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Original article

An Evolution of a Nexus between Malaysian Seaport Centric Logistic and Industrial Revolution 4.0: Current Status and Future Strategies ☆

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Abstract

In late 1950's, the beginning of container revolution has started a new paradigm shift in maritime industry worldwide. This new paradigm has become a major reason for seaport systems to prepare their physical capacity, space availability, multi-modalism, transport connectivity via regionalisation. However, in early 2010's the introduction of industrial revolution 4.0 (IR4.0) which starts the era of immersive digitalization proved that seaport systems need to be prepared to face pattern of unstable magnitudes in dynamic maritime trade. Therefore, this paper analyses key components required for Malaysian seaport system to be aligned with the key requirements in IR4.0. By employing document analysis, this research analyses the challenges faced by Malaysian seaport system as well as suggests strategies to muddle through the key requirements of IR4.0. The findings from this research indicate that Malaysian seaport system need to be improved by enforcing skill-based education system, flexibility in labour structure, development in skill and competence level as well as improvement in infrastructure suitability. The findings from this research also reflect significant strategies to improve seaport system in the era of IR4.0 including enhancing requirements for intermodal terminals, improving preparation for seaport alliances, developing mechanism for interoperability, improving utilisation of intra and interregional economic development as well as scrutinising safety and security.

Keywords: Malaysia, Seaport Centric Logistic, Industrial Revolution 4.0, Freight, Trade

1. Introduction

Trade policy liberalisation and technological advancement have contributed to a robust development in international trade (Bernhofen et al., 2016). Since the 1960s, containerisation has improved the performance of international trade at a rapid pace. For example, global containerised trade has increased from 50 million TEUs in 1996 to 185 million twenty equivalent unit (TEUs) in 2016 (UNCTAD, 2017). The growth of containers has been witnessed since the era of containerisation take place and eventually has become a starting point for the revolution of containerisation. Dynamism in maritime logistics has been significant principle in this sector. This has been evident in the several momentous changes especially on vessels enlargement, seaports alliances via cooperation, emergence of intermodalism in the seaport system, implementation of unmanned system for cargo handling in foreland and inland and demand for multimodal transportation via seaport regionalisation.

In year 2011's, the concept of IR4.0 has emerged and this concept infuses machines interconnected via a network or internet which operates in a new term called Cyber Physical System or known as CPS. Further the data from CPS will be analysed and utilised for significant decision making by human or machines (MIGHT, 2016). According to Ministry of International Trade (MITI, 2016), IR4.0 is a global force of development that will have substantial impact on economies, industries, business and society. In addition to that, industries which embrace the concept of IR4.0 may garner the benefits such as productivity improvement, optimization, providing higher quality product at lower cost via flexible, automated and integrated system which corresponding with Information Technology (IT). The preparation of Malaysian seaport system towards this revolution need to be explored to strategies the national agenda towards the prosperity of Malaysian trade. Therefore, the objective of this paper is to disclose the status of Malaysian seaport system, analyses the prerequisite that need to possess by Malaysian seaport systems to cope with IR4.0 as well as reveal strategies to improve Malaysian seaport system in the dimension of IR4.0. The remainder of this paper is organised as follows. Section 2 provides a brief introduction to the seaport centric logistic. Then, Section 3 briefly presents the methodological approach employed in this paper. Section 4 discusses seaport centric logistics from the perspective of Malaysian seaport system, Section 5 reveals challenges and strategies in Malaysian seaport system from the context of IR4.0 and finally a conclusion is provided in Section 6.

2. Seaport Centric Logistic

The provision of distribution and other value-adding logistics services at a seaport is the key definition for seaport centric (Mangan et al 2008, p. 36). This definition elucidates that the integration of inland terminal, freight transport network, freight corridors are important components in the seaport centric logistics. In addition to that, Paixao and Marlow (2003) claim that seaport centric logistic promises cargo continuity by extending seaport territory towards inland and improving leagility in the daily operation. Further, Cullinane and Wilmsmeier (2011) argue that seaport centric logistic allows location splitting which prolong seaport life cycle by enhancing seaport capacity, space and accessibility to be engaged with a broader trade market.

Seaports play an essential role in maritime logistic and in the increase of the development of inland terminals and infrastructure for inland connections (Lee and Cullinane 2016). Emphasising the role of seaports as the logistic hub of supply chains reflects the concept of seaport centric logistic (Mangan et al., 2008). Prior to containerisation, a seaport system is about the competition between different ports and terminal operators as well as interaction between hinterlands and forelands (Ng and Tongzon, 2010). The technological advancement in multimodal transportation and transportation infrastructure change the borders of the connectivity between seaports and its hinterland network through inland facilities (Notteboom and Rodrigue, 2005). The function of container seaports as intermodal nodes enables containers to be shipped across the globe to fulfil market demand (Song, 2003).

