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ORIGINAL ARTICLE

A two-dimensional approach to assessing the impact of port selection factors on port competitiveness using the Kano model

Hokey Min[1] · Byung-In Park[2]

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Abstract

In the global supply chain, a seaport, as an important part of the intermodal network, plays a pivotal role in linking exporters and importers. In this context, carriers and shippers are no longer selecting a port per se, but rather looking at it as an integral part of the supply chain. That is to say, port users may no longer measure port attractiveness solely by traditional attributes such as port infrastructure, geographical features, prices, and services. Instead, they may place more value on a port's ability to add value to the global supply chain process and its adaptability to changing business environments. Considering this port paradigm shift with growing complexity, this paper proposes a Kano model to identify multidimensional, nonlinear port selection attributes, including intermodal network accessibility and service route diversity. Such identification will help port service providers, such as port authorities and terminal operating companies, develop wise port marketing and investment strategies. To validate the rigor and usefulness of our model, we experiment with survey data collected from the users of three major hub ports—Busan, Incheon, and Gwangyang in Korea—serving the Asia–Pacific market.

Keywords Port selection · Asia–Pacific shipping market · Kano model · Importance–performance analysis

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✉ Byung-In Park
bipark@chonnam.ac.kr

1 James R. Good Chair in Global Supply Chain Strategy, Department of Management, College of Business, Bowling Green State University, Bowling Green, OH 43403, USA

2 Department of Logistics and Transportation, Chonnam National University, 50 Daehak-ro, Yeosu, Chonnam 59626, Korea

1 Introduction

As of 2017, there exist 8292 seaports and inland ports in 222 countries across the world (Ports.com 2018). Depending on their role in the port or container network, ports can be divided into hub ports and feeder ports. Generally, a hub port is a transshipment center that is connected to a large number of smaller ports, including feeder ports, in a hub-and-spoke transportation network. A feeder port is a port that is not large enough physically or in terms of freight demand to handle large container vessels, thus playing a role in connecting large container ports to smaller ones by transferring containers from a large vessel (or main liner) to a number of smaller feeder vessels (Robinson 1998; Veldman and Bückmann 2003; Chang et al. 2008). Given these diverse classifications, port selection is an onerous task. In fact, a multitude of factors can influence a port selection decision. They include port location, cost (including cargo handling charges), infrastructure, congestion, berth availability, port dwell time, cargo volume, quality of port services, multimodal connectivity, and feeder links (Murphy et al. 1992; Murphy and Daley 1994; Malchow and Kanafani 2001; Lirn et al. 2004; Ugboma et al. 2006; Chang et al. 2008; Sanchez et al. 2011; Martínez and Feo 2017). In addition to these well-known factors, a variety of service routes that can influence supply chain connectivity should be factored into the port selection decision. To make the port selection decision even more complicated, some of these factors can be in conflict with each other. For example, a port equipped with better infrastructure may increase its charges to recover infrastructure development costs.

Considering the complexity involved in the port selection decision, we propose a mathematical model, built upon a Kano model, which is useful for identifying and then prioritizing a variety of port selection factors in terms of their relative importance to port user satisfaction. The Kano model proposed by Kano et al. (1984) is a service development tool that abandons a strictly linear view of the impact of service attribute-performance on customer satisfaction, in favor of identifying the particular attributes that have the potential to elicit customer satisfaction or dissatisfaction (Löfgren and Witell 2008; Mikulić and Prebežac 2011). Put simply, the Kano model helps explain the significance of different quality attributes for customers by enabling firms to classify and understand the effects of different quality attributes on customer satisfaction. This paper proposes the Kano model in an attempt to weigh the relative importance of port selection factors by assessing their impact on port user satisfaction. In addition, the main objectives of this paper are:

(1) To help port service providers such as port authorities and terminal operating companies formulate sensible competitive strategies, maximizing port user satisfaction and port revenue;
(2) To analyze the characteristics of port selection factors based on the modified Kano model and the refined importance–performance analysis (IPA);
(3) To uncover any functional relationships between the port selection factors and the carrier's port choice behavior.

2 Relevant literature

A port selection decision has a profound impact on the efficiency of the global supply chain. For instance, the wrong location of a selected port can limit a port user's accessibility to distribution centers and terminals, which are essential for transshipment and storage. Similarly, the selected port and related infrastructure can dictate the port user's access to qualified workforces, navigation channels, foreign trade zones (FTZs), and intermodal transfers, which in turn may affect port services and their reliability. In addition, restrictions on cargo weight, vehicle dimensions (length, height, width), and operating hours, along with regulations on carbon footprints and routes into and out of the port, can adversely influence port services and lead to supply chain disruptions. Due to the inherent complexity of port selection dynamics, port selection has been a popular subject of maritime logistics studies (Yeo et al. 2014; Moya and Valero 2017). Some of the more important studies on port selection include Slack (1985), Murphy et al. (1992), and Murphy and Daley (1994), who conducted empirical studies to identify a number of situational port selection factors.

Following suit, Malchow and Kanafani (2001) developed a multinomial logit model to explain how a port was selected for the shipping of four different types of commodities exported from the United States. Lirn et al. (2004) conducted Delphi surveys to identify 47 port service attributes, and narrowed down those attributes into four criteria. The authors then applied the analytic hierarchy process (AHP) to select the most attractive port among six major container ports. One of their key findings was that both global container carriers and port service providers surveyed had a similar perception of the most important service attributes for transshipment port selection. Using a similar AHP method, Ugboma et al. (2006) identified six port selection criteria and then weighed their relative importance in selecting the best among four Nigerian ports. These authors found that shippers placed an emphasis on efficiency, frequency of ship visits, and adequate infrastructure when selecting a port. Guy and Urli (2006) proposed a multicriteria analysis to examine whether the accepted rationale of port selection by shipping lines—based on the combined importance of quality of infrastructure, cost, service, and geographical location—was useful in explaining the port choice behavior observed in selected North American ports. Chou (2007) presented a fuzzy multiple-criteria decision-making method (FMCDM) for selecting the best transshipment container port in terms of cost reduction opportunities. The other follow-up studies, using the multiple-criteria decision-making (MCDM) method or the AHP for port selection, include Yang et al. (2009), Onut et al. (2011), Park and Min (2011), Bagočius et al. (2013), Lirn et al. (2015), Gohomene et al. (2016), Mittal and McClung (2016), and De Icaza and De Parnell (2018).

Considering that *port choice behavior* may vary depending on port user perspectives, a number of prior studies have attempted to determine user preferences (priorities) for certain port selection factors. For example, Nir et al. (2003) presented a preference multinomial logic model to examine port choice behavior among shippers in Taiwan. The authors used data collected from three international Taiwanese ports to ascertain shippers' preferences (e.g., port service, routes, and cost) in selecting container ports. Similarly, based on a survey of containerized cargo shippers in China, Tiwari et al. (2003) developed a discrete choice model to understand how port characteristics affected the port choice behavior of shippers. The characteristics they considered included the frequency of ship calls, the total volume (in twenty-foot equivalent units [TEU]) of cargo handled by the port, number of berths and cranes, water depth, routes offered by the port, hauling volume, port dues, loading charges, and geographical distances. They observed that the distance of the port from the shipper was an important determinant of port choice, but the total volume of cargo handled by the port was not a significant factor.

