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Original Article

Factors contributing to the imbalances of cargo flows in Malaysia large-scale minor ports using a fuzzy analytical hierarchy process (FAHP) approach

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ABSTRACT

Malaysian ports have been recording imbalances in cargo flows year after year, whether in the form of a deficit or surplus, and the condition is becoming significant. As such, it has raised concerns among port stakeholders about the impact of such a situation on the sustainability of port operations, as well as questions about the actual reasons behind the occurrence, which is still ambiguous with regard to large-scale minor ports in Malaysia. This study was aimed at identifying the main factors that are contributing to the imbalanced cargo flows at large-scale minor ports in Malaysia by ranking all the possible factors using a systematic decision-making technique known as FAHP. The results showed that “economic factors” are the main contributors to these imbalances, followed by several other factors. This study contributes a clear insight into the main factors that are causing the imbalances in cargo flows at large-scale minor ports in Malaysia. Also, it may assist decision-makers and policymakers in identifying the key factors that are affecting business operations at these ports as well as guide them into using a systematic analytical approach like the FAHP to evaluate other situations with regard to the business, operations and management of ports, where applicable.

1. Introduction

Malaysia is known as a maritime nation as more than three-quarters of its total land mass is exposed to coastal waters, and it is also strategically located along the key shipping routes of the world (Jeevan, Ghaderi, Bandara, Saharuddin, & Othman, 2015; Othman, Jeevan, & Rizal, 2016; Othman, Abdul Rahman, Ismail, & Saharuddin, 2019). As such, the maritime industry is an important one for the Malaysian economy (Jeevan et al., 2015), and Malaysian ports form the backbone that boosts the international and local trade of the nation via seaborne transport (Jeevan et al., 2015; Lam & Yap, 2006; Othman et al., 2019).

From the perspective of the Malaysian port industry, the ports in this country can be classified as federal ports, state ports, private ports/terminals/jetties, major ports, minor ports, primary ports and secondary ports (Othman et al., 2019). However, Othman et al. (2019) argued that such a classification system has several significant weaknesses, including the fact that it causes confusion among industry and academic practitioners, and is misleading in terms of the operational and functional backgrounds of the ports as some of the ports under several categories have become redundant. Several Malaysian ports were selected from the ‘minor ports’ category for the scope of this study due to their growing importance in empowering the national economy and in supporting the main national gateways in handling the level of trade flows in the country. This group of secondary ports are referred to as large-scale minor ports. According to Abdul Rahman, Ismail, Othman, Mohd Roslin, and Lun (2018), large-scale minor ports can be considered as secondary ports as they lie relatively between large- and small-sized ports. These ports are generally the developing minor ports that have grown in terms of their size and capacity to accommodate more cargo trade, and this distinguishes them from small-scale

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minor ports. A similar opinion was shared by Othman et al. (2019), who also proposed that large-scale minor ports in Malaysia be segregated from regular minor ports (comprised of large-scale minor ports, small-scale minor ports, terminals, and jetties), and be defined as intermediate-sized ports or secondary ports. The authors also proposed that these ports be conceptually defined as ports with intermediate development in terms of their size, capacity and infrastructure installations that act as secondary nodes for the transport network of the hinterland (secondary national seaborne gateways), and are secondary economic contributors to the nation, with an annual cargo throughput ranging from 1 million to 10 million tonnes (Othman et al., 2019). Nevertheless, based on a critical review by Abdul Rahman et al. (2018) on the background of secondary ports, the annual cargo throughputs of these ports can be up to 15 million tonnes. The emerging importance of large-scale minor ports or secondary ports has also been acknowledged by the Economic Planning Unit of Malaysia through the 11th Malaysia Plan (EMP), which encourages their potential development in Malaysia in an effort to enhance the national economy (Economic Planning Unit of Malaysia, 2015). According to the Economic Planning Unit of Malaysia (2015), the development of a secondary ports network can help to strengthen major port hubs in Malaysia as well as in the region, and improve the competitiveness of the national logistics chain.

Due to the importance of large-scale minor ports in Malaysia to the national economy, the significant imbalances in cargo flows between imports and exports recorded by UNCTAD (2017, 2018a) in the regions of developing economies have raised concerns with regard to the state of international seaborne trade activities in Malaysia, particularly in Malaysian ports. Based on this situation, significant imbalances in cargo flows have also been recorded at several Malaysian ports, especially at the large-scale minor ports (Ministry of Transport Malaysia, 2018), as shown in Table 1 (see Appendix). Thus, questions are being raised by port stakeholders as well as practitioners (i.e. in the industry and academia) regarding the key reasons for such an occurrence since the main cause of this situation is still uncertain.

The existing uncertainty could be due to the lack of established literature in relation to the background and operations of large-scale minor ports, particularly in the Malaysian context (Abdul Rahman et al., 2018; Othman et al., 2019). Therefore, the objective of this study was to identify the main factors that are contributing to the imbalances in cargo flows at large-scale minor ports, particularly in Malaysia.

2. Literature review

Maritime transport, which is one of the important economic agents, plays a significant role in global trade, where about 80–90% of the world's trade is transported by sea (Rodrigue, 2013; United Nation Business Action Hub, 2017; UNCTAD, 2017). In a maritime transport system, ports form a crucial infrastructure that drives maritime trade between trading partners, supports economic activities, and provides traders with the connectivity to move their goods to their destinations (Dwarakish & Salim, 2015; United Nations Business Action Hub, 2017; UNCTAD, 2017). Given that many types of ports have been established throughout the world, Abdul Rahman et al. (2018) indicated that the ports of the world can be summarised into three major categories, namely, primary, secondary, and tertiary ports. These major categories were established to classify the ports according to their operational background and significance in developing the local economy. Apart from that, as large-scale minor ports can be classified as belonging to the class of secondary ports, their importance in developing the national and global economy is undeniable (Economic Planning Unit of Malaysia, 2015; Khalid, Ang, & Abu Hasan, 2011; Othman et al., 2019). This is because they can also engage in international trade via short sea shipping or intra-continental trade, provided that they are capable of serving bigger vessels (Abdul Rahman et al., 2018; Lam & Iskounen, 2010). However, the sustainable development of ports under several categories is being threatened yearly by imbalances in cargo flows.

According to the theory of international trade, a trade imbalance is defined as the condition where there are differences between the outbound and inbound trade of one state or country and other states or countries with which they carry out the trade (Marchetti, Ruta, & Teh, 2012), whether in the form of volume or value (UNCTAD, 2018a). It happens when one of the paired states or countries consumes more or less than they produce at any given period of time (Marchetti et al., 2012). From a maritime perspective, a trade imbalance can be seen by looking at the differences between the volume of imports and exports via each port, whether it is a surplus (exports more than imports) or deficit (imports more than exports) (UNCTAD, 2018a).

UNCTAD (2018a) reported that developing economies have been the net importers of seaborne trade volumes from the net exporters since 2014. They recorded that about 541 million tonnes more of cargo were unloaded than loaded in 2016. Trade imbalances in seaborne cargo flows caused about 45% of ships to travel empty (Guilford, 2017), and indirectly exposed the respective ports to various risks that threatened to affect their operating systems and business. As one of the countries in the region of developing economies, imbalances in cargo flows pose quite a challenge to all ports in Malaysia. This is because the ports may face some difficulties in coping with imbalances in the volume of cargo flows and in overcoming the risks that may arise from the situation (Notteboom, 2018). According to a few studies, significant imbalances in cargo imports and exports may expose ports to various risks in their operations, including:

1) Increased accumulation of empty containers and unloaded cargoes in the ports (Rodrigue, 2017a),
2) Increased repositioning of empty containers and unloaded cargoes in the ports (Rodrigue, 2017a),
3) Limitations in providing sufficient cargo space (Karmelić, Dundović, & Kolanović, 2012; Ng, 2012, chap. 3; Ramphul, Ramesh, and Jaunky, 2017),
4) Affects the utilisation of facilities and equipment at the ports (Karmelić et al., 2012; Ng, 2012, chap. 3; Ramphul et al., 2017; Rodrigue, 2017a),
5) Increased possibility of congestion (Mooney, 2016a; UNCTAD, 2015),
6) Diseconomies of scale in ports (UNCTAD, 2015),
7) Creation of problems in cargo handling and clearance processes (Mooney, 2016b),
8) Increased cargo dwell time at the ports (Gaete, González-Araya, González-Ramírez, & Astudillo, 2017; Moini, Bolie, Theofanis, & Laventhal, 2012), and
9) Interruption of port development (Khalid, 2006; Ng, 2012, chap. 3).