Confronted with these changes, container seaports adjust their infrastructure for hinterland connection, create efficient cargo information systems and value add services as these are essential inputs required for becoming familiar with the changes in the container seaport system (Notteboom and Rodrigue, 2005). In this context, a container seaport system is thus extended to seaport hinterlands through the development of inland

transportation facilities connecting the relevant stakeholders in the seaport community (Li et al., 2012). Container seaports, inland freight facilities, multimodal transportation and freight corridors are the main components in the container seaport system (Jugovic et al., 2011). It also involves many players such as seaport authorities, freight forwarders, container shipping lines, seaport and inland terminal operators. Container shipping lines offer shippers door-to-door services by coordinating with feeder operators, road carriers, rail operators, logistic service providers and terminal operators (Lun, 2009).

Figure 1 shows the components and players consisting in a container seaport system. These are the key determinates for seaport regionalisation which emphasise the integration of seaports and their hinterland (Jeevan, 2017). In container seaport systems, logistic systems facilitate the flow of goods by seeking linkages that will enable the product to flow faster at the lowest cost (Christopher, 2005). For freight facilitation, the support from a freight corridor and intermodal terminals is required for effective freight distribution (Rodrigue, 2004).

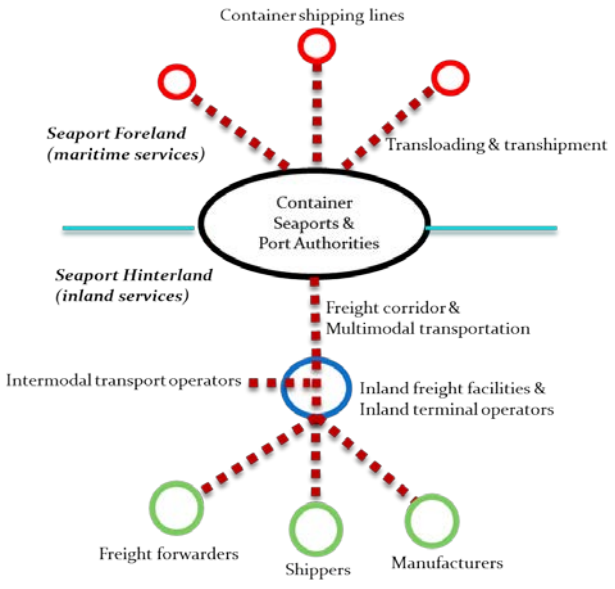

Figure 1: Components and players in a container seaport system

Source: Adapted from Jeevan (2016)

The internationalisation of container trade required modern container terminal operators with resourceful facilities and possessing experience in managing container terminals (Lun and Cariou, 2009). Therefore, container seaport systems change their static supply chain into a flexible business network to increase their competitiveness in the global transport system (Vervest and Li, 2009). The latest vessel of the Maersk Line, Triple E, has the capacity to accommodate almost 18,000 TEUs and progress in seaports and hinterland operations must become compatible. Conversely, support from intermodal transport operators can assist seaports in fully realising the economies of scale (Taneja et al., 2013). Competition prompts seaports to change their strategies to compete between transport chains (Horst and de Langen, 2008).

Intra-regional seaport competition leads seaports to pursue business opportunities in hinterlands and thus deep hinterland connections become vital in this competitive environment (Rodrigue et al., 2010). Increase in seaport competition has placed seaports at a risk when shipping companies move to other seaports. Hence, Roso and Lumsden (2010) argue that seaports have to become competitive in their hinterland operations by extending their gates through dry ports where flows are effectively manageable. Of notice is the modal shift or transportation interface in inland terminals which contribute to a cooperative freight distribution network. This phenomenon has a significant effect on the environment, social, economic benefits, reduction of congestion and improve the competitiveness in seaports without physical expansion to the site (Wisetjindawat et al., 2007). These paradigms prove that the seaport has been established a collaborative network within, among seaports and between the players in the system. Therefore, substantial interoperability has been a prerequisite to seaports to establish and sustain in this system.

3. Methodological Approach

A thorough multiple case study will be employed as the research approach and content analysis will be executed among major seaports in Malaysia including Penang Port, Port Klang and Port of Tanjung Pelepas. Owing the capability to explore new phenomenon and reveal comprehensive descriptions on certain case and its analysis (Starman, 2013), a multiple case study approach has been employed in this paper.