From a carrier's perspective, Wiegmans et al. (2008) investigated how deep-sea container operators select container ports and container terminals in the Hamburg–Le Havre area. The authors observed that the most important port selection criteria were the availability of hinterland connections, reasonable tariffs, and immediacy of consumers (large hinterland). From the freight forwarder's perspective, Tongzon (2009) identified the relative importance of various port selection factors including port efficiency, calling frequency, adequate infrastructure, location, port charges, quick response to port user needs, and record of cargo damages. By analyzing data from Southeast Asia freight forwarders in Malaysia and Thailand, the authors concluded that port efficiency was the most important factor in port choice. In contrast, De Langen (2007) analyzed the port choice behavior of both shippers and carriers (actually freight forwarders) in Austria's contestable hinterlands, and discovered that shippers and forwarders had similar views on port selection, in that both port users valued their perceived port quality and price for port choice, but shippers had a less price-elastic demand. In other words, shippers were less willing to accept lower service levels and less eager to change ports for lower prices. Knowing the heterogeneity of different port users and their perceived preferences, Garcia-Alonso and Sanchez-Soriano (2009) employed the discrete choice model to analyze the actual inter-port traffic distribution that revealed port selection patterns of port users, instead of surveying their perceived importance of port selection factors. More recently, Gohomene et al. (2016) learned that port infrastructure and port draught were the two most important factors in port choice among liner companies serving West Africa.

Regardless of the aforementioned pioneering attempts, the existing literature on port selection, summarized in Table 1, does not necessarily reflect the complexity of port selection decisions and the diversity of port characteristics, which often vary from one port (region) to another. As such, most of the prior literature reflected the views of only particular groups of port users or identified port selection factors for a particular set of ports in a certain region or country. In addition, the main fallacy in all prior studies was their premise that every port selection factor has an equal impact on the actual port selection decision, thereby ignoring the potentially nonlinear relationship between port selection factors and the actual port selection decision. In other words, all prior studies have assumed that every port selection factor has equal weight in port selection decisions, regardless of its importance or role in enhancing port attractiveness.

Table 1 A summary of selected prior literature on port selection

Author(s)	Key factors	Port type	Methodology
Murphy et al. (1992)	Cargo damage, infrastructure	Gateway	Importance ranking
Lirn et al. (2003)	Location, charges, infrastructure	TS	Delphi, AHP
Veldman and Bückmann (2003)	Transit time, location cost, frequency, intermodality	Gateway	Multinomial logit
Lirn et al. (2004)	Location, charges, infrastructure	TS	AHP
Tai and Hwang (2005)	Location cost, location, efficiency, frequency, charges, infrastructure	TS	Gray decision model
Guy and Urli (2006)	Location, charges, infrastructure	TS	MCDM
Ng (2006)	Location, efficiency, reputation, cargo damage, charges, infrastructure	TS	Average scores, *t* test
Tongzon and Sawant (2007)	Location, efficiency, charges, infrastructure	Gateway	Binary logit
Chang et al. (2008)	Location, reputation, intermodality, charges, infrastructure	Gateway	Mean value, *t* test, EFA, CFA
Wiegmans et al. (2008)	Location, efficiency, reputation, intermodality, charges, infrastructure	Gateway/TS	Importance ranking
Yeo et al. (2008)	Distance, location cost, congestion, quick response to customers' needs, intermodality, infrastructure	Gateway/TS	EFA
Anderson et al. (2009)	Distance, transit time, location, cost	Gateway	Nested logit
Tongzon (2009)	Location, efficiency, cargo damage, quick response to customers' needs, frequency, charges, infrastructure	Unknown	Regression
Chou (2010)	Location cost, efficiency, frequency, intermodality, charges, infrastructure	Gateway/TS	AHP
Caillaux et al. (2011)	Transit time, cost, efficiency, charges	TS	Ordinal Copeland method, DEA
Park and Min (2011)	Location, charges, infrastructure	TS	Hybrid DEA/AHP
Yeo et al. (2011)	Distance, location cost, congestion, quick response to customers' needs, intermodality, infrastructure	Unknown	Fuzzy AHP
Tang et al. (2011)	Efficiency, frequency, intermodality, charges, infrastructure	Gateway/TS	NICE, Multinomial logit
Yuen at al. (2012)	Location, efficiency, frequency, intermodality, charges, infrastructure	Gateway/TS	AHP
Da Cruz et al. (2013)	Location, efficiency, intermodality, infrastructure	Gateway/TS	AHP
Ng et al. (2013)	Distance, cost, efficiency, charges	Gateway	Importance ranking

TS transshipment port, *AHP* analytical hierarchy process, *DEA* data envelopment analysis, *MCDM* multiple-criteria decision-making, *EFA* exploratory factor analysis, *CFA* confirmatory factor analysis, *NICE* network-based integrated choice evaluation

To fill the void left by prior literature discussed above, this paper develops a Kano model that aims to structure port users' needs and assess their impact on the port selection decision in the presence of multiple and conflicting influencing factors in dynamically changing maritime environments.

3 A Kano model framework

To identify and distinguish port characteristics that will motivate port users to select a particular port, we adopted and modified the Kano model of *attractive quality* as a theoretical framework. Built on Herzberg's motivation–hygiene theory, which determines factors causing employee job satisfaction and dissatisfaction (Herzberg, 1987), Kano et al. (1984) categorized five different types of customer satisfaction for product and service quality that are essential for a firm's success. These are (1) must-be requirements, (2) one-dimensional requirements, (3) attractive requirements, (4) reversal quality, and (5) indifferent quality.

Must-be requirements (expected quality) are the minimum prerequisites (basic needs or threshold) acceptable to customers and encompass those quality attributes that customers take for granted and do not even think about. If these requirements are unfulfilled, the customer will be extremely dissatisfied and likely to complain that these qualities are missing. As such, must-be requirements are a decisive competitive factor (Sauerwein et al. 1996; Mikulić and Prebežac 2011). One-dimensional requirements (desired quality) represent consciously stated needs. The customer can consciously notice their presence, whereas they may feel their absence as a disappointment or as a disadvantage. Attractive requirements (exciting quality or delighters) are those features (latent needs) that delight customers and inspire their loyalty. Since customers are usually unaware of attractive requirements, they will not miss them when they are not provided (Nilsson-Witell and Fundin 2005). However, over time and imitation by others, attractive requirements can become one-dimensional requirements, and one-dimensional requirements can migrate towards must-be requirements (Revell 1998). In other words, product and service quality attributes are dynamic, and over time an attribute will evolve from being attractive to being one-dimensional, and finally to a must-be requirement. Adding two more levels of requirements, "reverse quality" expresses a situation where the higher the level of fulfilment of an attribute, the more dissatisfied is the customer. For example, some customers prefer a smartphone with many additional features such as panoramic picture capabilities and group calls, while others prefer a simple function (e.g., voice recording) and will be dissatisfied with a smartphone that has too many extra features and options. If a requirement is classified as an "indifferent quality" feature, the degree of satisfaction is not influenced by the state of fulfilment of that attribute (Nilsson-Witell and Fundin 2005). These five levels of customer requirements are graphically displayed in Fig. 1. As discussed above, the Kano model shies away from a strictly linear view of the impact of product/service quality attribute-performance on customer satisfaction in favor of identifying the particular attributes that have the potential to elicit customer satisfaction/delight or dissatisfaction/frustration (Mikulić and Prebežac 2011). Therefore, the Kano model is a two-dimensional grid, based on customer-perceived importance of quality attributes and attribute performance