Each of the aforementioned risks may put the ports at a disadvantage when it comes to attracting and accommodating bigger and more consistent volumes of cargo throughputs. They may also reduce the expected generation of income from available port services. Apart from that, growing imbalances between imports and exports in global trade may also cause the operational productivity of the ports to decrease significantly due to the increased risk of congestion and diseconomies of scale at the ports. These threats can be alarming to secondary ports as productivity is one of the most important aspects that guide the choice of a port by shipping

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lines (Ha, 2016; Murphy, Daley, & Dalenberg, 1992). If the productivity of the port is low, then shipping lines will choose another port of call to handle their cargo. As such, it is necessary to analyse the imbalances in cargo imports and exports, specifically at large-scale minor ports, so that the main factors that are affecting the balance of maritime trade at these affected ports can be identified, monitored and controlled, if necessary, to avoid undesirable impacts on port operations and the overall components of the supply chain system.

2.1. Factors contributing to imbalanced cargo flows in ports

According to the literature, various factors affect cargo flows in ports, including the balance of cargo imports and exports, which may vary for each port in a country. This is because the operational conditions at the ports are dynamic, and are linked to the heterogeneity of their environment (Liu, Wang, & Zhang, 2018; Othman et al., 2019). It was pointed out in some of the literature out that cargo import and export flows are often associated with insufficient port competitiveness (Yeo, Roe, & Dinwoodie, 2008, Tongzon, 2009) and port performance (Ha, 2016; Abdul Rahman et al., 2018). This is because such weaknesses may affect the attractiveness of a port when it comes to the selection of ports by port users, and may cause it to be ranked lower than other competing ports (Tongzon, 2009; Yeo et al., 2008). Hence, the port may be unable to capture the shipping and trade markets as port users would be attracted to a port that is competitive, for instance, in terms of efficiency and productivity. However, port competitiveness and performance are dependent measures that are driven by the criteria of the respective ports such as the service costs, geographical location, infrastructure, efficiency of services, quality of services, level of maritime connectivity, and port accessibility (Parola, Risitano, Ferretti, & Panetti, 2016). These criteria play important roles in influencing the levels of cargo imports and exports at ports (Sanchez, Ng, & Garcia-Alonso, 2011; Tongzon, 2009).

Meanwhile, in other parts of the literature, it was claimed that cargo flows are associated with economic, political and geographical factors and production activities as they are linked to the demand for port services (De Monie, Rodrigue, & Notteboom, 2009; Ingpen, 2015; UNCTAD, 2017; Yang, Chin, & Chen, 2014).

In view of the variety of factors that can be associated with cargo flows at ports, this study has summarised them into several major factors, namely, economic factors, political factors, geographical factors, port infrastructure factors, industrial production factors, supply chain and logistical factors, port organisational factor, port services factors, and port and hinterland competition factors. The links between these major factors and cargo flows at the ports are cited in various studies, and some of them also claim that these factors will have a negative impact on ports if they are not optimised for the operational conditions at the port.

2.1.1. Economic factors

The influence of the economy on seaborne trade is undeniable as the seaborne trade of the world is interrelated with the global economy and trade (UNCTAD, 2017, 2018a). According to UNCTAD (2017), the performance of the current economy may influence the demand for maritime transport services in seaborne trade activities. Such a situation can happen because the growth of maritime transportation is strongly correlated with the growth of the economy and international trade in the world, where maritime shipping and ports are the main physical supports for international trade transactions (De Monie et al., 2009). Yang et al. (2014) also shared a similar opinion in their study on port traffic in China. Based on their study, one of the largest influences on ports in China, especially in terms of port traffic for both imports and exports, originate from economic events. Hence, the occurrence of seaborne trade imbalances at ports should not be underestimated as coming from certain economic factors. These economic factors can range from various elements, and these elements may have varying degrees of influence on import and export traffic at different stages (Yang et al., 2014). The economic factors that particularly affect the balance of seaborne trade in ports may include current economic conditions/events (Cui, Huang, & Wang, 2015; Ingpen, 2015; Monios, Wilmsmeier, & Ng, 2018), market demands (Monios et al., 2018; Mohd Fikri Lai, Bujang, & Su-Chu, 2017), market supply (Monios et al., 2018; Mohd Fikri Lai et al., 2017), foreign direct investments (FDI) (Gujar, Yan, Gangwar, & Jain, 2014; UNCTAD, 2018a), changes in currency exchange rates (Aliyu & Tijjani, 2015; Kim, 2017; Mohd Fikri Lai et al., 2017), industry production values (i.e. sectoral output) (Jin & Steffens, 2015; Sun & Chen, 2008), value of imports and exports for commodities or products (Brancaccio, Kalouptsidi, & Papageorgiou, 2018; Hui, Ng, Xu, & Yip, 2010; Mohd Fikri Lai et al., 2017; Sun & Chen, 2008), national economic plans and policies (Gujar et al., 2014; Yang et al., 2014), and foreign exchange reserves (Arize & Malindretos, 2012; Krušković & Maričić, 2015).

2.1.2. Political factors

Apart from economic factors, Yang et al. (2014) highlighted that some political factors have also been found to have varying degrees of influence on the import and export traffic at ports, and these can result in imbalances in trade flows as they are linked to the economic environment. This aspect can influence the making of decisions and policies in a country and region, which may also affect the business of a port and its trade partners. The influence of the political environment on seaborne trade traffic can be generated by various aspects, including current political conditions (Cui et al., 2015; Ingpen, 2015; Wu, Li, Shi, & Yang, 2016), trade relationships between nations (Mohd Fikri Lai et al., 2017; Rodrigue & Notteboom, 2017c), and the level of government influence or support for seaborne trade activities (Liu & Park, 2011; Yang et al., 2014).

2.1.3. Geographical factors

Monios et al. (2018) indicated that, in many cases, the success of dominant ports is not limited to economic and political factors alone, but is also associated with the geography of the ports themselves, together with the incorporation of other factors. The geographical location of a port can be considered as an important factor that is strongly related to the volume of cargo imports and exports at ports because it can influence the demand for port services by shipping lines and other inland customers (Caldeirinha, Felicio, & Dionisio, 2013; Song & Yeo, 2004), as well as improve the level of port competitiveness (Parola et al., 2016). Besides that, the success of a port and its cargo flows can be influenced by several other aspects, including the climatic conditions in the region (Cui et al., 2015; Ingpen, 2015), and the level of maritime interface (Rodrigue & Notteboom, 2017a).

2.1.4. Port infrastructure factors

Another potential factor that can also influence the trade balance is the port infrastructure. The port infrastructure has often been associated with the performance of a port (Abdul Rahman et al., 2018; Ha, 2016), and it has been identified as one of the most important indicators for the selection and competitiveness of a port (Parola et al., 2016; Sanchez et al., 2011; Tongzon, 2009; Yeo et al., 2008).

