

# Weighing the Importance of Mode Choice Factors on Intermodal Transportation Service in Europe

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**Abstract** : Since 1995, Korean enterprises have been rapidly expanding their business, especially to Eastern European countries such as Poland, Slovakia, Czech Republic, Hungary and so on. After the establishment of Korea-EU FTA in 2011, close relationship between the two through economic cooperation has been maintained. To efficiently connect the seaport regions to inland factories located in Eastern European countries, researches on mode choice in the intermodal sector are needed to perform. However, there is a scant of research for mode choice factors on intermodal transportation service in Europe. Therefore, the aim of this research is to understand the current situation of intermodal transportation sector in Europe, identify key factors of mode choice, and weigh the importance among factors influencing intermodal selection in the perspective of Korean exporters or forwarders with overseas cargo to Europe. A survey and in-depth interviews to CEOs and executives who have more than 20 to 30 years of career in logistics sector were carried out from April 01 to May 01, 2013. Using the fuzzy theory as the methodology, 'Reliability of arrival time', 'Transit time', and 'Freight Rate' are equally ranked as the most important factor in the selection of intermodal transportation.

**Key Words** : Weighing the Importance, Mode Choice Factors, Intermodal Transportation Service, Europe

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## I . Introduction

In freight transportation, intermodality has become a crucial point for efficient logistics strategy over the past decades. Growing demand of cargo movement due to global supply chain management and international trade causes congestion problems and the consequent increase in environmental concerns all around the world. In this sustainable and socio-economic point of view, intermodal transportation is considered as one of the solutions to alleviate above mentioned issues because the use of at least two different modes during a single journey to the final destination can resolve the imbalance between modes by moving freight off roads to more environmentally-friendly modes such as rail and shipping.

In this regard, EU's transport policies and specific measures for promoting intermodal transportation can be exemplary cases to study, not only for EU countries but also for Korean government and industries. Since the establishment of diplomatic ties between Korea and EU in 1963, EU has become our No.2 trade partner and No. 1 foreign investor in Korea. After the establishment of Korea-EU FTA in 2011, close relationship between the two through economic cooperation has been maintained so far. Moreover, not only exporting finished goods to the whole European market, Korean enterprises have been expanding their business, especially by establishing their manufacturing facilities in Eastern European countries such as Poland, Slovakia, Czech Republic and so on. Consequently, that situation helps to generate more cargo flows from Korea to Europe.

Accordingly, the purpose of this research is identifying key factors of mode selection and analyzing the importance, while understanding the current situation of intermodal transport sector in Europe. In addition, the result of this study has the potential to benefit Korean companies which intend to inroad into European market with overseas cargo from Korea by providing relevant data for enhancing their competitiveness.

Even though there has been many researches using fuzzy theory in intermodal sector, there is no preceding study on intermodal choice factors in Europe from the view point of countries outside of Europe. To conduct fuzzy method, 15 factors, when choosing intermodal transportation, were selected by in-depth interviews with small number of carefully chosen logistics experts who have many years of

experience of managing overseas cargo from Korea to Europe, along with a review of applicable literature. This study presents importance and priority among 15 selected factors.

## **II. Overview of Intermodal Transportation in Europe**

### **1. Definition of Intermodal transport and Intermodality**

There are various versions of definition of intermodal transportation but the most commonly used one is "the movement of goods in one and the same loading unit or vehicle which uses successively several modes of transport without handling of the goods themselves in changing mode", provided by ITF(International Transport Forum at the OECD, former European Conference of Ministers of Transport). One other popular definition by McKinzie et al.(1989) is "the shipment of containerized cargo using more than one mode". However, the "seamless transition of cargo between modes" should be included in the definition as a goal of intermodal transport, according to Jones et al.(2000) In Europe, the term, combined transport, is also widely used as defined by ITF, "an intermodal transport where the major part of the European journey is by rail, IWT(Inland Waterways Transport) or sea, and any initial and/or/final leg is carried out by road over as short a distance as possible"

The EU Commission proposed a definition of intermodality as "a character of transport system, that allows at least two different modes to be used in an integrated manner in a door-to-door transport chain". It can also be considered as a "quality indicator" of the level of integration. So, higher level of intermodality means more integrations between modes in the aspects of infrastructure and transport means, operations, services, and regulations.