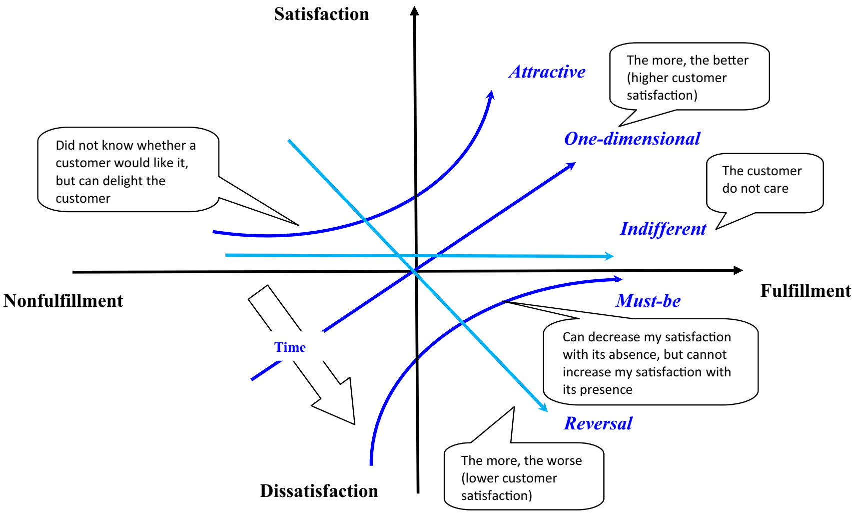

Fig. 1 The underlying Kano model framework

(Matzler et al. 2004). Depending on the interplay of these two dimensions, the firm can derive appropriate strategies for enhancing customer satisfaction.

4 Model assumptions

Prior to developing the Kano model, we make the following underlying assumptions.

(1) Port user (customer) expectations or needs can change over time, and thus port user (customer) satisfaction with port services or features can deteriorate over time.
(2) Respondents (port users) to the Kano questionnaire know exactly what they liked and disliked before receiving the questionnaire survey, and their cognitive biases were minimal.
(3) Not all port characteristics (features) play the same role in satisfying port user needs, and thus some port characteristics can be prioritized over others by port users.
(4) Port users' satisfaction ratings are reliable indicators of port service performance.
(5) Port selection factors are multidimensional.

5 A Kano model design for port selection

The Kano model is designed to offer insight into the product/service attributes that customers perceive as important. As such, it has been primarily used to gauge the level of customer satisfaction with certain product or service offerings. For various applications of the Kano model including marketing, new product development, tourism, quality function deployment, website development, hospitality, health care, restaurant services, airline services, and manufacturing technology, the interested reader should refer to Yang (2005), Rashid (2010), Bilgili et al. (2011), Basfirinci and Mitra (2015), Materla et al. (2017), and Pai et al. (2018). The interested reader should also refer to Mikulić and Prebežac (2011), who introduced various techniques for classifying quality attributes in the Kano model. In our port selection case, the Kano model application process is diagramed in Fig. 2.

Following the process shown in Fig. 2, we first listened to the voices of port users and service providers for their opinions about *port attractiveness* through the telephone questionnaire surveys and in-person interviews. Instead of using traditional mail surveys, we chose a survey methodology based on telephone and in-person interviews to reduce non-responses. Before conducting surveys, we asked each potential respondent whether they were willing to participate in our surveys after explaining the main purposes of our study. These opinions are reflected in their responses to the Kano questionnaire illustrated in the Appendix. These responses have both positive and negative tones.

Based on the port user or service provider responses to both positive and negative questions, we can evaluate current port performance in the manner described in Table 2. This evaluation would allow us to determine the extent of the impact of each port attribute (port selection factor) on port performance. With five positive and five negative questions, there are 25 combinations of possible answers. As Table 2 illustrates, if a port user or service provider response to positive questions is "must-be" and their response to negative questions is "dislike," their evaluation (in terms of their satisfaction level) of the port service is considered "must-be." In a situation where the port user or service provider response to both positive and negative questions is "dislike," and thus does not make logical sense, such a response is considered "questionable."

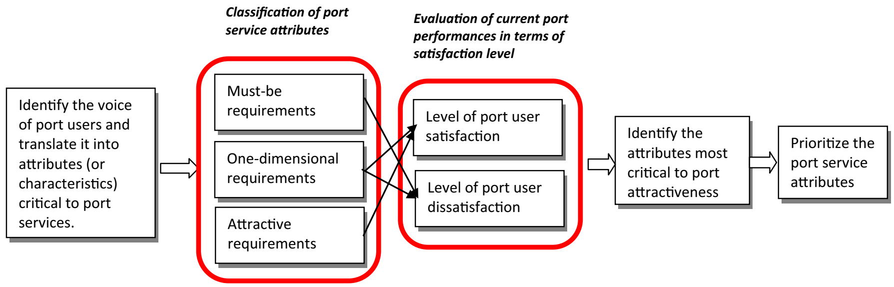

Fig. 2 The Kano model process

Table 2 The evaluation of port selection factors using the Kano questionnaire

Customer requirements → ↓		Dysfunctional (negative) question				
		1. like	2. must be	3. neutral	4. live with	5. dislike
Functional (positive) question	1. like	Q	A	A	A	O
	2. must-be	R	I	I	I	M
	3. neutral	R	I	I	I	M
	4. live with	R	I	I	I	M
	5. dislike	R	R	R	R	Q

Customer requirement is ...

A: Attractive
M: Must-be
R: Reverse
O: One-dimensional
Q: Questionable
I: Indifferent

According to Berger (1993), the extent (level) of customer (port user) satisfaction is calculated as:

$$\text{Extent of satisfaction} = (\mathrm{A} + \mathrm{O})/(\mathrm{A} + \mathrm{O} + \mathrm{M} + \mathrm{I}) \tag{1}$$

$$\text{Extent of dissatisfaction} = (\mathrm{O} + \mathrm{M})/(\mathrm{A} + \mathrm{O} + \mathrm{M} + \mathrm{I}) \times (-1) \tag{2}$$

In Eq. (2), it is noted that a negative sign (−1) for the customer satisfaction coefficient (CSC) represents the adverse impact on the level of port user satisfaction and the subsequent port performance (or attractiveness). Before identifying port characteristics (attributes) critical to port performance, we considered a multitude of port characteristics that could affect port performance evaluation. These are listed in Table 3.