Besides, face to face interviews were executed, in which the four respondents are seaport experts from the Johor port authority, port of Tanjung Pelepas and port Klang Authority. Towards the application of IR4.0 in Malaysian seaports, the interviewees indicated their

ideas about the challenges that the seaports are facing and suggested appropriate strategies to improve the situation.

In addition, document analysis has been used to review the status, challenges and strategies which have been identified by Malaysian Ministry of Transportation. Therefore, several documents including Logistics and Trade Facilitation Masterplan (2016), Malaysian Shipping Masterplan (2017) and Global Competitiveness Index (2016) have been utilised to reveal the content to answer the main research question in this paper. Document analysis requires that data be examined and interpreted to elicit the theme, gain sufficient understanding and develop pragmatic knowledge (Corbin and Strauss, 2008).

4. Seaport Centric Logistics: Status of Malaysian Seaport System

Malaysia's total coastline is 4,675 kilometres in length and three quarters of Malaysia's total land is exposed to seas which thereby emphasises the importance of maritime trade to the country. This has been further evidenced by the growth of shipping and seaport activities over the past few decades which continue to provide economic development for Malaysia (Nazery, 2013). Malaysia's geographical location is advantageous and has contributed to the development of container seaports in Malaysia. This specific advantage also determines the high dependency of its national trade and economy on maritime business. For example, container freight equated to 329.9 million tonnes compared to 179.0 million tonnes for non-containerised cargo in all main container seaports in 2013 (MOT, 2014).

4.1. Freight corridors in Malaysian seaport centric logistic

According to Rodrigue (2004), a freight corridor is a transport infrastructure servicing global and regional flows. Freight corridors provide physical capacity including multimodal transportation, gateways and intermodal terminals for effective freight distribution. In Malaysia, freight corridors are classified as intra-regional within the nation and inter-regional, i.e. between nations, including Thailand, Singapore and other countries in Southeast Asia (Ninth Malaysia Plan, 2006).

There are four major freight corridors in peninsular Malaysia, namely northern, central, southern and east coast freight corridors (see Figure 2). Each freight corridor incorporates several economic development plans initiated by the Malaysian government. Each development plan is designed for a specific region, i.e. north, central, south and the east coast of peninsular Malaysia. The central freight corridor, for example, is the outcome of the New Development Policy established in the early 1990s (EYGM, 2014).

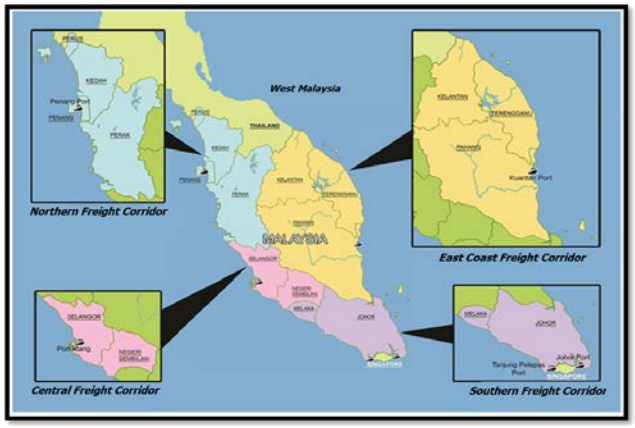

Figure 2: Location of freight corridors in peninsular Malaysia

Source: Adapted from Nasir (2014)

4.2. Inter-regional Freight Corridors

The strategic location of Malaysia grants an opportunity for involving neighbouring countries in freight corridors in order to amplify its economic progress. There are three (3) inter-regional freight corridors involving Malaysia, Thailand, Singapore, Indonesia and Brunei. These include the Indonesia-Malaysia-Thailand Growth Triangle (IMT-GT), Indonesia-Malaysia-Singapore Growth Triangle (IMS-GT) and Brunei-Indonesia-Malaysia-Philippines-East Asian Growth Area (BIMP-EAGA) (Figure 3).

First of all, IMT-GT is a sub-regional economic development plan established in 1993. The vision of this cooperation is to accelerate economic transformation between Malaysia, Indonesia and Thailand (IMT-GT, 2012). In Malaysia, this IMT-GT has potential to improve cross border infrastructure and increases the quality of transport service connections between Malaysia, Thailand and Indonesia.