### **2. EU's Transport Policies and Measures related to Intermodal Transport**

Under the slogan of "Roadmap to a single European transport area-Towards a

competitive and resource efficient transport system”, the European Commission’s White Paper, also known as ‘Transport 2050’ was published in 2011. Compared to previous White Papers, this one uniquely sets different goals for three different types of journey such as intercity travel, long-distance travel, and urban travel to increase mobility and reduce emissions by proposing 40 initiatives. Among many goals concerning other topics such as passenger traffic, infrastructure, clean energy and so on, the objective which is to shift more than 50% of road freight over 300km to rail or waterborne transport by 2050, is intimately related to intermodal transport because realizing high level of intermodality can be a solution to achieve the goal.

Within the frame suggested in White Paper, some of the measures and programmes which support the declared goals are successfully on-going. One of them is Marco Polo Programme. It is the EU’s funding programme which financially supports projects for modal shift to lessen road congestion and its accompanying environmental issues. Currently it is in its second period covering 2007~2013 with €450 million of budget, after the first period from 2003 to 2006. The distinctive feature of this programme is that it is specially focused on commercial actions in the freight transport market from start-up to profit-making stage. No projects concerning research, pure infrastructure, passenger or air transport are qualified for the grants. Only international freight transport projects are qualified. There are five areas of funding but the main is direct modal shift. Catalyst action, motorway of the sea actions between ports, traffic avoidance actions, and common learning actions are the other four.

TEN-T(Trans-European Transport Networks) is also the EU’s funding programme, first launched in 1993, to improve transport infrastructure for trans-European network, by building missing links and removing bottlenecks on the purpose of sustainable mobility. It also focuses on the projects of improving interconnection points such as seaports, inland ports, intermodal terminals for the integration of the different transport modes. According to Jun. 30, 2013 update by TEN-T Executive Agency, out of all 411 projects under the 2007~2013 financial perspective, 164 of them are rail projects(40%), 31(8%) are multimodal, 29(7%) are inland waterways(IWW), 42(10%) are European rail traffic management system. In the viewpoint of actual amount of TEN-T funding by transport mode, rail accounts

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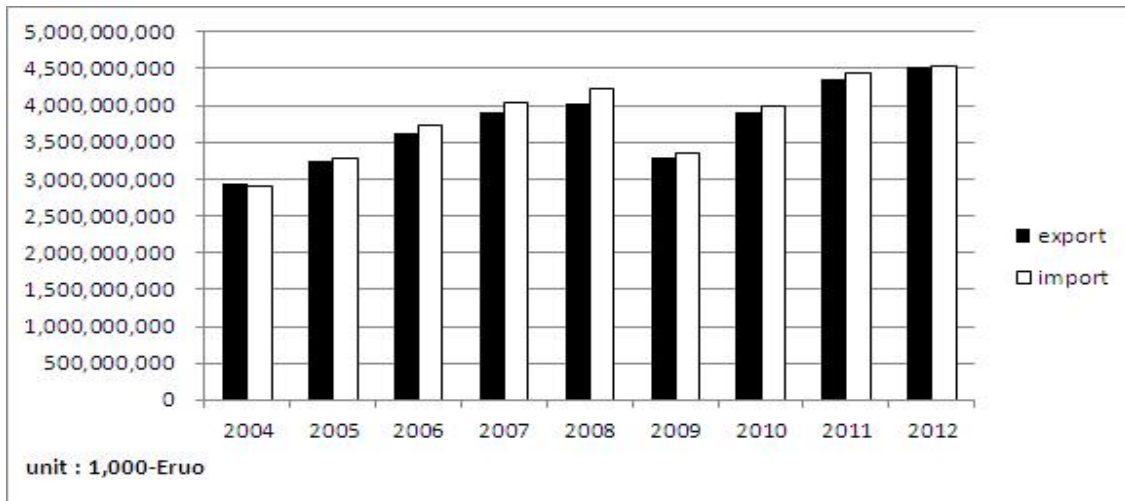
for the largest portion, 53%(€2,925.4 million) of total €5.56 billion, followed by IWW 11%(€599 million), European rail traffic management system 8%(€462.4 million), air traffic management 7%(€407.6 million), and multimodal 4%(€249.3 million). It indicates that TEN-T also strongly supports the projects which are to improve infrastructures of more environmentally friendly modes such as rail and IWW.