Since port selection factors listed in Table 3 are too numerous and thus could complicate the port performance evaluation, we trimmed them down to a manageable 12 categories by extracting the most common factors among the 49 that were considered in the prior literature on port selection (e.g., Slack 1985; Murphy et al. 1992; Murphy and Daley 1994; Nir et al. 2003; Chang et al. 2008; Sanchez et al. 2011; Martínez and Feo 2017). We chose these categories based on a preliminary survey of port stakeholders in Korea. These stakeholders include five port administrators representing the Gwangyang Port in Korea; three terminal operating companies (TOCs) SM, KIT, CJ; and nine carriers (HMM, Sinokor, PanOcean, Namsung, Heunga, KMTC, YangMing, APL, Maersk). These categories are summarized in Table 4.

5.1 A case study and Kano model application

To demonstrate the validity and practicality of the proposed Kano model in developing effective port selection strategies, we applied it to an actual problem encountered

Table 3 Potential port selection factors

Attributes	Attributes	Attributes
Traffic volume and throughput	Port service coverage	Port tradition and organization
Containerized cargo proportion	Economic size of local and regional market	Quality of customs handling
Geographical merit	Vessel berthing capacity of port	Port authority policy and regulations
Major container center	Sufficiency and quality of port equipment	Container handling efficiency
Frequencies of feeder vessels	Cargo handling system support	Flexible operation process
A variety of service routes	State-aided and influence on cost	Reliability of cargo handling
Competitiveness and diversity of other modes	Cost for terminal handling and storage	Port marketing
Deviation from trunk routes	Free dwell time	Length of port berthing time
Short transit time	Related business operation	Port productivity
Proximity to alternative port	Privileged ownership contract to carrier	Port safety and security
Intermodal links and network accessibility	Balance of inbound and outbound cargo	Port recognition and reputation
Frequency of trunk routes	Calling of alliance members	Prompt response to claim and request
Depth of the port	Calling of competitors	Supporting services
Size of port and terminal	Port dues	Cargo handling safety
Infra- and superstructure of port	Port incentive scheme	Speedy cargo handling
Port information system	National stability (politics, society, labor, etc.)	Quality and availability of staff
Cost for inland transportation		

Table 4 Key categories of port characteristics used for port selection

Code	Port selection factors	Code	Port selection factors
SF01	Traffic volume and throughput	SF07	Cost for terminal handling and storage
SF02	A variety of service routes	SF08	Port dues
SF03	Intermodal links and network accessibility	SF09	Cost for inland transportation
SF04	Depth of the port	SF10	Reliability of cargo handling
SF05	Size of the port and terminal	SF11	Speedy cargo handling
SF06	Sufficiency and quality of port equipment	SF12	Quality and availability of Staff

by three major hub ports in Korea: Incheon (IC), Gwangyang (GY), and Busan (BS). To determine the extent of the impact of port selection factors on port performance (attractiveness) listed in Table 4, we conducted a Kano response survey during the period May 22 through June 9, 2017. The survey questionnaire was distributed to 47 potential respondents comprising selected port service providers and users. The identities of these respondents are provided in the Appendix. Their survey results are summarized in Table 5.

As Table 5 indicates, with the exception of two factors (SF01-traffic volume and throughput, and SF05-size of port and terminal), the respondents believed that the factors had a one-dimensional relationship with port user satisfaction levels. In other words, those factors have a direct positive impact on port user satisfaction. On the other hand, respondents were indifferent to port traffic volume (port traffic flow during a given time period), throughput (the average quantity of cargoes that pass through a port on a daily basis from arrival at the port to loading onto a ship), and

Table 5 Summary of the Kano survey results

Factor code	(Original) Kano model						Satisfaction coefficients		
	A	O	M	I	R	Final evaluation	Satisfaction level	Dissatisfaction level	Final evaluation
SF01	7	9	10	13	1	Indifferent	0.4103	− 0.4872	Indifferent
SF02	3	20	3	14	0	One-dim.	0.575	− 0.575	One-dim.
SF03	1	16	9	13	1	One-dim.	0.4359	− 0.641	Must-be
SF04	6	17	7	10	0	One-dim.	0.575	− 0.6	One-dim.
SF05	5	13	5	17	0	Indifferent	0.45	− 0.45	Indifferent
SF06	8	18	5	9	0	One-dim.	0.65	− 0.575	One-dim.
SF07	3	22	6	9	0	One-dim.	0.625	− 0.7	One-dim.
SF08	2	20	4	14	0	One-dim.	0.55	− 0.6	One-dim.
SF09	2	20	7	10	1	One-dim.	0.5641	− 0.6923	One-dim.
SF10	2	19	8	11	0	One-dim.	0.525	− 0.675	One-dim.
SF11	5	23	8	4	0	One-dim.	0.7	− 0.775	One-dim.
SF12	4	18	7	11	0	One-dim.	0.55	− 0.625	One-dim.

A attractive, *O* one-dimensional, *M* must-be, *I* indifferent, *R* reverse size of the port in selecting a particular port. However, the perceived importance of port selection factors differed depending on the varying roles of the respondents. We broke down their responses into three different perspectives (port authorities, terminal operating companies and carriers). Figure 3 shows the perceptual map of port selection factors from the carrier's perspective. It indicates that carriers regarded SF03 (intermodal links and network accessibility) and SF05 (size of the port and terminal) as "must-be" categories. That is to say, other things being equal, greater intermodal links, easier access to the intermodal network, and larger port and terminal size do matter in the port selection decision. However, those factors are not decisive for port selection.

To examine how port service providers perceive the role of port selection factors, we analyzed the Kano survey results of the port authorities of the three Korean ports mentioned above. As shown in Fig. 4, port authorities felt that SF05 (size of port and terminal) would not matter for port selection, while SF03 (intermodal links and network accessibility), SF09 (cost for inland transportation), and SF10 (reliability of cargo handling) would matter for port selection, even though they would not be considered deciding factors.