Some of the factors concerning port infrastructure that can affect the level of trade flows and contribute to cargo imbalances at ports, as highlighted in the literature, include the size of the port area (Sohn & Jung, 2009; Song, Cheon, & Pire, 2015), the port handling equipment (Ruto & Datche, 2015; Shetty & Dwarakish, 2018), the number and size of the berths (Bureau of Transportation Statistics, 2017; Rodrigue & Notteboom, 2017a), the level of port transport infrastructure (Rodrigue & Notteboom, 2017a; Wan, Zhang, & Li, 2018), the port terminal capacity (Jeevan et al., 2015; Shetty & Dwarakish, 2018), capacity of the cargo storage facilities at the port (Bureau of Transportation Statistics, 2017; Liu & Park, 2011), the depth and width of its navigable waterways (Cui et al., 2015; Monios et al., 2018), and the anchorage capacity (Cui et al., 2015). According to the literature, these aspects have their own effect on import and export flows at ports. In this case, if the infrastructure aspects of the port are adequate, then the port will gain a comparative advantage in its operations, and it will be able to instil confidence in its customers to use its services. However, if these aspects are not at an adequate level, then it will be difficult for the port to attract more customers, and this may result in an imbalance in cargo flows and low port throughputs. This is because most customers prefer to choose ports with more adequate infrastructure to handle their cargo as this will influence their transport and operational costs. If fewer customers were to call for port services due to unattractive port infrastructure facilities, then the cargo traffic at the port will be affected and an imbalance in cargo flows may occur. These arguments are also supported by the findings of a study conducted by Bottasso, Conti, Porto, Ferrari, and Tei (2018), where the literature also noted the significant positive influence of port infrastructure on import and export flows in Brazilian ports.

2.1.5. Supply chain and logistical factors

The supply chain and logistics can also be one of the contributing factors to the level of import and export flows at a port. This because the relationship between the supply chain and logistics and the import and export of cargo at ports cannot be denied as they are interrelated. According to Wang and Cullinane (2006) and Munim and Schramm (2018), port activities are no longer limited to just cargo handling because in an international context, the supply chain and logistics are considered to be at the core of the operations and business of a port. They can have a significant influence on port operations in terms of the physical movement of cargo from both the import and export sides, either by sea or land transportation. This is because an optimal logistical system enables a greater efficiency of cargo movements with an appropriate choice of modes, terminals, routes and schedules (Rodrigue, 2017b). Rodrigue (2017b) also added that logistics is believed to act as a fundamental component of improved efficiency in a market economy. Such influences will attract more cargo traffic to a port (Munim & Schramm, 2018). The importance of this aspect in empowering the level of cargo flows was also emphasised by the United Nations' Conference on Trade and Development (UNCTAD), as the logistics system is recognised as one of the important systems for supporting global trade, supply chains, production processes and the economic integration of countries (UNCTAD, 2018b). Apart from that, the logistical aspect is also regarded as a crucial component for monitoring and measuring the operational, financial, economic, social and environmental performance of ports (Ruto & Datche, 2015; UNCTAD, 2018b). In the case of seaborne trade, the influence of this aspect can be viewed through several angles such as the transport service network (Cui et al., 2015; Rodrigue, 2017b), transport costs (Rodrigue & Notteboom, 2017b; UNCTAD, 2015), increase in the size of operating vessels (Guerrero, 2019; Prokopowicz & Berg-Andreassen, 2016), efficiency of the transport service (Gani, 2017; Nordas, Pinali, & Grosso, 2006), quality of the transport service (Behar & Venables, 2011, chap. 5; Gani, 2017), and the level of safety and security of a supply chain system (Slack & Rodrigue, 2017; Veselko & Bratkovic, 2009).

2.1.6. Industrial production factors

Industrial production can also be one of the important aspects that influence the balance of cargo flows. This is because the production sector and ports are interrelated through their links with trade activities. As much as the production industry needs ports to handle their goods for international trade, the ports also need this industry to support their operations through their demand for services (Essoh, 2013; Zhang, Loh, & Thai, 2015), which is based on the level of import and export activities. Without a sufficient demand for port services as well as consistent levels of import and export activities, the operations of a port will not grow as ports are services-driven. Therefore, production from industries or the hinterland behind a port, whether in terms of commodities or manufactured products, support the growth of port operations as it influences the demand for maritime transport services as well as the flow of traffic at the port for both imports and exports (Essoh, 2013; Zhang et al., 2015). Some of the elements that influence the contribution of this aspect may include the level of production and distribution activities by the production sector (Notteboom & Rodrigue, 2008; Rodrigue, 2017c; UNCTAD, 2015, 2017), the strength of the industries that are linked to the ports (Rodrigue, 2017b, 2017c; Zhang et al., 2015), the fluctuation of specific resources (Ingpen, 2015; Rodrigue, 2017b, 2017c), production costs (Seabrooke, Hui, Lam, & Wong, 2003; Zhang et al., 2015), and also the level of production networks (Rodrigue, 2017b, 2017c). The influence of this aspect on the balance of trade should not be underestimated as it can affect cargo volumes at ports through their import and export activities. The influence of industrial production factors on a port and its traffic has been discussed in numerous studies such as by Chlomoudis, Karalis, and Pallis (2003), Seabrooke et al. (2003), Essoh (2013), Loh and Thai (2015), UNCTAD (2015, 2017), to name a few.

2.1.7. Port organisational factors

When the internal aspects of the environment at a port are taken into consideration, port organisation can be one of the important aspects that contribute to imbalances in imports and exports at a port. This because according to Cubas, Briceno-Garmendia, and Bofinger (2015), port organisation plays an important role in ensuring that the port is competitive and more appealing than neighbouring ports. A competitive and appealing port will attract more sustainable trade flows from both the import and export sides, and thus contribute to the improvement in the balance of cargo flows. If a port is uncompetitive and unappealing, then this will affect not only the level of trade flows at the port but also the balance of the flows.

One of the factors that can lead a port to be uncompetitive and unappealing is a weak and ineffective port organisational system as this will result in high port management and handling costs (Cubas et al., 2015). Cubas et al. (2015) also added that port organisation is an important aspect that determines the growth in the potential of a port to attract trade flows, both in imports and exports. It acts as a core component that drives a port towards fulfilling its functions and roles. Without an effective and efficient organisational system to manage and support port operations, a port would be less competitive in attracting the desired trade flows. This aspect may comprise a few elements such as the management and operational system of a port (Cubas et al., 2015; Orji, 2014), the effective marketing and commercialisation of the port (Murati, 2013; Pando, Araujo, & Maqueda, 2005), port formalities and clearance systems (Nyema, 2014; Sanchez et al., 2011; UNCTAD, 2015), the workforce (Ha, 2016; Rockson, Annan, & Muntaka, 2017), information and communication management of a port (Beresford, Gardner, Pettit, Naniopoulos, & Wooldridge, 2004; Olesen, Dukovska-Popovska, & Hvolby, 2013), and financial strength (Brooks, 2006; Ha, 2016; Talley, 2006).