Both Marco Polo Programme and TEN-T are the supporting measures for intermodal transport in Europe, which are successfully underway, but have different roles and characters. Marco Polo Programme is more into supporting projects about modal-shift transport service driven by private sectors and TEN-T is focused on improving infrastructure to create transport network driven by public sector.

### 3. Current Situation of Korea-EU relationship

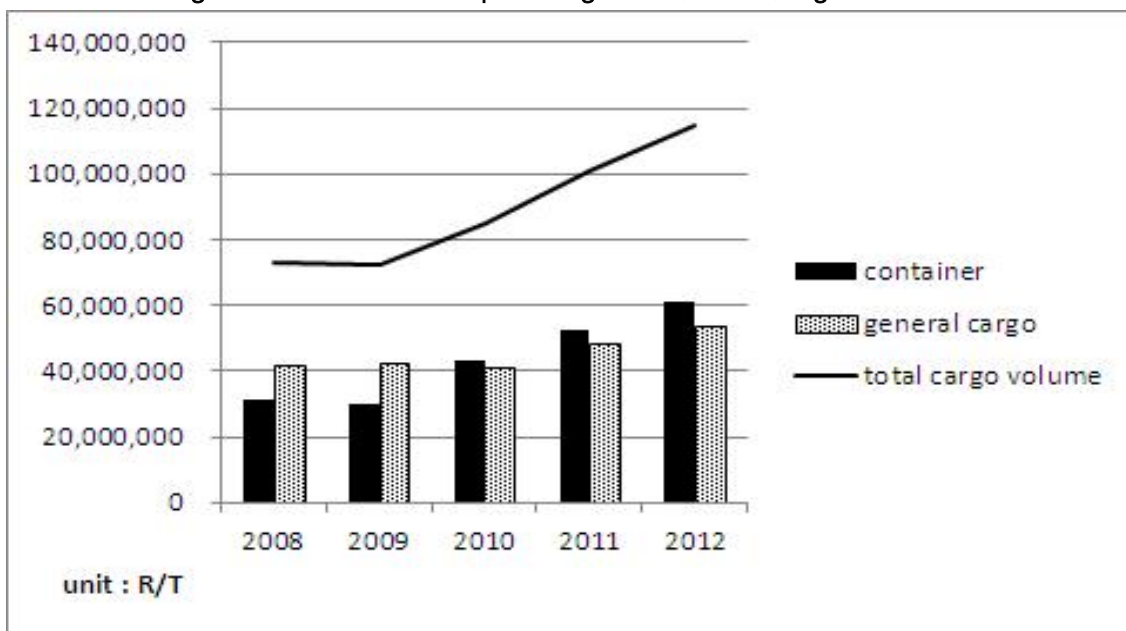
In 2013, it has been 50 years since the establishment of diplomatic relations between Korea and EU. Their economic relationship became even closer after the Free Trade Agreement(FTA) which entered into force in July 2011. Even after the 2009 financial crisis in Europe, the two-way trade has been continuously growing both in value and volume. It surpassed the \$100 billion mark and 114 million tons in 2012.

<Figure 1> Korea-Europe trade balance during 2004~2012



So does the trade between Korea and Eastern European countries such as Poland, Slovakia, Czech Republic, Hungary and so on because since 1995, Korea has become one of the biggest investor in this region by establishing manufacturing factories because of cheap labor cost, customs benefit, and favorable geographical location towards the huge Western European market together with Russia. Therefore the cargo volume between Korea and Poland/Czech Republic/Slovakia also has increased and in 2012, it reached over 1.3 million tons.