When we asked terminal operating companies to determine the extent of the impact of 12 port selection factors on port attractiveness, they responded that SF01 (traffic volume and throughput), SF02 (variety of service routes), SF04 (depth of the port), SF05 (size of the port and terminal), and SF12 (quality and availability

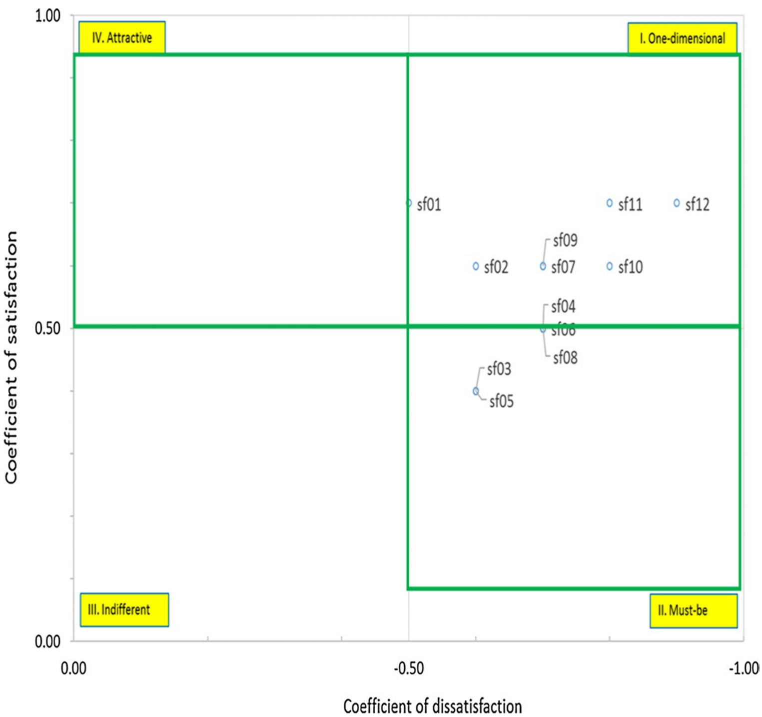

Fig. 3 Perceptual mapping of the port selection factors by the carriers

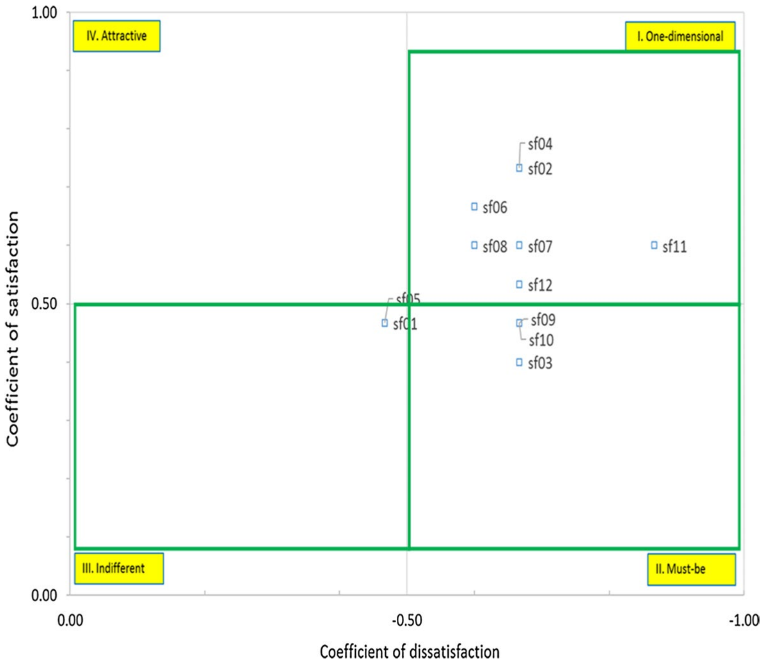

Fig. 4 Perceptual mapping of the port selection factors by the port authorities

of staff) would not influence port attractiveness. On the other hand, they believed that SF06 (sufficiency and quality of port equipment) would be the most influencing (deciding) factor for port attractiveness (Fig. 5).

Table 6 presents a bird's-eye view of differences in the perceived roles of port selection factors in enhancing port attractiveness (performance). As summarized in this table, there were marked differences in the perceived importance of selection factors between the port users and the port service providers. The presence of such differences can be a source of service gaps between service providers and users, and thus they can influence port performance and subsequent port competitiveness. To reduce such gaps by enhancing port user satisfaction and thus port attractiveness, we propose a port competitive strategy in the following section.

6 Development of port competitive strategy based on Kano evaluation

Prior to developing the port competitive strategy, we carried out an importance–performance analysis (IPA) to take into account the relative importance of port selection factors to the overall port evaluation decision. Generally, IPA is a useful tool for developing firm strategy, since it can facilitate data analysis interpretation through the use of a two-dimensional grid and subsequently provide guidelines for the firm's resource allocation (Martilla and James 1977). IPA

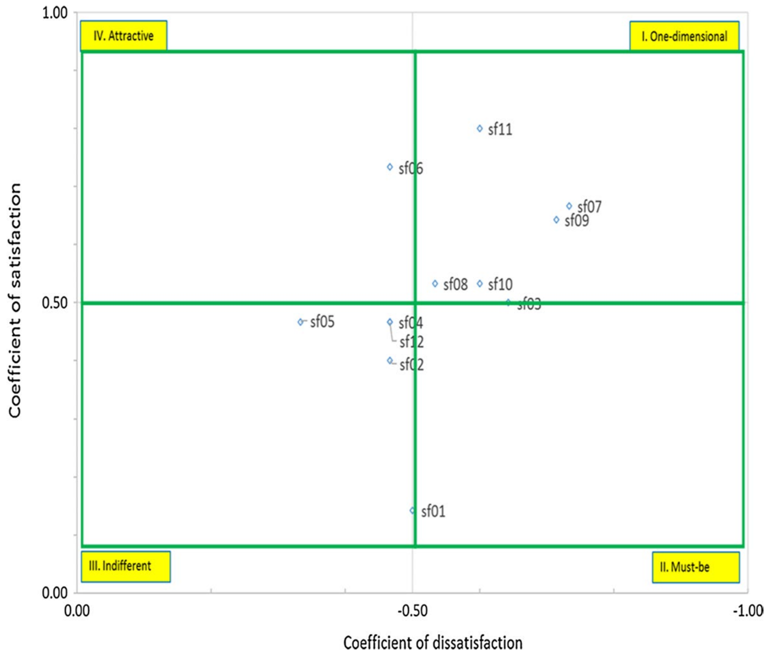

Fig. 5 Perceptual mapping of the port selection factors by the terminal operating companies

typically comprises four guidelines: "keep up the good work," "possible overkill," "low priority," "concentrate here." The port selection factors, which belong to "keep up the good work" categories (high importance/high performance), indicate that those factors are important and their importance was recognized by the respondents. The port selection factors belonging to "possible overkill" categories (low importance/high performance) indicate that those factors are unimportant, but their importance is exaggerated (or overvalued) by the respondents. The port selection factors belonging to "low priority" categories (low importance/low performance) indicate that those factors are unimportant, and the respondents recognize their insignificance. The port selection factors belonging to "concentrate here" categories (high importance/low performance) indicate that those factors are important, but respondents underestimate their significance (Martilla and James 1977; Wong et al. 2011).

As part of IPA, we have first measured the relative importance of 12 port selection factors to port evaluation, based on the recent study by Yun (2017), who weighed such importance using the analytic hierarchy process (AHP). Table 7 summarizes the relative importance of the 12 port selection factors to port attractiveness on a scale of 0 to 1. Higher scores indicate greater importance.

In an effort to develop a competitive strategy relevant to each port and its stakeholders, we conducted a survey of port stakeholders and asked them to rate their perceived level of satisfaction for each port performance with respect to each port selection factor on a five-point Likert scale. The survey results are summarized in Table 8.