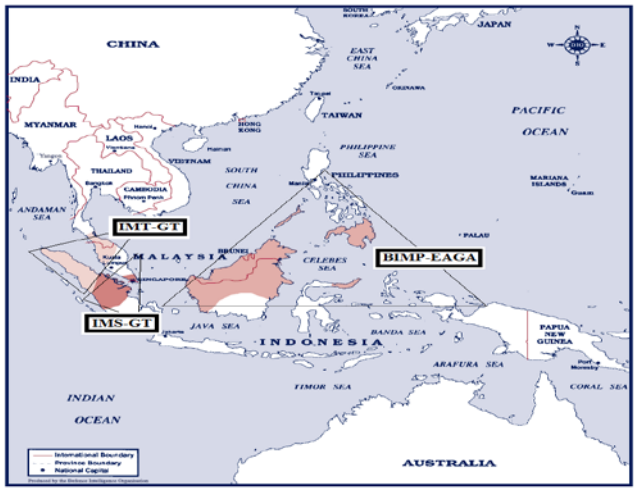

Figure 3: Partners in the South East Asia Growth Triangles
Source: Adapted from Humphries (2004)

Besides, IMS-GT was initiated by Singapore in 1990 to enhance cooperation between Indonesia, Malaysia and Singapore. The cooperation has generated more investment in southern Malaysia whereby many investors invest in industrial estates, which substantially improving facilities and encouraging the emergence of new industries to rural areas. Finally, BIMP-EAGA is the current collaboration between Brunei, Indonesia, Malaysia and the Philippines which was initiated by the Philippines in 1992 (Annuar, 1994). The main focus of this collaboration is on transport and shipping services, tourism and fisheries cooperation (Annuar, 1994).

4.3. Container Seaports

In Malaysia, seaports are the main gateways for maritime trade and play a key role in the nation's economic growth (Soon and Lam, 2013). Firstly, Port Klang was privatised into a container terminal in 1986 and the establishment of two seaport operators starts from here (PKA, 2014). In world rankings, Port Klang was ranked 13th out of 30 container seaports in the world in 2014 (Alphaliner, 2015). Port Klang, also known as the National Load Centre, plays a crucial role as a main container hub for the regional and economic development of the country. The location of this seaport on the crucial trade lane of Malacca Strait makes Port Klang attractive to many ships on the eastbound leg and the last port of call on the westbound leg of the Far East–Europe trade route (PKA 2014).

Secondly, Port of Tanjung Pelepas (PTP) is an operator for Johor Port Authority. PTP is known as an ideal seaport for regional and global transhipment activities (JPA, 2014). In world rankings, PTP recorded 7.63 million TEUs and ranked 19 out of 30 container seaports around the world in 2014 (Alphaliner, 2015). Accessibility to Singapore and connection to the national rail grid in the future places PTP in an ideal position for cross border transactions through an intermodal network by 2015 (MITI, 2013).

Thirdly, the landlord for Penang Port and Teluk Ewa Jetty is Penang Port Commission which was established in 1956 (PPC, 2014). Penang Port is an international seaport located strategically at the northern entrance of the Strait of Malacca. Penang Port handles various cargo, namely containers, bulk cargo and general cargo (PPC, 2014). Penang Port has become an important hub by benefiting from the development plan of NCER and Indonesia-Malaysia-Thailand Growth Triangle economic corridors (IMT-GT), which encourage container traffic from the northern region of peninsular Malaysia and Southern Thailand (Chen et al., 2015).

4.4. Dry ports

The growth of dry ports in Malaysia began in 1984 and there are four dry ports currently operated in peninsular Malaysia: Padang Besar Cargo Terminal (PBCT), Ipoh Cargo Terminal (ICT), Nilai Inland Port (NIP) and Segamat Inland Port (SIP) (Jeevan et al., 2015). Firstly, PBCT encourages cross border transactions between Malaysia and Thailand. This dry port contributes 40% of the containers to Penang Port and 10% to Port Klang (Jeevan et al., 2015). Port Klang and Penang Port are the main shareholders for this dry port, with almost 90% of shares being from Penang Port and 10% from Port Klang. PBCT serves domestic and international manufacturers that operate close to the Malaysia-Thailand border.

Secondly, ICT established in 1989 and is well connected to Penang Port, Port Klang and PTP (ICT, 2015). ICT is the only dry port in Malaysia which is connected to all three major container seaports in Malaysia. This dry port is located in the northern region of peninsular Malaysia and generates 35% of containers to Port Klang, 10% to Penang Port and 5% to PTP (Jeevan et al., 2015). NIP is the third dry port in Malaysia. This dry port started operations in 1995 and is located in the central region of peninsular Malaysia (UNESCAP, 2006). NIP contributes 60% of containers to Port Klang and 10% to PTP (Jeevan et al., 2015). This volume of containers to seaports makes NIP the highest generator of containers to seaports among all Malaysian dry ports.