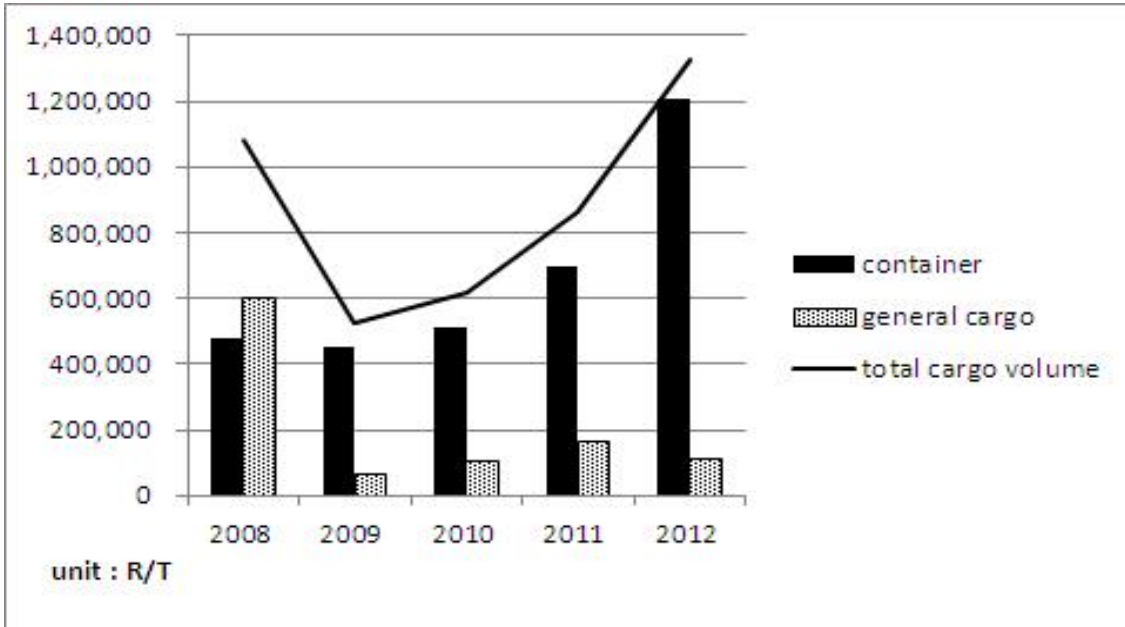
<Figure 2> Korea-Europe Cargo volume during 2008~2012



Consequently, Korea's establishment of local branches in European regions surged, especially from 2000 to 2007 and it has slowed down since then.

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<Figure 3> Cargo volume between Korea and 3 Eastern European countries : Poland, Czech Republic and Slovakia



<Figure 4> The numbers of Korea's newly-established local branches in Europe during 1996~2012



### III. Literature Review

Within transport literature, researches on the factors which affect the decision on mode choice has been widely performed, especially in the intermodal sector.

Fawcett, McLeish, and Ogden(1992) stated that 5 important factors of transportation mode choice are cargo characteristics, cargo quantity, urgency of cargo, cargo value, and market situation.

In Evers, Harper and Needham's research (1996), out of 17 factors regarding service characteristics of each transportation mode(intermodal, rail and truck) and overall service, 6 transportation service factors including timeliness, availability, firm contact, cost, restriction and sustainability affect shipper's perception of transportation mode. Also, their finding is that shippers' perception is heavily influenced by their past experience and other aspects, regardless of whether they are realistic or not, such as common knowledge, carrier's advertisements, image of the mode, and even inaccurate information.

Fowkes and Shinghal(2002) stated that among other important factors, frequency of service is the most crucial factor when choosing transportation mode. The result of this study varies depending on respondents' conditions, i.e. which sectors they work in, or what kind of product they deal with. Among exporters, forwarders and transporters, intermodal transportation is mostly favored by exporters even with 10% extra cost because their concept of cargo is containerized. In the aspect of product type, food and auto parts are more suitable for intermodal transportation than chemicals or electrical/electronics, due to low cargo damage in transit.