Table 6 An overall summary of the Kano factor evaluation from different perspectives

Evaluation	Overall perspective	Carrier perspective		Service provider perspective	Port authority perspective	Terminal operating company perspective
Attractive						SF06
Att-one		SF01	Traffic volume and throughput			
One-dimensional	SF02	SF02	Variety of service routes	SF02	SF02	SF07
	SF04	SF07	Cost for terminal handling and storage	SF04	SF04	SF08
	SF06	SF09	Cost for inland transportation	SF06	SF06	SF09
	SF07	SF10	Reliability of cargo handling	SF07	SF07	SF10
	SF08	SF11	Speedy cargo handling	SF08	SF08	SF11
	SF09	SF12	Quality and availability of staff	SF09	SF11	
	SF10			SF11	SF12	
	SF11					
	SF12					
Ond_MB		SF04	Depth of the port	SF10SF12		SF03
		SF06	Sufficiency and quality of port equipment			
		SF08	Port dues			
Must-be	SF03	SF03	Intermodal links and network accessibility	SF03	SF03	
		SF05	Size of port and terminal		SF09	
					SF10	
MB_Ind						SF01
Indifferent	SF01			SF01	SF01	SF02
	SF05			SF05	SF05	SF04
						SF05
						SF12

Att_One The borderline between attractive and one-dimensional, *OnD_MB* the borderline between one-dimensional and *Must-be*, *MB_Ind* the borderline between must-be and indifferent

Table 7 The relative importance of port selection factors to port attractiveness

Factor code	Description	Carriers	Port authorities	Terminal operating companies
SF01	Traffic volume and throughput	0.1573	0.1386	0.1906
SF02	Variety of service routes	0.1058	0.217	0.1326
SF03	Intermodal links and network accessibility	0.0751	0.1024	0.1449
SF04	Depth of the port	0.0361	0.0257	0.0278
SF05	Size of port and terminal	0.0719	0.0552	0.0286
SF06	Sufficiency and quality of port equipment	0.0531	0.0281	0.0232
SF07	Cost for terminal handling and storage	0.2012	0.1278	0.1554
SF08	Port dues	0.0612	0.044	0.0466
SF09	Cost for inland transportation	0.0643	0.1212	0.1095
SF10	Reliability of cargo handling	0.0556	0.0667	0.0459
SF11	Speedy cargo handling	0.081	0.0513	0.0604
SF12	Quality and availability of staff	0.0373	0.022	0.0344
Total		1	1	1

Source: Yun (2017)

By combining the results in Tables 7 and 8, we obtain the IPA results for each port summarized in Fig. 6a–c. Figure 6a indicates that all three stakeholders viewed SF01 (traffic volume and throughput) and SF02 (variety of service routes) as the high importance/high performance category. Thus, SF01 and SF02 are essential for enhancing the competitiveness of the Busan port. Since multiple stakeholders categorized SF03 (intermodal links and network accessibility), SF07 (cost for terminal handling and storage), and SF09 (cost for inland transportation) as the high importance/low performance category, those factors deserve more attention and need greater improvement from the Busan port. On the other hand, since all three stakeholders categorized SF08 (port dues) as low priority, any effort to reduce port dues will be fruitless towards enhancing the competitiveness of the Busan port. Also, any additional efforts (including investment) to improve SF04 (depth of the port), SF05 (size of the port and terminal), SF06 (sufficiency and quality of port equipment), SF10 (reliability of cargo handling), SF11 (speedy cargo handling), or SF12 (quality and availability of staff) will not pay off and thus are not needed for enhancing the competitiveness of the Busan port. In other words, any additional investment in improving those factors will be wasted.

However, it should be noted that the IPA category would vary from one port to another as shown in the IPA grids in Fig. 6b, c. That is to say, we need to develop different competitive strategies for different ports due to varying importance/performance categories.

By combining the results of the Kano models and IPA grids discussed earlier, we present Table 9, which specifies competitive strategies most relevant to each port. To elaborate, we note the discrepancy between the perceived importance–performance evaluation of the Busan port service providers (i.e., port authority and terminal

Table 8 A summary of the port performance ratings in terms of satisfaction level

Factor Code	Description	Carriers			Port authorities			Terminal operating companies		
		BS	IC	GY	BS	IC	GY	BS	IC	GY
SF01	Traffic volume and throughput	4.6522	3.4783	3.0435	4.9333	3.5333	2.9333	4.8	3.4667	3.0667
SF02	Variety of service routes	4.8696	2.8696	3	5	3	2.8	4.8	3.4667	2.8667
SF03	Intermodal links and network accessibility	4.3913	3.5217	3.3478	4.1333	4.4	2.9333	4.4	3.8667	3.0667
SF04	Depth of the port	4.3043	3.0435	4	4.6667	2.8667	4.4	4.7333	3.3333	3.7333
SF05	Size of port and terminal	4.6522	3.3043	3.8261	4.9333	3.4	3.8	4.7333	3.3333	3.6
SF06	Sufficiency and quality of port equipment	4.3913	3.3043	3.5652	4.7333	3.2667	3.6	4.8	3.4667	3.8667
SF07	Cost for terminal handling and storage	3.6522	3.1304	4.0435	4.0667	3.4	4.1333	3.7333	3.2	3.8667
SF08	Port dues	3.7391	3.2609	4.1304	4	3.5333	4.2667	3.8	3.5333	3.5333
SF09	Cost for inland transportation	3.7826	3.1739	3.4783	3.7333	4.4	3.2	3.6	3.8667	3.2667
SF10	Reliability of cargo handling	4.5217	3.5217	3.9565	4.8	3.8	3.7333	4.4	3.9333	4
SF11	Speedy cargo handling	4.3478	3.2609	3.3913	4.5333	3.4667	3.8667	4.4	3.6667	3.9333
SF12	Quality and availability of staff	4.3913	3.6522	3.7391	4.4	3.6	3.7333	4.5333	3.7333	3.7333