2.1.8. Port services factors

Along with port organisation, port services should also not be missed out. This is because ports provide a variety of service activities for vessels, cargoes and inland transportation (Shetty & Dwarakish, 2018). In addition, the flow of imports and exports at a port is associated with the level of demand and supply for port services (Hui et al., 2010). Such a relationship is due to the role played by the level of demand and supply for port services in influencing the attractiveness and competitiveness of a port. In the case of a dynamic port environment, the level of demand and supply should be favourable or balanced in order to attract port users and service providers to engage with the port services. Otherwise, it will give rise to a number of consequences (Jugović, Hess, & Jugović, 2011), including diversion of trade flows and imbalances in imports and exports. Without the appropriate level of services at a port, the port will lose the opportunity to attract new customers and improve its trade flows. Although the supply of services can attract port users, but if they are not at appropriate levels in terms of quantity or quality, then some of those services will be wasted. The degree of satisfaction expressed by port users will indicate the level of performance achieved by the port (Shetty & Dwarakish, 2018). The level of satisfaction of port users with regard to the performance of the port will improve the attraction of port services as well as the trade flows at the port (Sanchez et al., 2011). The underlying elements of this aspect may include the demand and supply for port services (Gallego, Núñez-Sánchez, & Coto-Millán, 2015; Jugović et al., 2011), level of access to port services and cargo information (Ha, 2016; Ruto & Datche, 2015), productivity of port services (Brooks, 2006; Ha, 2016), efficiency of port services (Ha, 2016; Song & Panayides, 2008), value-added services at the port (Ha, 2016; Okorie, Tipi, & Hubbard, 2016), service costs (Ha, 2016; Yeo, Ng, Lee, & Yang, 2014), quality of port services (Lobo & Jain, 2002; Sanchez et al., 2011; Ha, 2016), and types of cargoes/commodities handled by the port (Jara-Diaz, Martinez-Budria, & Diaz-Hernandez, 2006; Rødseth & Wangsness, 2015).

2.1.9. Port and hinterland competition factors

In addition to the factors mentioned above, competition in ports and the hinterland is sometimes inevitable. Competition is a normal situation in a port environment, especially when the competing ports are operating in similar markets. The competition is basically created when a port desires to have a competitive advantage, particularly in attracting and increasing the volume of traffic to the port. According to Yeo et al. (2008), the level of competition in ports or hinterland areas can also be attributed to a variety of situations, not just what is obvious. In this regard, if a port does not pay attention to the related attributes, then it will difficult for it to attract cargo flows or even balance the cargo traffic between the import and export sides, as the attributes may affect the competitiveness of the port in the global trade chain. Such a situation will definitely have a negative impact on the local economy (Yeo et al., 2008). Based on a few studies, the attributes that may affect the level of competition in ports or hinterland areas in the global trade chain could be, but are not limited to, the level of industrial development in the hinterland (Rodrigue, Slack, & Notteboom, 2017), port and hinterland connectivity (Merk & Notteboom, 2015; Paflioti, Vitsounis, Tsamourgelis, & Bell, 2014), changing forms of port customers' operations and expectations (Heaver, Meersman, Moglia, & Van De Voorde, 2000; Merk, Kirstein, & Salamitov, 2018), evolution of technological applications in seaborne trade markets (Brümmerstedt et al., 2017; UNCTAD, 2018b; World Bank, 2007), population of the hinterland areas (Ducruet, 2009; Jafari, Ismail, & Kouhestani, 2011), trade barriers between trading partners (Elwell, 2005; Islam, Mohamad Ismail, & Siwar, 2010), and the level of investments at ports (Munim & Schramm, 2018; Portugal-Perez & Wilson, 2012).

As far as this study is concerned, the influence of each group of factors on the trade imbalance situation at large-scale minor ports in Malaysia is still uncertain, although their relationship with the level of cargo imports and exports has been discussed in the various literature. Hence, due to the dynamic backgrounds of ports globally and the heterogeneity of their environment, this study, therefore, was aimed at identifying the main factors that are contributing to imbalances in cargo flows at large-scale minor ports by using a fuzzy analytical hierarchy process (FAHP) approach.

3. Methodology

This study applied a combination of qualitative and quantitative approaches, namely, the fuzzy analytic hierarchy process (FAHP) method to analyse the factors that are contributing to imbalances in cargo flows at large-scale minor ports.

The fuzzy analytic hierarchy process (FAHP), which is method of analysis that combines the fuzzy theory and the analytic hierarchy process (AHP), was introduced in 1983 by Laarhoven and Pedrycz (Balli & Korukoğlu, 2009; Laarhoven & Pedrycz, 1983). This method converts the opinions of experts from previous definite values in the classical AHP to fuzzy numbers, and the membership functions of the fuzzy theory, such as triangular fuzzy numbers, are presented as paired comparisons of matrices (Valahzaghard, Mozaffari, Valehzagharad, & Memarzade, 2011). According to Saaty, the consistency ratio (CR) calculated in the AHP helps to determine the levels of quality and reliability of the judgements, which should be equal to or less than 0.1 (Golden, 1989; Rahmatdin & Abdul Rahman, 2016, 2017; Saaty, 1980, 1990, 2008). Fig. 1 (see Appendix) shows the systematic steps that were taken in this study to analyse the factors that contribute to imbalances in cargo flows at large-scale minor ports in Malaysia using the FAHP method.

3.1. Step 1: Develop the hierarchical structure of the evaluation index system

A hierarchical structure that is constructed can consist of the goal (objective), the criteria (factors), and sub-criteria (sub-factors) that may relate to the research problem (Ayhan, 2013; Praščević & Praščević, 2016; Saaty, 2008; Tseng & Cullinane, 2018). In the evaluation system for this study, the objective was set at the first level, while the criteria were set in the successive levels or lower levels (Ayhan, 2013; Praščević & Praščević, 2016). The sub-criteria and alternatives, however, were not included as the goal of this study was only to focus on the contributing factors (Saaty, 2008; Tseng & Cullinane, 2018). The criteria used in this analysis were identified from the literature using the cause-and-effect analysis method. This is a systematic way of examining the interactions among factors that are affecting a particular process or causing a particular problem (Watson, 2004). Fig. 2 shows the hierarchical structure of the evaluation index system developed for this study.

3.2. Step 2: Determine the linguistic variables and fuzzy conversion scale

The pairwise comparisons of the importance or preference between each pair of criteria were performed using the linguistic variables and fuzzy conversion scale (Zadeh, 1965). This step enables decision-makers to understand the pairwise comparison technique for comparing the importance or preference between each pair of criteria. In this study, the triangular fuzzy number and linguistic variables were used to determine the linguistic values in the fuzzy numbers as they give a better performance in terms of the rise time, overshoot and steady-state behaviour compared to other fuzzy membership functions (Ali, Ali, & Sumait, 2015).

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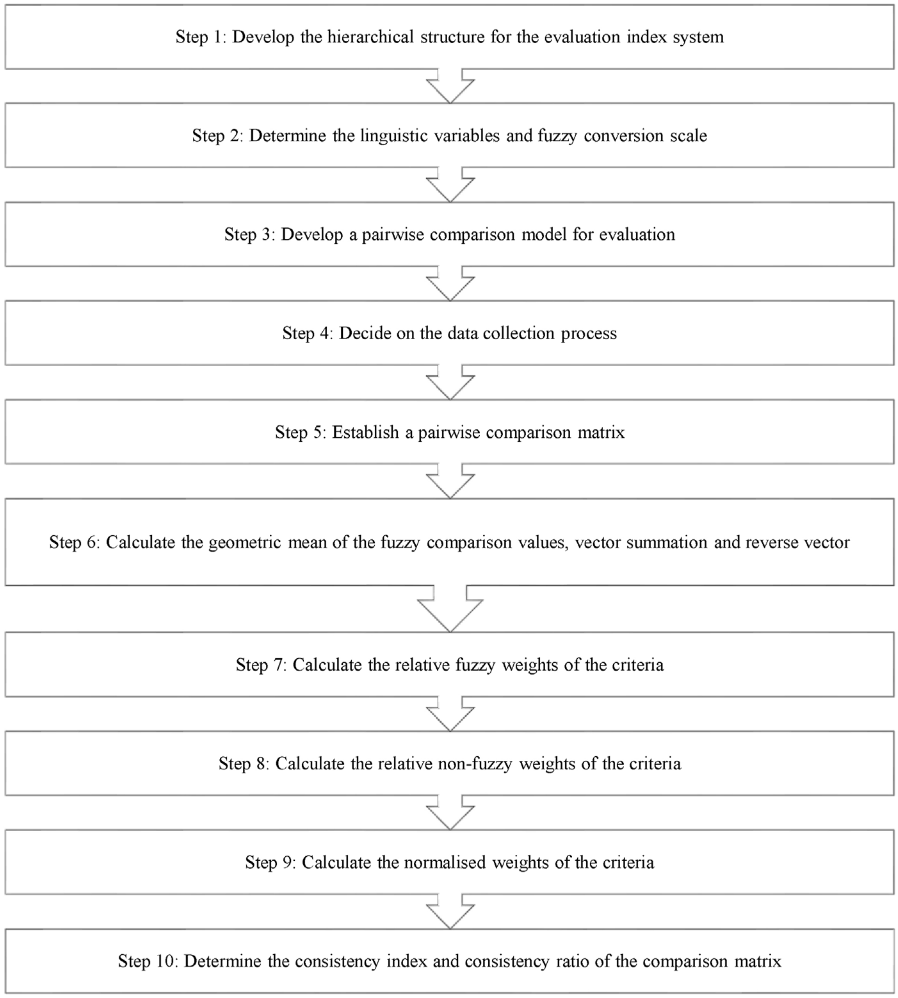