According to Bolis and Maggi (2003), when shippers choose transportation mode, the choice is made based on the factors such as time and other service characteristics including reliability and frequency. However, their research confirmed that shippers' modal selection is only a part of their complex logistics strategy such as JIT strategy by suppliers or customers.

According to Yoo, et al. (2008)'s research on the preference of domestic container transportation, lead time(64.44%) is the most important factor which determines the mode selection by forwarder, shipping line, inland transporter and other related companies. Other factors are transportation cost (23.25%), transportation mode (8.09%), service (6.22%) and so on. Among all respondents,



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forwarders are more sensitive about transportation mode compared to other respondent groups. Shipping lines which have to cooperate with inland transporters take cost and service factors into account more seriously.

In Keith W. Roberts(2012)'s research, cost, service, product characteristics, relationships, and capacity are the five key factors in transportation mode choice and carrier selection. Unlike previous research(Coyle et al., 2006), he claims that these two choices are not made separately, as stepped-procedure. Usually these decisions blends together and are made simultaneously, based on carrier's capabilities on multi-modal transportation because the greatest concern for shippers is whether or not the product is shipped on time at expected service level, regardless of mode. And he also stated that two other factors such as environment and security have become newly concerned matters when making transportation decisions. Security matter is a crucial point depending on the cargo character and environmentally-friendly logistics has become heavily important due to government regulations.

### IV. Empirical Analysis

#### 1. Fuzzy Method

The fuzzy theory was introduced by Lotfi A. Zadeh(1965) to deal with the uncertainty due to inexactness and ambiguity. In other words, it is a probabilistic method. Fuzzy theory is different from existing science as shown in table 1.

<Table 1> Comparisons with Fuzzy theory and existing science

Classification	Fuzzy theory	Existing science
Viewpoint	Admitting subjectivity	Objectivity
Data	Admitting incompleteness, ambiguity	Accuracy
Theory	Not necessary to be precise	Mathematical Theoretical Rigidity

Measurement	Possibility of qualitative interpretation	Quantitative
Interference	Admitting somewhat	Eliminate within the limits of the possible
Experience	Use possibility	Eliminate within the limits of the possible
Application efficiency	Complication Taking a long time	Relatively easy
Offering information	Verification of much information	High probability of information distortion
Fairness	Relative high	Very low because of subjectivity problem
Possibility of participation	Depend on expert	One sided & Using a subjective judgment

Source : Kim(2008), Park(2011), Park(2012)

Triangle fuzzy number  $\bar{A}$  composed of three parameters ( $a_1, a_2, a_3$ ) and the membership function of  $\bar{A}$  can be represented  $\mu^A(x)$  as shown in Equation 1.

$$\mu^A(x) = \begin{cases} 0, & x < a_1 \\ \frac{x - a_1}{a_2 - a_1}, & a_1 \leq x \leq a_2 \\ \frac{a_3 - x}{a_3 - a_2}, & a_2 \leq x \leq a_3 \\ 0, & x > a_3 \end{cases} \quad (1)$$

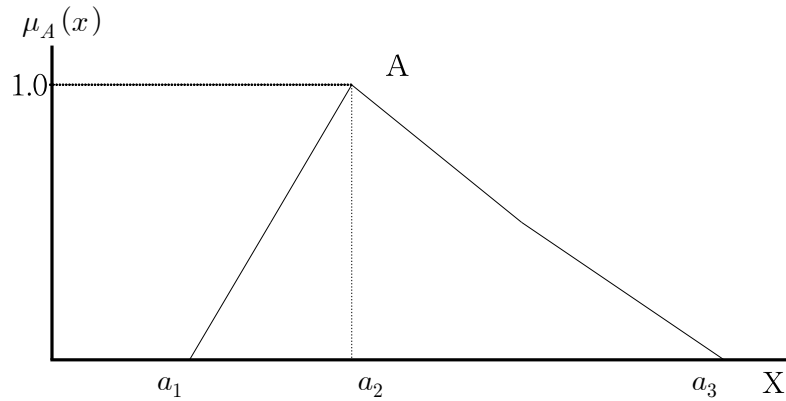
This triangle fuzzy number among membership function 'n' is defined as in Equation 2.