BS Busan Port, *IC* Incheon Port, *GY* Gwangyang Port

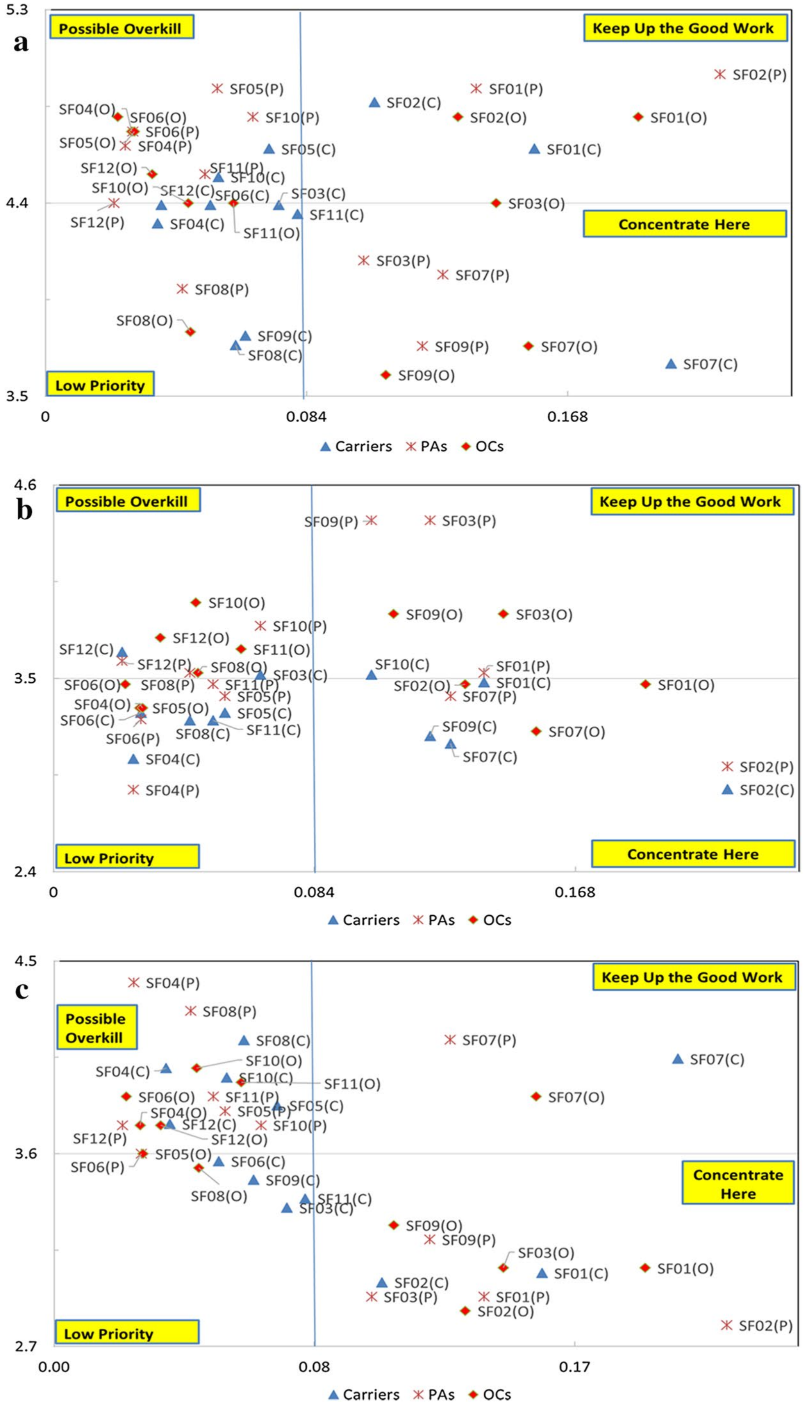

Fig. 6 **a** The IPA result for the Busan Port. PA = port authorities, OC = terminal operating companies. **b** The IPA result for the Incheon Port. **c** The IPA result for the Gwang Yang Port

Table 9 A summary of the competitive strategy for each port

KANO	Factor	Busan			Incheon			Gwangyang		
		Carriers	PAs	OCs	Carriers	PAs	OCs	Carriers	PAs	OCs
A_O	SF01	K	K	K	C	K	C	C	C	C
One D.	SF02	K	K	K	C	C	C	C	C	C
M-B	SF03	P_L	C	C_K	P	K	K	L	C	C
O_M	SF04	L	P	P	L	L	L	P	P	P
M-B	SF05	P	P	P	L	L	L	P	P	P_L
O_M	SF06	L	P	P	L	L	L	L	P_L	P
One D.	SF07	C	C	C	C	C	C	K	K	K
O_M	SF08	L	L	L	L	P	P	P	P	L
One D.	SF09	L	C	C	C	K	K	L	C	C
One D.	SF10	P	P	P	K	P	P	P	P	P
One D.	SF11	L	P	P_L	L	L	P	L	P	P
One D.	SF12	L	P_L	P	P	P	P	P	P	P

A_O: Attractive and One Dimensional, One D.: One Dimensional, M-B: Must-Be, O_M: One Dimensional and Must-Be

C: Concentrate Here, K: Keep Up the Good Work , P: Possible Overkill, L: Low Priority

operating companies) and that of port users (i.e., carriers) as displayed in Table 9. For example, the Busan port service providers viewed SF03 (intermodal links and network accessibility) as either high importance/high performance or high importance/low performance IPA categories, whereas the port users regarded this factor as the borderline of the low importance/low performance and low importance/high performance categories. Thus the Busan port service providers were likely to over-invest their efforts and resources in a port attribute (e.g., intermodal links and network accessibility) that was considered unimportant by the port users. Similarly, the Busan port service providers might have expended far too much effort on controlling SF03 (intermodal links and network accessibility) and SF09 (cost for inland transportation). In the case of the Incheon port, the port service providers might have overinvested their efforts and resources in improving the port's intermodal links and network accessibility and in reducing cost for inland transportation, while neglecting the high importance of SF10 (reliability of cargo handling). In other words, the Incheon port service providers should have invested more in improving the port's ability to handle cargoes. The Gwangyang port seemed to make strategic errors similar to those of the Busan port service providers. Overall, all three port service providers tended to overvalue the importance of SF03 (intermodal links and connectivity) and SF09 (cost for inland transportation).

7 Concluding remarks and future research directions

This study is one of the first attempts to develop port competitive strategies tailored to the needs of port users, using the Kano model and IPA grids. In particular, the proposed Kano model has allowed us to determine how each port selection factor influences port users' satisfaction levels and thus determines the functional relationship between the port selection factors and satisfaction levels. The knowledge gained from the results of the Kano model experiments will be useful for understanding the specific role of each port selection factor in satisfying the needs of port users and the subsequent attractiveness and competitiveness of each port. With that in mind, the Kano model was applied to an actual situation faced by the three major hub ports in Korea, which can be considered gateway ports to the Northeast Asian shipping market (Min and Guo 2004). After experimenting with the Kano model and conducting its follow-up importance performance analyses (IPAs), we found some intriguing results that are noteworthy.

First, we discovered that the extent of the impact of port selection factors on port user satisfaction levels differed from one factor to another. In other words, the conventional premise that all port selection factors have a one-dimensional, linear relationship between their improvements and port performance was discovered to be untrue. Therefore, port service providers should adjust their investment strategy according to the specific role of each port selection factor in enhancing port performance (attractiveness).

Second, we observed marked differences in perception of port services providers and users when they were asked to determine the relative importance of port selection factors. These differences are likely to create service gaps between service providers and users, leading to lower satisfaction levels among port users. In other words, port service providers' failure to reduce these differences will deteriorate port competitiveness. For instance, the current study revealed that, with the exception of traffic volume and throughput and the size of the port and terminal, port service providers and users never agreed on the relative importance of port selection factors or the extent of the impact on port performance.

Third, based on the IPA results, we learned that all three port service providers tended to overvalue the importance–performance of intermodal links and network accessibility of the port, as well as that of inland transportation cost, thus wasting their efforts and resources in improving those two factors.

Finally, our study revealed that a "one-size-fits-all' strategy for every port service provider would not work well, due to differences in port users' needs in each port. Therefore, port competitive strategies customized for individual ports makes sense. The proposed IPA was useful for formulating a more customized competitive strategy for each port given its visual displays of strategic errors made by port service providers.