Fig. 1. The systematic methodological steps in conducting FAHP.
Sources: Hsu, Lee, & Kreng, 2010; Valahzaghard et al., 2011; Ayhan, 2013; Do, Chen, & Hsieh, 2015.

The triangular fuzzy numbers and linguistic variables used in this study are shown in Table 2 (see Appendix).

3.3. Step 3: Develop a pairwise comparison model for evaluation

A pairwise comparison model was formed to evaluate the criteria involved in the study. Based on the pairwise comparison model, the decision-makers were required to compare the criteria via linguistic terms and the applied scales, as shown in Table 2 (see Appendix). An example of a pairwise comparison model can be referred to in Ayhan (2013).

3.4. Step 4: Conduct the data collection

Close-structured questionnaires were distributed to the large-scale minor ports and several maritime scholars in Malaysia so as to gain their feedback regarding the issue being investigated. The expert sampling technique was applied as this technique focuses on the selection of a group of qualified decision-makers, based on their experience and expertise within the scope of this study. A total of ten (10) decision-makers were selected as the experts for this study. The details of the experts who were selected are summarised in Table 3.

Some of the information on the experts listed in Table 3, however, could not be disclosed due to the agreement between the authors and the experts with regard to the protection of privacy and confidentiality.

3.5. Step 5: Establish a pairwise comparison matrix

A pairwise comparison matrix was established for all the criteria in the hierarchy system. The established pairwise comparison matrix can be presented in the form of (1), where $a_{ij} = 1$ and $a_{ji} = 1/a_{ij}$ (Abdul Rahman et al., 2018; Aydin & Kahraman, 2010; Rahmatdin & Abdul Rahman, 2016, 2017; Rahmatdin, Abdul Rahman, & Othman, 2018; Saaty, 2008; Valahzaghard et al., 2011).

$$A = a_{ij} = \begin{array}{cccccc} i/j & A_1 & A_2 & \ldots & A_n \\ A_1 & 1 & a_{12} & \ldots & a_{1n} \\ A_2 & 1/a_{12} & 1 & \ldots & a_{2n} \\ \ldots & \ldots & \ldots & \ldots & \ldots \\ A_n & 1/a_{1n} & 1/a_{2n} & \ldots & 1 \end{array} \quad (1)$$

where $i,j = 1,2, \ldots, n$.

The pairwise comparison matrix shown in (1) indicated the kth decision-maker's preference for the ith criterion over the jth criterion via the fuzzy triangular numbers, represented as a_{ij}. As there was more than one decision-maker in this study, the preferences of

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Table 1
The volumes of import and export handled by several large-scale minor ports in Malaysia (in '000 tonnes).

Ports		Year					
		2012	2013	2014	2015	2016	2017
Teluk Ewa	Exports	3237	3473	3059	2795	2927	2338
	Imports	696	706	717	597	516	535
	Differences	2541	2767	2342	2198	2411	1803
Port Dickson	Exports	2613	2928	2470	2331	2064	4155
	Imports	11,755	10,179	9542	11,714	11,711	11,811
	Differences	−9142	−7251	−7072	−9383	−9647	−7656
Kemaman	Exports	3432	2506	2655	3524	3694	3335
	Imports	3249	1853	2208	2956	2129	2181
	Differences	183	653	447	568	1565	1154
Rajang	Exports	1649	613	453	374	298	185
	Imports	1614	1513	1325	1150	1109	1000
	Differences	35	−900	−872	−776	−811	−815
Miri	Exports	4823	5563	5226	4701	4494	4321
	Imports	842	866	697	579	591	682
	Differences	3981	4697	4529	4122	3903	3639
Kuching	Exports	1875	2183	2284	2529	2260	1900
	Imports	7314	7395	6851	6800	6902	6807
	Differences	−5439	−5212	−4567	−4271	−4642	−4907

Source: Ministry of Transport Malaysia (2018).

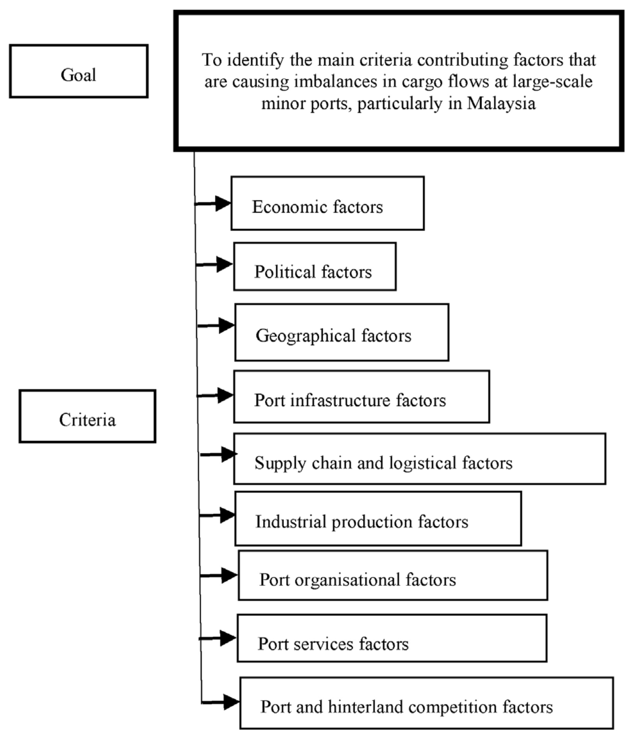

Fig. 2. The hierarchical structure of the evaluation index system.

the decision-makers (a_{ij}^k) were averaged, and the value of (a_{ij}) was calculated using Eq. (2) (Ayhan, 2013):

$$a_{ij} = \frac{\sum_{k=1}^{k} a_{ij}^k}{K} \tag{2}$$

where K = total number of decision-makers.

Based on the evaluation of the experts on the pairwise comparison model and the calculations performed in this step, the pairwise comparison matrix was established for the criteria, as shown in Table 4 (see Appendix).