$$\tilde{A} = (a_1^{(i)}, a_2^{(i)}, a_3^{(i)}), i = 1, 2, 3, \dots, n \quad (2)$$

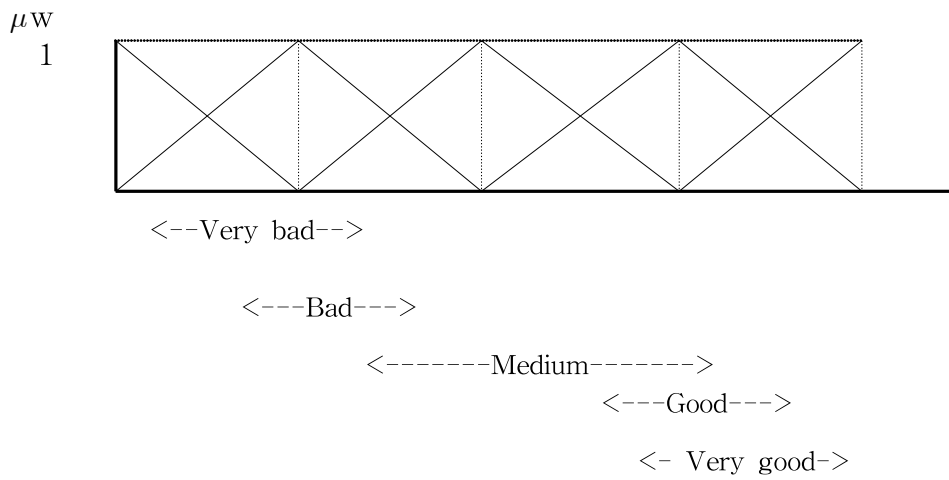
Fuzzy number  $\tilde{A}$  is defined below.

$$\tilde{A} = A_{ave} = \frac{\tilde{A}_1 + \tilde{A}_2 + \dots + \tilde{A}_n}{n} = \frac{(\sum_{i=1}^n a_1^{(i)}, \sum_{i=1}^n a_2^{(i)}, \sum_{i=1}^n a_3^{(i)})}{n} = (a_1, a_2, a_3) \quad (3)$$

<Figure 5> Function of Triangle Fuzzy Number



<Figure 6> Function of Triangle Fuzzy Number



Several fuzzy sets representing linguistic concepts such as very bad, medium, very good, and so on are often employed to define states of a variable.

## 2. Application of Fuzzy Method

1) Basic survey of respondents for importance analysis of intermodal selection factors

Mode choice factors on intermodal transportation in existing researches can be found as follows. Choi et al. (2012) stated that freight rate, transit time, amount of cargo are affecting factors on mode choice. Kim et al. (2005) analyzed that the followings are key factors on mode choice such as reputation and image of transport companies and means of transportation, tracking information service, and capability of customs clearance. In addition, urgency of cargo and types of export contract were also suggested by Bang et al. (2011).

<Table 2> Mode choice factors on intermodal transportation in existing researches

Authors	Factors
Choi et al. (2012)	freight rate, transit time, amount of cargo, tracking information service, types and conditions of cargo, safety of cargo, reliability of arrival time
Kim et al. (2005)	freight rate, transit time, safety of cargo, reputation and image of transport companies and means of transportation, tracking information service, capability of customers clearance, flexible and customized departure, cost of inventory control
Bang et al. (2011)	urgency of cargo, types of export contract, security of cargo handling facility, reliability of arrival time, transit time, freight rate, tracking information
Kim et al. (1996)	freight rate, tracking information service, capability of customers clearance, safety of cargo, reputation and image of transport companies and means of transportation
Jun et al. (2006)	information service, transit time, freight rate
Choi et al. (2012)	reliability of arrival time, transit time, information service, reputation and image of transport companies and means of transportation, safety of cargo, Security of cargo handling facilities

In this paper, factors were selected based on above existing researches, then a few more were added by in-depth interviews for practical application of the study. By this process, 15 factors were finally selected as <Table 3>.