Finally, SIP is the newest and the largest dry port in Malaysia, located in the southern region of peninsular Malaysia. It started operations in 1998. SIP provides facilities and services to manufacturers and traders in southern Malaysia and Singapore (SIP, 2015). Although SIP is the largest dry port in Malaysia, it only produces 10% of containers to Port Klang and the same percentage to PTP (Jeevan et al., 2015).

4.5. Multimodal transportation in Malaysian seaport system

Basically, multimodal transportation is 'means the carriage of goods by at least two different modes of transport' whereby intermodal refers to the connection between modes of transportation (Kanafani and Wang, 2010, p. 4). In Malaysia, multimodal transportation exists through road and rail and these types of transportation are the dominant modes used in the trade system, influencing the growth of seaports by integrating the land use and road network systems (Anor et al., 2012).

4.5.1. Road networks

The major mode of transportation in Malaysia is by road. The road system covers about 210,658 kilometres and almost 79% of the road is paved with flexible or rigid pavement (PWD, 2014). About 1,969 kilometres of the total length of the road system is highway, managed by the Malaysian Highway Authority. State road systems cover about 61,420 kilometres in length and connect villages or rural areas within the state (PWD 2014). Almost 80% of the Malaysian road system usage is for freight logistic purposes and 20% for passenger transportation (Masriq, 2012). In 2012, almost 1.03 million vehicles were used for freight distribution whereby 166,576 vehicles were used for general purposes (MOT, 2013). These statistics show that the Malaysian road system plays a vital role in the freight task.

4.5.2. Rail networks

Containerisation in Malaysia started in 1972 and, a year later, container transportation by rail began (Valautham, 2007). In 1973, the total amount of containers transported by rail was 974 TEUs, however the volume started to increase significantly, for example from 105,300 TEUs in 1991 to 343,395 TEUs in 2013 (MOT, 2014). Of notice is that the volume of containers transported by rail dropped dramatically in 2001 and 2008 due to the global economic recession. However, the trend of containers being transported by rail has gradually increased from 266,722 TEUs in 2009 to 343,395 TEUs in 2013 (MOT, 2014).

The total length of Malaysia's railway track is 1,641 kilometres, of which 80% is single track and 20% double track, connecting from the border of Thailand in the north to Singapore in south peninsular Malaysia with a maximum speed of 70 kilometres per hour (Naidu, 2008). Moreover, the capacity of the train service is only able to carry 60 TEUs per trip which is lower than the world average of 66 TEUs per trip (Woodburn, 2011).

Although the existing Malaysian rail network connects container seaports and hinterlands, it is not fully utilised. This is evidenced by containers having only a low share of rail freight, about 2%. The extreme imbalance of modal split in land freight transport creates challenges for seaports–dry ports–hinterland freight transportation. Malaysia has rail links connecting to other nations including Thailand, Singapore and other countries in Southeast Asia. This inter-regional rail network consists of the Malaysia-Thailand Landbridge (MTL) and Singapore-Kunming Rail Link (SKRL). MTL is already operating and SKRL link is still at the development stage.

5. Industrial Revolution 4.0: Challenges and Strategies in Malaysian Seaport System

According to MIGHT (2016), main determinants that affecting industrial revolution are including labour structure flexibility, skill and competence level, adaptive skills and infrastructure suitability. Therefore, every nation needs to embrace those prerequisites to move along with the momentum in the industrial revolution. In term of flexibility on labour structure, Switzerland leads the table, followed by Singapore, Malaysia and Korea respectively. In the meantime, from the perspective of high skill level, Singapore and Switzerland leading the other two nations while, Rep. Korea and Malaysia are left behind and need significant improvement in order to cope with this new industrial agenda. Further, Singapore and Switzerland have indicated their readiness by restructuring the education and infrastructure suitability. However, the other nations need further development especially in these components in order to cope with IR4.0.

In general, there are several significant challenges faced by Malaysia maritime sector to cope with this revolution (see Figure 4). Firstly, the investors are still skeptical on the impact that will occur from this IR4.0. Therefore, they still reluctant to invest without knowing the benefits that will be gained in future. Secondly, in order to involve in IR4.0, all components in seaport centric logistic including seaports, dry ports, multimodal transportation and freight corridors need to be improved and thus, a massive amount of investment is required.

Thirdly, insufficient qualifications and skills among employees is the major limitation faced by the maritime sector. In addition to that, the outputs from higher education system need to be revised to cater the requirement for the IR4.0 workforce necessities.