3.6. Step 6: Calculate the geometric mean of the fuzzy comparison value, vector summation and reverse vector

The geometric mean of the fuzzy comparison value of each criterion was calculated using Eq. (3) (Ayhan, 2013). Here, $\tilde{r}_i$ still represents the triangular values (Ayhan, 2013; Karim, Abdul Rahman, & Syed Johari Shah, 2018; Soberi & Ahmad, 2016).

$$\tilde{r}_i = (\tilde{a}_{i1} \otimes \tilde{a}_{i2} \otimes \cdots \otimes \tilde{a}_{in})^{1/n}, \quad i = 1, 2, \ldots, n \tag{3}$$

The summation vector of each $\tilde{r}_i$ was calculated by vertically summing up each $\tilde{r}_i$ value using Eq. (4). Meanwhile, the reverse vector for each fuzzy $\tilde{r}_i$ was determined by using Eq. (5) (Ayhan, 2013; Hsieh, Lu, & Tzeng, 2004; Valahzaghard et al., 2011). According to Ayhan, if the reverse vectors are not in an increasing order, then the fuzzy triangular numbers need to be rearranged to make them into an increasing order (Ayhan, 2013).

$$\text{Summation vector of each } \tilde{r}_i = (\tilde{r}_1 \otimes \tilde{r}_2 \otimes \cdots \otimes \tilde{r}_n) \tag{4}$$

$$\text{Reverse vector of each } \tilde{r}_i = (\tilde{r}_1 \otimes \tilde{r}_2 \otimes \cdots \otimes \tilde{r}_n)^{-1} \tag{5}$$

By using the information in Table 4 (see Appendix), the geometric mean of the fuzzy comparison values, summation vectors, and reverse vectors of the criteria were calculated and summarised, as in Table 5.

3.7. Step 7: Calculate the relative fuzzy weight, $\tilde{w}_i$ of the criteria

The relative fuzzy weight, $\tilde{w}_i$ of each criterion, as shown in Table 6, was determined based on the fuzzy number for each evaluation dimension by multiplying each $\tilde{r}_i$ with the reverse vector determined in Step 6 using Eq. (6) (Ayhan, 2013; Karim et al., 2018; Soberi & Ahmad, 2016).

$$\begin{aligned}\tilde{w}_i &= \tilde{r}_i \otimes \left(\tilde{r}_1 \oplus \tilde{r}_2 \oplus \cdots \oplus \tilde{r}_n\right)^{-1} \\ &= (lw_i,\ mw_i,\ uw_i)\end{aligned} \tag{6}$$

3.8. Step 8: Calculate the relative non-fuzzy weights of the criteria

Next, the fuzzy numbers of the relative fuzzy weights, $\tilde{w}_i$, had to be defuzzified by applying Eq. (7) (Ayhan, 2013; Chou & Chang, 2008; Karim et al., 2018; Soberi & Ahmad, 2016).

$$M_i = \frac{(lw_i \otimes mw_i \otimes uw_i)}{3} \tag{7}$$

The relative non-fuzzy weights of the criteria were calculated and summarised, as in Table 7.

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Table 2
The linguistic terms and the corresponding scale.

Saaty's scale	Triangular fuzzy number	Definition of scale (linguistic term)	Triangular fuzzy reciprocal number	Definition of scale (linguistic term)
1	(1, 1, 1)	Equally important	(1, 1, 1)	Equally unimportant
3	(2, 3, 4)	Weakly important	$\left(\frac{1}{4}, \frac{1}{3}, \frac{1}{2}\right)$	Weakly unimportant
5	(4, 5, 6)	Fairly important	$\left(\frac{1}{6}, \frac{1}{5}, \frac{1}{4}\right)$	Fairly unimportant
7	(6, 7, 8)	Strongly important	$\left(\frac{1}{8}, \frac{1}{7}, \frac{1}{6}\right)$	Strongly unimportant
9	(9, 9, 9)	Absolutely important	$\left(\frac{1}{9}, \frac{1}{9}, \frac{1}{9}\right)$	Absolutely unimportant
2	(1, 2, 3)	The intermittent values of important between two adjacent scales	$\left(\frac{1}{3}, \frac{1}{2}, 1\right)$	The intermittent values of unimportant between two adjacent scales
4	(3, 4, 5)		$\left(\frac{1}{5}, \frac{1}{4}, \frac{1}{3}\right)$	
6	(5, 6, 7)		$\left(\frac{1}{7}, \frac{1}{6}, \frac{1}{5}\right)$	
8	(7, 8, 9)		$\left(\frac{1}{9}, \frac{1}{8}, \frac{1}{7}\right)$	

Sources: Ayhan (2013); Karim et al. (2018).

Table 3
The details of the selected experts.

No.	Experts	Organisation	Background experience	Year of experience
1.	Senior Researcher	Organisation A	Has been engaged and collaborated in various industrial researches related to cargo flows in the context of maritime ports and supply chains.	More than 5 years
2.	Senior Researcher	Organisation A	Has been engaged in some industrial researches related to cargo flows in the context of maritime ports.	More than 5 years
3.	General Manager	Organisation B	Has led in managing, operating and maintaining the port operations	More than 20 years
4.	Marine Manager	Organisation C	Has led in managing, operating and maintaining the marine operations of the port	14 years
5.	Senior Port Executive, Operation	Organisation C	Has been engaged in port operations	5 years
6.	Senior Marine Superintendent	Organisation D	In charge of managing and maintaining the marine operations of the port	20 years
7.	Manager, Logistics – Port Operation	Organisation E	Has led in managing, operating and maintaining the logistics and operation system of the port	17 years
8.	Manager, Port Planning and Development	Organisation F	Has led in managing the planning and development of the port	35 years
9.	Assistant Port Traffic Superintendent	Organisation G	Assisted in managing and monitoring port traffic	More than 12 years
10.	Assistant Manager, Port Business Development	Organisation H	Has been engaged in the planning and development of the port	More than 10 years

3.9. Step 9: Calculate the normalised weights of the criteria

The relative non-fuzzy weight, M_i, of each criterion then had to be normalised by using Eq. (8) to determine the normalised weight of each criterion (Ayhan, 2013; Karim et al., 2018). Referring to Eq. (8), $\sum_{i=1}^{n} M_i$ is the total weight of the relative non-fuzzy weight, M_i.

$$N_i = \frac{M_i}{\sum_{i=1}^{n} M_i} \tag{8}$$

The normalised weights of the criteria are summarised in Table 8.

3.10. Step 10: Determine the consistency index (CI) and consistency ratio (CR) of the comparison matrix

In the last step, the consistency of the evaluation for the comparison matrix was computed to determine the quality level of a decision. The consistency rate (CR) of the comparison matrix had to be determined to ensure that the pairwise comparison evaluation made by the decision-makers was consistent and trustworthy. In the CR equation, the CI measured the consistency of a given evaluation matrix. The CR was computed by using Eq. (9) (Abdul Rahman et al., 2018; Abdul Rahman et al., 2018), and the CI was computed by using Eq. (10) (Saaty, 1980, 2008; Rahmatdin & Abdul Rahman, 2016, 2017; Srichetta & Thurachon, 2012).

$$\text{Consistency ratio,} \quad \text{CR} = \frac{CI}{RI} \tag{9}$$

$$\text{Consistency Index,} \quad \text{CI} = \frac{\lambda_{\max} - n}{n - 1} \tag{10}$$

The random index, RI of Eq. (9), however, depended on n, as shown in Table 9.

The overall maximum eigenvalue, $\lambda_{\max.av.}$, of the comparison matrix in the CI was computed using Eq. (11) (Abdul Rahman, 2012; Abdul Rahman & Ahmad Najib, 2017; Abdul Rahman et al., 2018; Asuquo, Coward, & Yang, 2014; Golden, 1989; Rahmatdin & Abdul Rahman, 2017; Saaty, 1980, 1990, 2008).

$$\lambda_{\max.av.} = \sum_{i=1}^{n} \frac{\sum_{i=1}^{n} N_i a_{ij} / N_i}{n_T} \tag{11}$$

where, N_i = normalised weight of eigenvector, a_{ij} = comparison matrix value of each criterion, and n_T = total number of criteria in the comparison matrix.

Based on the calculation performed in this step, the consistency ratio of the comparison matrix that was calculated for the criteria was 0.0766, which is less than the 0.1. Therefore, it means that the values of the comparison matrix for the criteria evaluated by the experts were acceptable and considered to be reliable as they were consistent, in accordance with the classical theory of AHP (Saaty, 1980, 2008).

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Table 4
The pairwise comparison matrix of the criteria.