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<Table 3> Derived mode choice factors

Factor	Explanatory note
Reliability of arrival time	related to the proportion of cargo arriving within scheduled time
Tracking information service	ability for tracing cargo in real-time basis
Transit Time	overall transport time to the final destination
Freight Rate	cost of transport service
Capability of Customs clearance	ability for customs clearance offered by service operators
Flexible and customized departure	availability of customized transport service to particular cargoes or customers
Safety of cargo	damage or lost of cargo
Cost of inventory control	level of benefit or loss on inventory control when using a specific mode. Especially for cargoes like parts or raw materials for manufacturing, facilities such as rail terminal or port during the transport journey can reduce cost of inventory.
Types of Export contracts	concerning price condition in the contract. e.g. FOB, CIF, etc.
Types and conditions of cargo	e.g. containerized, liquid, heavy and bulk, out of gauge etc.
Urgency of cargo	related to the matter of how fast or slow the cargo should be transported
Amount of cargo	e.g. cargo quantity for one lot, or regular cargo for long term contract
Possibility of realization of the green logistics transportation	for corporate social responsibility, or for practical reasons like environmental taxes and charges.
Security of cargo	ability to maintain a certain level of compliance depending on the cargo type
Reputation and image of transport companies and means of transportation	regarding the established image of a certain mode or company

In-depth interviews to 5 CEOs and executives in logistics sector were conducted for this study, along with a survey with questionnaire. 3 of them have more than 30 years of work experience and the others have more than 20 years. Every respondent used to or is currently involved in intermodal transportation and each of

their range of business activities includes European region. Therefore, they can be recognized as the proper sample of carefully selected 5 people for the purpose of the research.

## 2) Result of analysis

We apply the equations suggested in Section 1, the importance of mode choice factors can be obtained as shown in Table 4.

**<Table 4> Importance of mode choice factors**

Factors	Importance	Priority
Reliability of arrival time	0.900	1
Tracking information service	0.733	7
Transit Time	0.900	1
Freight Rate	0.900	1
Capability of Customs clearance	0.640	9
Flexible and customized departure	0.687	8
Safety of cargo	0.800	5
Cost of inventory control	0.767	6
Types of Export contracts	0.593	13
Types and conditions of cargo	0.640	9
Urgency of cargo	0.867	4
Amount of cargo	0.640	9
Possibility of realization of the green logistics transportation	0.453	15
Security of cargo	0.547	14
Reputation and image of transport companies and means of transportation	0.640	9

As a result of the analysis, 'Reliability of arrival time', 'Transit time', and 'Freight Rate' are equally ranked as the most important factor in the selection of intermodal transportation. Then, 'Urgency of cargo', 'Safety of cargo' and 'Cost of inventory control' follows, as the 4th, 5th, and 6th position in the list. Among the three No.1 important factors which are obviously crucial for the every-involved-party in the whole logistics chain, 'Transit Time' and 'Freight Rate' are always in trade-off relation. According to the in-depth interview, 'Reliability of arrival time'

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is often considered to be the most critical point than other two factors. No matter how fast the transit time is, or how competitive the rate is, there are some cases when 'Reliability of arrival time' has to be an essential precondition. Especially when inbound logistics of manufacturing plant, to prevent 'uncertainty' in the whole process is the key point for ensuring smooth operation of the factory because it has negative possibilities for an unlimited additional cost. In that regard, Korean forwarders which mostly deal with cargo for production facilities in Europe should enhance their reliability in arrival time and also in service quality, to compete with other global companies.

'Urgency of cargo' and 'Safety of cargo' are also important on certain occasions. For instance, in a situation when a cargo needs to be transported in 'hot-delivery' condition, or when it needs to go through some extremely high or low temperature which can cause damages to the cargo. Or even when it has to pass through some dangerous region due to political or other reasons such as war, temporary blockade, or natural disaster, these 2 factors should be foremost when choosing intermodal transport.