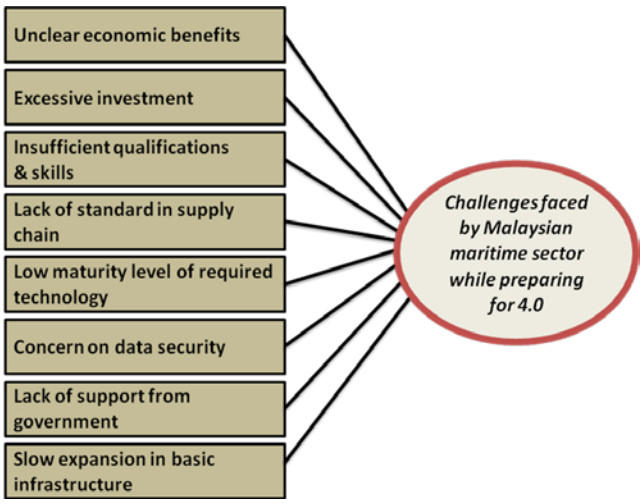

Figure 4: Challenges faced by Malaysian maritime sector during the preparation of IR4.0
Source: MIGHT (2016) & Survey outcome (2017)

Fourthly, lack of standardisation, certification and forms in the horizontal and vertical integration in the supply chain caused congestion, delays and extensive charges as well as schedule disintegration in Malaysian seaport system (Jeevan et al., 2015). Hence, these integrations need to be streamlined to ensure the infusion of IR4.0 in the seaport system will be benefited various key players comprehensively. Besides that, low maturity level of required technology, issue on data security, limited support from key stakeholders and slow expansion in basic infrastructure are some of issue arose in the seaport system.

Regarding the challenges faced by Malaysian seaport system to involve in the IR4.0, an interview was also carried out . The participants are from Malaysian port authorities and the following outcomes are attained. FIP 1 (Face to face interview participant 1) responded to the question of what challenges the ports face during the process of adapting the I.R 4.0 in the daily operation that the system is unable to cope with latest and rapid technology advancement in the maritime industry; and seaports need ample of time and resources to move towards smart ports. FIP 2 replied that there is less coordination between these ports and other players in the network, so they are unable to move towards smart ports. Besides, infrastructure in the seaports is limited despite massive amount of investment. He also stated that the policies and governments are still using the manual system in port operation and it needs to be changed to support the smart port operation process.

FIP 3 believed that the seaports are in comfort zone and refuse to face this new change. FIP 4 thought that in the pace of IR4.0, traditional jobs will not be relevant anymore. For instance, the need for tallyman can be replaced by robots. Therefore, people need to be trained based on the own skills and technology skills such as the usage of hand-held terminals etc. What is more, slow internet connection is also a barrier for Malaysian seaports to embrace IR4.0. Conflict between "job creation" and "using technology" to perform the job is another obstacle that needs to be considered. This is true especially in Malaysia where we still have obligations to create jobs.

In general, to overcome those challenges, four main principles need to be considered as indicated in Figure 5. Those principles are including dry ports, seaports, multimodal system and freight corridors. These components need to be improved in order to prepare Malaysian seaport systems towards IR4.0 and become competitive in the global market.

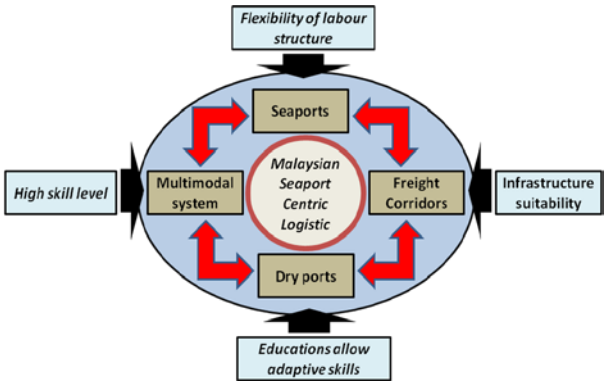

Figure 5: Integration between key components in Malaysian seaport centric
Source: Authors

5.1. Requirements for intermodal terminals

Firstly, there are three major themes identified as key necessities for Malaysian dry port operations, namely, operational infrastructure, personnel requirements and capital infrastructure (Jeevan et al., 2015). Lacks of these requisites have negative impacts on container supply chains. This is evident by insufficient operational infrastructure especially in PBCT. This dry port is suffering from insufficient machinery, such as tractor-trailers, rubber-tired gantries and rail-mounted gantries, for container lifting and manoeuvring. This situation has led to slow productivity, delays and inefficient container arrangements on the railway deck heading to Penang Port from southern Thailand. In turn, customer satisfaction has been affected. Therefore, via the introduction of infrastructure development and enhancement in skilled labours, this specific issue can be overcome.

