the PBCT, ICT, NIP, and SIP. These dry ports are connected to the seaports via rail and road network. This will enable the response and recovery procedure to be carried out not only at sea, but also inland. This centre is connected to the UNHRD to provide sufficient information, supply, and other required goods to dry ports, ELC and, finally, to the affected zone at the SOM. The UNHRD is classified as a centre for disaster prevention because it delivers training to humanitarian personnel, provides a warehouse to store supplies, and collaborates with inter-regional humanitarian organisations.

The incorporation between the ELC and dry ports is important due to the specific roles of these inland terminals, which include an extended seaport, regional intermodal nodes as well as interface terminal between seaport and hinterland. As an extended seaport, dry port manages to perform various services including storage function and simplifies seaport activities in the humanitarian supply chain. Meanwhile, as regional intermodal nodes, these dry ports may perform as regional centric entities to transform supplies, information, and other required facilities faster from seaport to inland and vice versa. This situation reduces the over-reliance on the ELC and improves the participation of regional area to assist the victim at Malacca straits via the ELC. Furthermore, as an interface terminal, this inland terminal is a link between rail and road transportation. The assimilation of unimodal and multimodal transportation via synchronodal transportation is also available between the NIP and other dry ports and seaport (See Figure 2). Moreover, the ELC 2 has been proposed as a plan to enhance humanitarian efficiency along the SOM (see Figure 2)

Although dry ports are designed to ease freight transportation and improve the competitiveness of seaports, it can be utilised to transform the operation procedure towards humanitarian logistics by serving the ELC. According to Jeevan et al. (2018b), the involvement of dry ports in seaports affects seaport performance, increases service variations for seaports, improves seaport-hinterland proximity, increases seaport trade volume, and enhances seaport capacity. Owing to these operational strengths, the incorporation of dry ports in the ELC is important to ensure the fluidity and protection of cargo vessels, crews, assets, and environment at this congested strait. Integration of all the components in maritime logistics is essential to improve the performance of the ELC at the SOM. Furthermore, the incorporation of the ELC with inland components ensures that immediate action will be taken towards maritime disaster victims, including cargo and crew members.

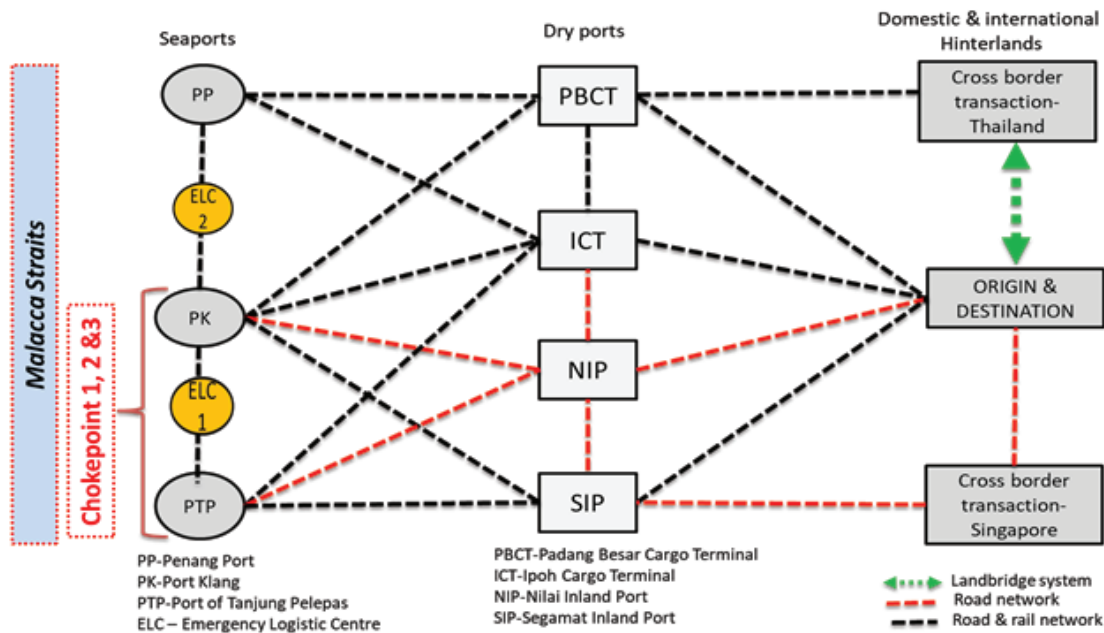


Figure 2. Incorporation of logistics nodes in the ELC operations. Source: Authors.

## 6. CONCLUSION AND FUTURE RESEARCH

Concisely, the outcome of this research shows that there are three main factors contributing to the development of the ELC at the SOM. The first factor is resources availability, which comprise adequate port facilities and infrastructure, sufficient human resources for the ELC operations, adequate transportation and distribution infrastructure, and the role of Kuala Linggi Port as a port of refuge strategically located at the SOM. The second factor that contributes to the ELC development at the SOM is risk management, which includes threat of ship accidents, increasing volume of ship traffic, and disaster caused by dangerous goods or noxious and hazardous substance spills from ships. Thirdly, the geographical factor (i.e. unpredictable weather and geographical conditions at the SOM) motivates the emergence of the ELC in this region. In this case, policy makers, shipping lines, and seaport authorities need to execute the development of the ELC at the SOM to ensure that the performance of seaports and shipping lines at this waterway are not affected for any reasons. Moreover, the development of the ELC is urgently required to ensure that the relationship between Malaysia and other neighbouring regions in Southeast Asia are not affected due to a disaster occurring in the SOM.

This research finds that all the components of the ELC including seaports, dry ports, and hinterland need to improve their disaster preparedness. This can be done through technology

enhancement and implementation, comprehensive emergency logistics training program, application of information system in the ELC, disaster preparedness, and collaboration among parties involved. In addition, the performance of the ELC can be improved by placing emphasis on the ELC management system, especially on unified command and network, coordination, infrastructure support system, and procurement management. Finally, the third strategy to enhance the performance of the ELC in this region are safety procedures focusing on contingency plan, emergency transportation channel, and legal guarantee. The performance of the ELC needs to be periodically upgraded due to rapid changes in maritime business and technology. Furthermore, the application of artificial intelligence is urgently required to handle potentially dangerous rescue situations at the Straits. In such a scenario, the application of e-navigation via unmanned vessels, especially for the purpose of search and rescue, will be highly encouraged for safety reasons.

As a maritime nation located adjacent to the world's busiest straits, the development of the ELC in Malaysia is vital to protect the trade system in this region as well as the efficiency of the global trade. Carriage of one third of the world's traded cargo through this waterway requires a smooth flow with sufficient and effective support system. Therefore, awareness of the importance of the ELC needs to be instilled among shipping lines, seaport operators, neighbouring regions, Sungai Linggi seaport ELC, and logistics nodes from inland. This will help them to understand the

role, objectives, and operating procedure of the ELC. In addition, the main limitation of this research is the respondent involved, not fully aware on the role of foreland, seaports, hinterland in the ELC operations. Therefore, an awareness needs to be developed among all the players in seaport system to indicate they have equal responsibility to be executed in the ELC operations. Besides establishing an ELC in Malaysia, ELC branches also need to be developed in all the neighbouring regions in order to bring comprehensive and collective benefits to the entire region, and this area is worthy of being explored in future.

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