Main criteria	Economic factors			Political factors			Geographical factors			Port infrastructure factors			Supply chain and logistical factors		
Economic factors	1.0000	1.0000	1.0000	4.4000	5.0000	5.6000	3.7236	4.4254	5.1292	2.1397	2.5458	2.9543	1.4611	1.7744	2.0976
Political factors	0.2273	0.2000	0.1786	1.0000	1.0000	1.0000	0.4240	0.4546	0.5121	0.2250	0.2466	0.2813	0.2317	0.2555	0.2937
Geographical factors	0.2686	0.2260	0.1950	2.3584	2.1999	1.9529	1.0000	1.0000	1.0000	0.5671	0.5777	0.5926	0.5728	0.5861	0.6060
Port infrastructure factors	0.4674	0.3928	0.3385	4.4444	4.0554	3.5543	1.7635	1.7309	1.6874	1.0000	1.0000	1.0000	2.4250	2.8286	3.2333
Supply chain and logistical factors	0.6844	0.5636	0.4767	4.3151	3.9137	3.4045	1.7459	1.7063	1.6503	0.4124	0.3535	0.3093	1.0000	1.0000	1.0000
Industrial production factors	0.4888	0.4257	0.3769	7.3922	6.5066	5.5263	4.2112	3.7900	3.2567	1.5352	1.5200	1.4991	1.0465	0.9424	0.8560
Port organisational factors	0.2703	0.2326	0.2041	1.1856	0.9515	0.7926	0.7573	0.6460	0.5562	0.2857	0.2564	0.2326	0.4439	0.3899	0.3463
Port service factors	0.5777	0.4471	0.3643	0.8918	0.7428	0.6302	3.0732	2.8484	2.5470	0.6440	0.5373	0.4603	1.6874	1.4080	1.1952
Port and hinterland competition factors	0.4126	0.3305	0.2757	0.5928	0.5005	0.4323	0.7268	0.6288	0.5520	1.0511	0.9465	0.8592	0.4494	0.4296	0.4113
Total	4.3970	3.8182	3.4097	26.5803	24.8704	22.8931	17.4255	17.2304	16.8908	7.8601	7.9839	8.1887	9.3178	9.6145	10.0395

Main criteria	Industrial production factors			Port organisational factors			Port service factors			Port and hinterland competition factors		
Economic factors	2.0458	2.3490	2.6532	3.7000	4.3000	4.9000	1.7310	2.2367	2.7450	2.4236	3.0254	3.6278
Political factors	0.1353	0.1537	0.1810	0.8435	1.0510	1.2617	1.1214	1.3462	1.5869	1.6869	1.9980	2.3130
Geographical factors	0.2375	0.2638	0.3071	1.3204	1.5480	1.7978	0.3254	0.3511	0.3926	1.3760	1.5902	1.8117
Port infrastructure factors	0.6514	0.6579	0.6671	3.5000	3.9000	4.3000	1.5528	1.8611	2.1726	0.9514	1.0565	1.1639
Supply chain and logistical factors	0.9556	1.0611	1.1683	2.2528	2.5644	2.8875	0.5926	0.7102	0.8367	2.2254	2.3278	2.4311
Industrial production factors	1.0000	1.0000	1.0000	3.1000	3.4000	3.7000	2.3236	2.5268	2.7310	3.8236	4.3268	4.8310
Port organisational factors	0.3226	0.2941	0.2703	1.0000	1.0000	1.0000	0.5772	0.7873	1.0011	0.9726	1.2852	1.6033
Port service factors	0.4304	0.3958	0.3662	1.7326	1.2702	0.9989	1.0000	1.0000	1.0000	3.8143	4.5167	5.2200
Port and hinterland competition factors	0.2615	0.2311	0.2070	1.0282	0.7781	0.6237	0.2622	0.2214	0.1916	1.0000	1.0000	1.0000
Total	6.0400	6.4066	6.8199	18.4773	19.8116	21.4695	9.4861	11.0407	12.6574	18.2738	21.1266	24.0017

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Table 5
The geometric mean of the fuzzy comparison values, $\tilde{r}_i$, summation vectors, and reverse vectors of the criteria.

Criteria	$\tilde{r}_i$		
Economic factors	2.2741	2.6672	3.0530
Political factors	0.4684	0.5136	0.5698
Geographical factors	0.6745	0.6961	0.7226
Port infrastructure factors	1.4588	1.5039	1.5361
Supply chain and logistical factors	1.2211	1.2200	1.2130
Industrial production factors	2.0618	2.0196	1.9590
Port organisational factors	0.5618	0.5452	0.5272
Port service factors	1.1929	1.0554	0.9473
Port and hinterland competition factors	0.5656	0.4918	0.4365
Summation vector	**10.4789**	**10.7128**	**10.9643**
Reverse vector	**0.0954**	**0.0933**	**0.0912**
Increasing order of reverse vector	0.0912	0.0933	0.0954

The bold values of **Summation vector** is the summed up value of the criteria listed from Economic Factors to Port and hinterland competition factors.
The bold values of **Reverse vector** is the value obtained from Eq.5.

Table 6
The relative fuzzy weight, $\tilde{w}_i$ of each criterion.

Criteria	$\tilde{w}_i$		
Economic factors	0.2074	0.2490	0.2913
Political factors	0.0427	0.0479	0.0544
Geographical factors	0.0615	0.0650	0.0690
Port infrastructure factors	0.1330	0.1404	0.1466
Supply chain and logistical factors	0.1114	0.1139	0.1158
Industrial production factors	0.1880	0.1885	0.1869
Port organisational factors	0.0512	0.0509	0.0503
Port service factors	0.1088	0.0985	0.0904
Port and hinterland competition factors	0.0516	0.0459	0.0417

Table 7
The relative non-fuzzy weights, Mi, of the criteria.

Criteria	M_i
Economic factors	0.2492
Political factors	0.0483
Geographical factors	0.0651
Port infrastructure factors	0.1400
Supply chain and logistical factors	0.1137
Industrial production factors	0.1878
Port organisational factors	0.0508
Port service factors	0.0992
Port and hinterland competition factors	0.0464
Total	1.0007

Table 8
The normalised weights of the criteria.

Criteria	Weight value of criteria	Ranking order
Economic factors	0.2491	1
Political factors	0.0483	8
Geographical factors	0.0651	6
Port infrastructure factors	0.1399	3
Supply chain and logistical factors	0.1136	4
Industrial production factors	0.1877	2
Port organisational factors	0.0508	7
Port service factors	0.0992	5
Port and hinterland competition factors	0.0463	9

4. Findings and discussion

This study was conducted in Malaysia, where the ports in this country have been classified into two major categories, namely major ports and minor ports, to distinguish their operational backgrounds (Marine Department of Malaysia, 2017; Othman et al., 2019). However, this study only focused on large-scale minor ports as they are the developing ports in the country, which are in need of serious attention in terms of their development and competitiveness requirements.

By using the fuzzy AHP, the potential contributing factors of this study were prioritised, and the main contributing factor that is causing imbalances in cargo flows at large-scale minor ports in Malaysia was also identified. The contributions of the factors were indicated in the form of weightage values, as shown in Fig. 3.

Table 9
The random index (RI) of random matrix.

n	3	4	5	6	7	8	9
RI	0.58	0.9	1.12	1.24	1.32	1.41	1.45

Source: Saaty, 2008.

Based on the results, the criterion of 'economic factors' was identified as the main contributor to imbalances in cargo flows at large-scale minor ports in Malaysia. This was based on the weight value assigned to the factor through the analysis, where this factor, with a value of 0.2491, recorded the highest contributing value compared to the other factors. Based on the order of priority, the top influencing criterion, 'economic factors', was followed by the other influencing criteria, namely 'industrial production factors', 'port infrastructure factors', 'supply chain and logistical factors', 'port services factors', 'geographical factors', 'port organisational factors', 'political factors' and 'port and hinterland competition factors'.