The main challenges faced by Malaysian dry ports are planning and managing containers due to unorganised containers on rail deck to seaports and limited space for managing empty containers. The containers on the railway deck from dry ports to seaports are not always organised according to vessel's schedules. As a result, seaport personnel were forced to spend more time identifying the containers and pairing them with the right vessels, which may affect the schedule integrity of shipping lines. The disarrangement of containers on the rail decks happened because of the rush at the dry ports, coupled with unavailability of precise information sharing along the container seaport system. Efficient information sharing for planning container distribution among dry port stakeholders, in particular between dry ports and seaports, through an information communication system is suggested. Hence, the emphasising of information sharing in the supply chain is expected to improve the competitiveness in the seaport sector, increasing the efficiency by cost reduction and effective connectivity via main key players in the freight chain.

5.2. Preparation for seaport alliances

Introduction of seaport alliances between Malaysia and China expedite fast track trade system by reducing customs bottlenecks at both countries. The collaboration between seven seaports in Malaysia including Port Klang, Malacca, Penang, Tanjung Pelepas, Johor, Kuantan and Bintulu seaports and eleven seaports in China including Dalian, Shanghai, Ningbo, Qinzhou, Guangzhou, Fuzhou, Xiamen, Shenzhen, Hainan, Taicang and Qindao aims to enhance the development in shipping and seaport logistics as well as preparing Malaysia to cope with One Belt One Route strategy. This mega-cross regional project also instigates investment and trade cooperation which improves the investment in trade facilitation, exchanging customs cooperation, integrating the application of e-commerce between nations and developing modern service in cross-border transactions (Hong, 2015). In addition, substantial benefits such as financial integration between nations and expanding human to human connections also expected as main outcome from this mega cross regional network.

5.3. Mechanism for interoperability

Information sharing between players in the container seaport system assists in operational integration of container distribution between different players in the container seaport system. Monios and Wilmsmeier (2014) argued that it is the commercial nature of the maritime industry that leads to one stakeholder's information not always being available to another stakeholder due to the complexity along the chain and low quality of links. This argument applies to Malaysian seaport systems as currently information on container distribution is not always accurate or received in a timely manner by seaports. The information disintegration among key players in the seaport system resulted in on average one to two hours to relocate and rearrange the containers according to the vessel's schedule at seaports. This situation will lead to increased empty space in the container vessel and damage the reputation of the seaports among its clients. Information sharing between dry ports and seaports for container freight movements can enhance seaport performance by reducing the waiting time of vessels in seaports, subsequently reducing the vessel turnaround time and avoiding shipping lines from demurrage charges.

There is a need to utilise information communication technology to coordinate information within the Malaysian seaport system. Currently, not all players in the Malaysian container seaport system are connected within a single information platform. Port Klang Authority (PKA) has developed its own electronic

supply chain system called Port Klang Net (PKN). However, this network only connects PKA with other operators within the port, i.e. West Port and North Port (Eleventh Malaysian Plan, 2016). This system is not connected to other key stakeholders along the supply chain and cannot achieve an efficient information coordination process in the transport chain. Therefore, the players in the container transportation chain need to be connected with a single information exchange network to improve the efficacy of information flow and sharing.

Some countries in the world have introduced the Port Community System (PCS) or similar to coordinate information along the seaport system. For example, Spain introduced the Port Community System (PCS) to manage information exchange and integration among the different players including dry ports in container seaport systems, and it is an effective solution for container planning and management (Dotoli et al., 2010). The government in Malaysia should consider cooperating with seaports, dry ports and other stakeholders in the system to invest in such an information integration platform. Hence, the harmonization of information using single window with the seaports, dry ports and other stakeholders in the seaport ecosystem is crucial for efficient interoperability of the Malaysian seaport sector and the investment in this platform should be taken seriously.

5.4. Utilisation of intra and interregional economic development

The intra-regional economic development plans North Corridor Economic Region (NCER) and Iskandar Malaysia (IM), focusing on northern and southern Malaysian regions, prioritise logistics and infrastructure development in these regions (Ngah, 2010). Additionally, inter-regional economic development plans Indonesia-Malaysia-Thailand Growth Triangle (IMT-GT) and Indonesia-Malaysia- Singapore Growth Triangle (IMS-GT) aim to strengthen infrastructure linkages, enhance public-private sector collaboration and generate investment in transport infrastructure especially on road, seaports and other freight transportation facilities (IMT-GT, 2012). These economic development plans provide opportunities for the private sector, in particular foreign investors, to invest in Malaysia's transport infrastructure including dry ports. Therefore, dry ports PBCT and NIP, which are within the freight corridors, should take this good opportunity to attract investment that would enhance their capacity to handle not only laden containers but also empty containers. The experience in Vietnam provides a good illustration of this strategy. The Government of Vietnam channelled high investment in infrastructure and transport corridor development to Vietnamese dry ports. As a result, 13 dry ports in Vietnam have sufficient capacity to handle 6 million TEUs by 2020 and 14 million TEUs by 2030 to support 150 seaports in the region (Nguyen 2014).