Despite these refreshing findings obtained from the combined methodologies of the Kano model and IPA grids, built upon the results of empirical surveys, the current study can be further extended to include:

- Surveys of other international hub port service providers and users for the ports of Hong Kong, Shanghai, Yokohama and Singapore in dynamically changing shipping environments;
- Cross-national comparisons of port users in Korea, Japan, China, the European Union and the United States in their perceived importance–performance of port selection factors;
- Addition of other port selection factors such as environmental regulations, port safety (or security) measures, port information and communication technology (ICT) infrastructure and service support, and hinterland industry clusters affecting the port viability.

Appendix

See Table 10.

Table 10 Structure of the Kano questionnaire

	Survey questions	Questionnaire items	
SF01 Traffic volume and throughput	Positive questions (functional form of questions)	How do you feel if traffic volume and throughput are low?	I like it that way
			I expect it to be that way
			I am neutral
			I can live with it that way
			I dislike it that way
	Negative questions (dysfunctional form of questions)	How do you feel if traffic volume and throughput are high?	I like it that way
			I expect it to be that way
			I am neutral
			I can live with it that way
			I dislike it that way
SF02 A variety of service routes	Positive questions (functional form of questions)	How do you feel if a variety of service routes is low?	I like it that way
			I expect it to be that way
			I am neutral
			I can live with it that way
			I dislike it that way
	Negative questions (dysfunctional form of questions)	How do you feel if a variety of service routes is high?	I like it that way
			I expect it to be that way
			I am neutral
			I can live with it that way
			I dislike it that way

Table 10 (continued)

	Survey questions	Questionnaire items	
SF03 Intermodal links and network accessibility	Positive questions (functional form of questions)	How do you feel if intermodal links and network accessibility are low?	I like it that way
			I expect it to be that way
			I am neutral
			I can live with it that way
			I dislike it that way
	Negative questions (dysfunctional form of questions)	How do you feel if intermodal links and network accessibility are high?	I like it that way
			I expect it to be that way
			I am neutral
			I can live with it that way
			I dislike it that way
SF04 Depth of the port	Positive questions (functional form of questions)	How do you feel if depth of the port is shallow?	I like it that way
			I expect it to be that way
			I am neutral
			I can live with it that way
			I dislike it that way
	Negative questions (dysfunctional form of questions)	How do you feel if depth of the port is deep?	I like it that way
			I expect it to be that way
			I am neutral
			I can live with it that way
			I dislike it that way

Table 10 (continued)

	Survey questions	Questionnaire items	
SF05 Size of the port and terminal	Positive questions (functional form of questions)	How do you feel if size of the port and terminal is small?	I like it that way
			I expect it to be that way
			I am neutral
			I can live with it that way
			I dislike it that way
	Negative questions (dysfunctional form of questions)	How do you feel if size of the port and terminal is large?	I like it that way
			I expect it to be that way
			I am neutral
			I can live with it that way
			I dislike it that way
SF06 Sufficiency and quality of port equipment	Positive questions (functional form of questions)	How do you feel if sufficiency and quality of port equipment are low?	I like it that way
			I expect it to be that way
			I am neutral
			I can live with it that way
			I dislike it that way
	Negative questions (dysfunctional form of questions)	How do you feel if sufficiency and quality of port equipment are high?	I like it that way
			I expect it to be that way
			I am neutral
			I can live with it that way
			I dislike it that way

Table 10 (continued)

	Survey questions	Questionnaire items	
SF07 Cost for terminal handling and storage	Positive questions (functional form of questions)	How do you feel if cost for terminal handling and storage are low?	I like it that way
			I expect it to be that way
			I am neutral
			I can live with it that way
			I dislike it that way
	Negative questions (dysfunctional form of questions)	How do you feel if cost for terminal handling and storage are high?	I like it that way
			I expect it to be that way
			I am neutral
			I can live with it that way
			I dislike it that way
SF08 Port dues	Positive questions (functional form of questions)	How do you feel if port dues are low?	I like it that way
			I expect it to be that way
			I am neutral
			I can live with it that way
			I dislike it that way
	Negative questions (dysfunctional form of questions)	How do you feel if port dues are high?	I like it that way
			I expect it to be that way
			I am neutral
			I can live with it that way
			I dislike it that way

Table 10 (continued)

	Survey questions	Questionnaire items	
SF09 Cost for inland transportation	Positive questions (functional form of questions)	How do you feel if cost for inland transportation is low?	I like it that way
			I expect it to be that way
			I am neutral
			I can live with it that way
			I dislike it that way
	Negative questions (dysfunctional form of questions)	How do you feel if cost for inland transportation is high?	I like it that way
			I expect it to be that way
			I am neutral
			I can live with it that way
			I dislike it that way
SF10 Reliability of cargo handling	Positive questions (functional form of questions)	How do you feel if reliability of cargo handling is low?	I like it that way
			I expect it to be that way
			I am neutral
			I can live with it that way
			I dislike it that way
	Negative questions (dysfunctional form of questions)	How do you feel if reliability of cargo handling is high?	I like it that way
			I expect it to be that way
			I am neutral
			I can live with it that way
			I dislike it that way

Table 10 (continued)

	Survey questions	Questionnaire items	
SF11 Speedy cargo handling	Positive questions (functional form of questions)	How do you feel if speedy cargo handling is slow?	I like it that way I expect it to be that way I am neutral I can live with it that way I dislike it that way
	Negative questions (dysfunctional form of questions)	How do you feel if speedy cargo handling is fast?	I like it that way I expect it to be that way I am neutral I can live with it that way I dislike it that way
SF12 Quality and availability of staff	Positive questions (functional form of questions)	How do you feel if quality and availability of staff are low?	I like it that way I expect it to be that way I am neutral I can live with it that way I dislike it that way
	Negative questions (dysfunctional form of questions)	How do you feel if quality and availability of staff are high?	I like it that way I expect it to be that way I am neutral I can live with it that way I dislike it that way

Switching variation: $CV_S = 30\%$

Within-subject variation: $CV_W = 30\%$

Constraint on point estimate = 25% (GMR = 1.25)

Type I error was recorded in simulated investigations. For the regulatory standardized variation (CV_0), corresponding to the assumed regulatory constant (σ_0), either 25% (the expectation of FDA) or 30% (the requirement of EMA) was considered. The computations were performed with or without the use of the mixed regulatory strategy, and with or without the constraint of GMR = 1.25 (GMR: ratio of geometric means). ([25], with the permission of the publisher.)

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Hokey Min (hmin@bgsu.ed) is a James R. Good Chair in Global Supply Chain Strategy, Department of Management, Bowling Green State University. He received his PhD in Management Sciences and Logistics from Ohio State University. Professor Min is also a member of the MEL Editorial Board.

Byung-In Park (bipark@chonnam.ac.kr) is a full professor of the Department of Logistics and Transportation, Chonnam National University, Korea. He received his PhD in Business Administration from Korea University.