'Cost of inventory control' is a factor related to rail terminals. When using rail and truck intermodal transportation, transport of larger volumes in one lot is possible so that it can reduce the risk of terminal storage fees in seaport when high frequency of departures can be provided by the rail operators. In addition, rail terminals near manufacturing plant can be utilized as an interim storage of containers to allow just-in-time delivery and customs clearance outside of seaport and factory.

Other factors like 'Security of cargo' and 'Possibility of realization of the green logistics transportation' have a comparatively low effect on mode choice. Even in Europe, where the environment issue is considered more seriously than any other regions in the world, to use of greener mode in the industry just for an environmental concern doesn't happen at all. For the purpose of modal shift, realistic benefit also has to be satisfied in any kind of aspects such as enhancing the corporate's public image by using more environmentally-friendly modes even though it is not very cost-efficient than other modes.

## V. Conclusions

The intermodal transportation is considered as one of the solutions to lessen road congestion and its accompanying environmental issues. In this regard, EU's transport policies and specific measures for promoting intermodal transportation has widely emerged. EU's funding programme such as Marco Polo Programme and TEN-T especially focuses on modal shift and improving interconnection points such as seaports, inland ports, and intermodal terminals for the integration of the different transport modes.

Since 1995, Korean enterprises have been expanding their business. After the establishment of Korea-EU FTA in 2001, economic relationship has been closely maintain so far. From the beginning, the trade between Korea and Europe has occurred from main land Europe area. After that stage, Eastern European countries such as Poland, Slovakia, Czech Republic, Hungary and so on are getting more popular because they have comparatively cheaper labor cost in addition to customs benefit and favorable geographical location towards the huge Western European market together with Russia. To efficiently connect the seaport regions to inland factories located in Eastern European countries, researches on mode choice in the intermodal sector is needed to perform.

However, there is a scant of research for mode choice factors on intermodal transportation service in Europe from the view point of countries outside of Europe. To fill the research gap, the aim of this research is to understand the current situation of intermodal transportation sector in Europe, identify key factors of mode choice, and weigh the importance among factors influencing intermodal selection in the perspective of Korean exporters or forwarders who deal with overseas cargo to Europe.

A survey to CEOs of intermodal industries and executives who have more than 20 years of career were carried out from April 01 to May 01, 2013. Using the fuzzy theory as the methodology, 'Reliability of arrival time', 'Transit time', and 'Freight Rate' are equally ranked as the most important factor in the selection of intermodal transportation. The result of this study has potential to benefit Korean companies which intend to inroad into European market by providing data on relevant factors and finally, help them to enhance their competitiveness among other



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global companies. The research on detailed modes' selection in Europe is remained as the future research.

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## 국문 요약

# 유럽지역 인터모달운송 선택요인의 중요도 측정에 관한 연구

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1995년 이후 한국기업의 유럽진출이 활발히 이루어졌으며, 특히 폴란드, 체코, 슬로바키아, 헝가리 등의 동유럽지역 진출은 두드러진다. 2011년 한-EU FTA 체결로 두 지역 간 경제적 관계는 더욱 밀접해졌다. 이러한 측면에서 항만을 가지고 있는 전통 유럽국가와 동유럽을 효율적으로 연결하기 위한 인터모달운송 선택에 관한 연구가 요청되고 있다. 하지만 유럽지역 수송수단 선택에 관한 연구는 아직 초보단계에 머무르고 있다. 본 연구는 현재 유럽지역의 인터모달운송의 현황을 파악하고, 열차와 트럭, 피더와 트럭 등의 인터모달운송선택의 핵심요인을 파악하며, 한국에서 유럽과 거래하는 수출기업 및 포워더 측면에서 고려할 때 주요하게 판단하는 요소의 가중치를 평가하는 것을 목적으로 하였다. In-depth interview는 2013년 4월에서 5월 사이 20년에서 30년 이상의 경력을 지닌 물류관련기업 사장단을 통하여 이루어졌다. 연구방법론으로 퍼지이론이 사용되었으며, 연구결과 도착의 신뢰도, 환적 시간, 운임이 인터모달운송 선택시 가장 중요한 요인으로 선정되었다.

**핵심 주제어** : 중요도 측정, 운송수단 선택요인, 인터모달운송서비스, 유럽