5.5. Safety and security

Cargo smuggling is one of the main concerns at the Malaysia-Thailand border. Therefore, the border dry port should perform strict immigration and quarantine examinations. Currently, the concerns from the clients were about the human resources to manage safety and security procedures in the dry ports. However, safety equipment or devices for security screening, especially at the borders have been neglected.

The application of RFID at the borders may improve the confidence of international shippers to meet the expectation of domestic customers in Malaysia. According to Masek et al. (2016), the application of RFID at the borders may reduce some redundancy during cross border transactions and simultaneously increase the reliability of services by reducing the transit time, providing a high frequency and providing convenience for the customers to track the condition and location of the cargo. The application of this device needs to be implemented in all dry ports to ensure the reliability and the safety of the cargo.

The impact from RFID will result in simplification of technological activities during border-crossing transactions. According to Fabian (2013) the nature of this technology, which is flexible, brings cost savings and benefits for carriers and their customers. Therefore, considering the implementation of RFID technology as a centralised centre of information sharing between international and domestic players in the container seaport system would be a practical idea.

5.6. Application of IR4.0 in seaports

According to the interview outcomes, the following strategies were suggested regarding the Malaysian

seaport system in embracing with IR4.0. Firstly, ports need to establish a network system that involves stakeholders and technology towards smart ports development which involving the utilisation of space, local resources as well as time and finance. It needs to be incorporated to enhance seaport competitiveness.

Secondly, technology and infrastructure as well as the supply chain need to move ahead in order to facilitate operations in seaports. Technology application should be utilized to reduce manpower in seaport industry. However, reducing manpower in maritime industry has become a major argument among the experts. Hence, the application of technological advancement needs to be implemented stage by stage and not abruptly.

Not all regions in this world are ready to adapt the changes as indicated in IR4.0 in the seaport sectors, in fact, many of the seaport in this world are still dwelling at second and third generation whereby the seaport operation are heavily influenced by conventional operation (Beresford et al 2004). Therefore, human factor in this arena needs to explore, understand and learn the implication of IR4.0 as well as the financial situation in those nations needs to be sufficient. Hence, the application or IR4.0 can be utilised in the humanitarian logistics or search and rescue procedures especially in foreland activities which require high level of safety procedure.

Thirdly, the ports should be equipped with efficient equipment to smoothen port operations and cooperation between authorities (Port Authorities, Marine Department, Customs, Immigration and all related agents) to ensure smooth efficient processes. Fourthly, continuous training is the most important element for both the old and new staff. Finally, upgrading of ICT infrastructure in the seaport; and connectivity of the seaport, the port community and the seaport equipment for more efficient operations were strongly recommended.

6. Implication and conclusion

Although there is a clear integration between the components in Malaysian seaport centric logistic system, the advancement in the technology prevents this system to move forward and adapt to the current industrial revolution due to the limited priority has been given to infrastructure, skill, labour and education system. Besides that, the significant prerequisites including labour structure flexibility, skill and competence level, adaptive skills via significant education system, and infrastructure suitability need to be emphasised in those four components in order to move align with IR4.0. Inability of seaport system to cope with this current revolution directing it towards ineffectiveness of seaports, dry ports, freight corridors and multimodal system and finally collapsing the whole seaport ecosystem. Almost 98.4% of Malaysian trade is carried by sea, therefore, efficient interoperability via ‘Internet of Logistics’ need to be implemented to improve the trade performance of nation. Furthermore, inability to cope with new changes in the seaport system via industrial revolution leads to incompetence performance of Malaysian inland terminals which become primary indication for underutilisation of inland components for trade between Singapore-Malaysia-Thailand and China.

Predicated these four components in order to prepare Malaysian seaport system to embrace industrial revolution, strategies to improve seaport system including enhancing requirements for intermodal terminals, improving preparation for seaport alliances, developing mechanism for interoperability, improving utilisation of intra and interregional economic development as well as scrutinising safety and security system need to be prioritised. Hence, agenda in Malaysian Shipping Master Plan as well as Logistics and Trade Facilitation Master Plan need to be revisited to ensure Malaysian seaport system providing systematic strategies to muddle through the current paradigm. As a guide for further research, the impact of IR4.0 to Malaysian seaport system is practical to be explored.

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