The analysis results were considered as relevant, based on the consistency test result in the fuzzy AHP method. In addition, from a theoretical perspective, the contribution of 'economic factors' in any business is undeniable, especially when the business is very much interrelated with the global economy, international trade and international seaborne trade, like ports. Economic factors can influence not only the markets for the products but also the wealth of a country, where they will create demands for imports by countries that are producing less or for exports by countries that are producing more. Such demands for goods will directly contribute to cargo flows in international trade and international seaborne trade, simultaneously. The identification of 'economic factors' as the most influential cause of imbalances in cargo flows indicated that the underlying elements of 'economic factors' play a huge role in emphasising the contribution of the economic aspect to attract cargo volume and ensure that cargo traffic is balanced at the ports compared to the underlying elements of the other factors. This finding was also in line with the findings of several studies conducted around the world. For instance, two separate studies conducted by Sun and Chen (2008) and Jin and Steffens (2015), respectively, found a significant influence of economic factors (i.e. industrial production value) on cargo traffic at several Chinese and U.S. ports. According to them, the lowest global production value of a dominating country will not only attract a greater demand for products from the country, but may also affect the production activities of related industries in other countries that have a higher production value, thereby resulting in imbalances in imports and exports at the respective areas involved (Jin & Steffens, 2015; Sun & Chen, 2008). In addition, Yang et al. (2014), in a seperate study,

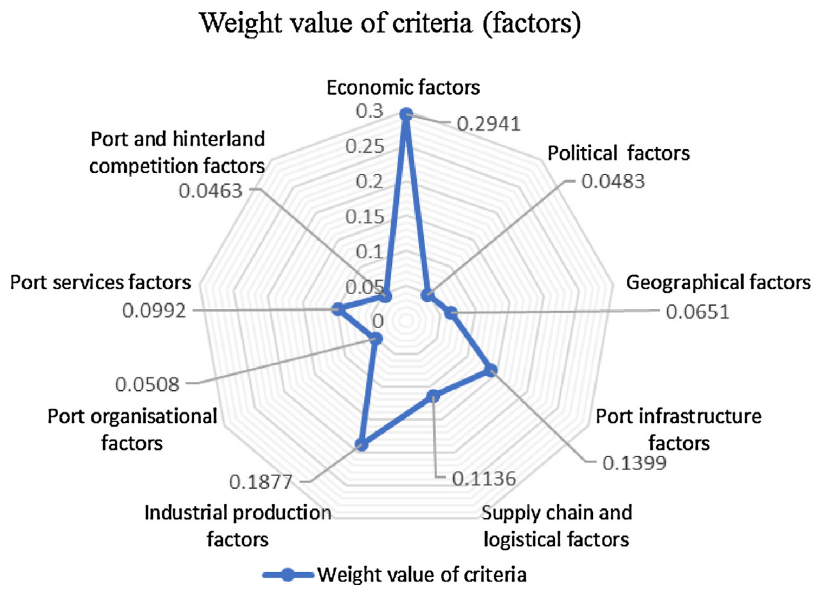

Fig. 3. The contributions of factors based on their weightages.

found that one of the largest influences in Chinese ports, especially in terms of port traffic, also originated from economic factors, hence indicating that the claim that this aspect is the highest contributing factor to imbalances in cargo imports and exports in large-scale minor ports in Malaysia is relevant.

Along with that, the aspect of 'production factors' was ranked as the second highest contributor to imbalances in cargo flows at large-scale minor ports in Malaysia, as this aspect controls the production of those products that will be exported to other countries. Apart from that, they may also import a significant volume of semi-finished products, whose production will be completed by the related manufacturing companies in the country to be re-exported to other regions or sold within the local market. Without the participation of the manufacturing sector, no products will be available for export. If no products are available, then no trade or export activities can be carried out to balance the import volume.

Meanwhile, 'port infrastructure' was ranked as the third highest contributor to trade imbalances in large-scale minor ports in Malaysia. This factor also contributed to seaborne trade from another angle, namely, port attractiveness. Despite the economic and production aspects, the influence of port infrastructure on cargo flows in a port cannot be denied. This is because an adequate and quality port infrastructure will connect the maritime transportation and inland transportation to international trade networks. Without adequate infrastructure, a port will not be able to attract enough customers to use its services, and thus, it will not be able to sustain or even balance the cargo flows at the port. Although this aspect was not ranked as the highest contributing factor, this finding, however, was almost consistent with the finding of a study by Sohn and Jung (2009), who found a positive influence of port size (i.e. a factor of port infrastructure) on cargo traffic in several Asian ports.

As for the other factors involved, their influence on cargo flows at a port should not be overlooked because different kinds of ports might be influenced by different kinds of factors, depending of the related environment and background of that particular port. The contributions of the factors involved to a particular kind of port need to be assessed specifically to identify the major determinants of cargo flow imbalances in that port. By means of this approach, all the plans and strategies by the government or port-related authorities (i.e. port authority, port operators, terminal operators, etc.) can be drafted adequately to address those situations that might be unfavourable for port operations. In this sense, the contributions of major factors has also highlighted the potentials of underlying sub-factors within each major factor in affecting the cargo balances at large-scale minor ports in Malaysia. In future, this study can be extended and examined in a systematic way according to the scenario.

5. Conclusion

In conclusion, the objective of this study was successfully achieved as the main factor contributing to imbalances in cargo flows at large-scale minor ports in Malaysia was identified using the fuzzy AHP. The contribution of each factor to cargo flows in large-scale minor ports in Malaysia was also identified by conducting a proper analysis using the fuzzy AHP, and results showed that the criterion of 'economic factors' was the main contributing factor compared to the other factors.

5.1. Contributions and Implications of the Study

This paper conducted a proper analysis using the fuzzy AHP, and also outlined the systematic steps that were taken. It will enhance the understanding of users with regard to the application of this method in their respective studies. Apart from that, this paper also closes the gap in the literature in relation to the occurrence of imbalances in seaborne cargo flows at ports, where limited studies were conducted on this issue, especially with regard to large-scale minor ports in Malaysia. Hence, the findings of this study highlighted the major factors that contribute to the occurrence of such a situation in ports, particularly in the developing ports.

In addition, the contribution of this paper can also be expanded to assist decision-makers and policymakers in arriving at any decision before making further plans and executing any strategies. Decision-makers or policymakers can gain valuable insights from the findings of this study, which can help them to adequately support the operations of the relevant ports, whether in terms of investments or policy improvements. In this regard, the relevant ports will gain an advantage in their operations and thus, improve the local economy. In addition, the decision-makers or policymakers may also use the same approach described in this study to evaluate and analyse other problems or sectors that are relevant to them, where appropriate.

Nevertheless, the findings of this study are only limited to the context of large-scale minor ports in Malaysia, and the outcomes from this study may not be similar to the findings of studies

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conducted in other ports. However, the main inputs, such the mentioned factors, can be reanalysed using a similar approach for other ports in other developing countries in order to identify the main contributing factor that is influencing the balance of cargo flows in the respective ports. The application of the emphasised approach can also be useful for investigating various issues either in ports or other industries.

In tracking the actual reasons for such imbalances in cargo flows at large-scale minor ports in Malaysia, an in-depth study could be conducted in future as an extended version of this study. With that, a better picture of the actual causes of the imbalances can be specifically identified to allow port stakeholders to take more intensive measures to reduce or eliminate the impact of such sources.

Conflict of interest declaration

The authors confirm that there are no known conflicts of interest associated with this publication and all the significant industries and financial support for this work have been addressed at Acknowledgement section in the manuscript.

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Appendix A. Appendix

See Fig. 1 and Tables 1, 2 and 4.

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