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International Multimodal Transport Route Development from Korea to Mongolia

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Abstract : *This study aimed to identify new routes for transporting automobiles from Korea to Mongolia by comparing them with the existing route. At present, a route from the Incheon Port through the Tianjin Port to Zamiin-Uud is commonly used to transport containerized cargo from Korea to Mongolia. This study examined five possible logistics routes from Korea to Mongolia using a time/cost-distance methodology based on real data. Through consecutive discussions with importers and freight forwarders in Mongolia, the potential routes were selected and costs, distance, and lead time were evaluated to provide additional route options for automobile logistics from Korea to Mongolia. The results indicated that each route could be ranked in terms of the total cost while the lead time for all options in the present COVID-19 period is 2 – 4 months, with no difference among the routes. In addition, although the confidence index of all routes was not impressive, route 3 was the most preferred option, followed by route 1. However, the study results cannot provide the answer to the question of "which route is more attractive for transporting automobiles from Korea to Mongolia." This limitation notwithstanding, this study provides real information on the critical factors of distance, cost, and lead time in terms of the selected transportation routes so that importers and exporters can compare the routes in terms of the priority of each factor in uncertain logistics environment.*

Key words : *logistics, multimodal transport, sutomobiles, time/cost-distance model, Korea, Mongolia*

1. Introduction

Due to the impact of COVID-19, global supply chains have faced uncertainty and especially Mongolia, as a land-locked country, is one of the worst cases. The service quality of the international logistics for Mongolia depends absolutely on the situation of the neighbouring countries (ADB, 2018). In other words, international trade and transportation via third countries are essential through Tianjin port in China and Vladivostok or Vostochny ports in Russia, respectively. These limited-routes options hinder the connections to Mongolia from origins, especially during the COVID-19 pandemic period. Thus, Mongolia has undergone difficulty in receiving imported goods from foreign countries due to congestions in transit sites in China and Russia, generating more costs and longer lead-time. In this situation, the choice of a multimodal transportation route among possible options is crucial in terms of transport costs, transportation safety and lead-time(Seo et al., 2012; Jung et al., 2012). This indicates that new transportation connections to Mongolia via China or Russia need to be identified and evaluated to see their viability. To this end, this study develops possible logistics routes from Korea to Mongolia via third countries using the Time/Cost-Distance methodology (Beresford and Dubey, 1990), which allows the analysis and comparison of alternative multimodal transport routes. Consequently, this study aims to identify new routes for transporting automobiles from Korea to Mongolia by comparing them with existing route. This may help importer and exporter to decide feasible route selection under highly uncertain logistics environments such as lockdowns or congestions placed in logistics nods or links.

2. General Reivew

2.1 Mongolia's Status-Quo of Logistics Environment

The high cost of international transportation leads to high import prices, high inflation rates, and high export prices (World Bank, 2018). In particular, the international trade costs of landlocked countries are much higher than that of alongshore countries due to a greater number of transits at the nodes and links. On top of that, the situation of landlocked Mongolia, which is located in between China and Russia, has even

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worsened since early 2020 due to COVID-19. According to the Bank of Mongolia (2022), Mongolia's inflation has continued to rise, reaching 16.1% as of June 2022, which is a sharp increase of 10% compared to the same period last year. In addition, the transportation costs in the national consumer price index have increased by more than 20% compared to the same period last year. The direct reason for the hyper-inflation can be explained by the Chinese "Zero-Covid" policy in which the country has imposed a curfew in major cities and has closed the main ports bordering Mongolia, leading to the slowdown working process, in particular, at Tianjin port that is the main corridor for Mongolia's foreign trades (Bank of Mongolia, 2022). Congestion at the port caused by the epidemic has affected the increase in the costs of foreign trade in Mongolia but also caused the delay of the import goods for several months or an indefinite period for customs service.

Mongolia imports almost 100% of its goods including equipment, fuels, and automobiles, to mention but a few because of its lack of manufacturing facilities. According to the estimation of the Bank of Mongolia (2022), the inflation rate will continue to rise and gradually decrease from the second half of next year. Due to the impact of COVID-19, there are still difficulties in the transport and logistics sector of Mongolia, and it is hard to estimate when the situation will be stabilized. In this situation, reducing the inbound logistics costs for Mongolia is a primary task to be solved. However, relevant studies are scanty. To this end, this study conducts to suggest possible solutions for the challenges by estimating the cost of inbound transport operations in the manner of diversifying transportation corridors to Mongolia. In particular, this work focuses on automobile transportation from Korea to Mongolia as Korea is the second largest automobile exporter for Mongolia next to Japan (Bank of Mongolia, 2022). Currently, more than 90% of the automobiles imported from Japan and Korea are second-hand ones. As environmental issues become critical, however, the Mongolian government is exerting to reduce the import of used automobiles by increasing tariffs and taxes. On the other hand, Mongolia arranges a new policy of tax discounts on electric, hybrid types, and new automobiles. This can be a new opportunity for Korean automobile manufacturers that increase their market shares in Mongolia by exporting a greater number of new automobiles. In this situation, Mongolia may need additional trade corridors beside the existing route of the Tianjin passage to reduce the costs of international trade, particularly in the transportation sector.

2.2. Literature Review

One of the biggest challenges for landlocked economies is the high cost of freight trade and the high degree of unpredictability in transportation time. If the landlocked countries have good connections to seaports without any obstacles, their economies would be more sustainable. To this end, the studies on developing better port-hinterland connections have been much attracted by researchers (Nasanjargal et al., 2018). To strengthen the port-hinterland connection, an efficient multimodal transport system is one of the key criteria, thereby, expecting the trade competitiveness of the landlocked economy (Banomyong and Beresford, 2001). The efficient multimodal transport system concerns both the choice of transport mode and the combination of transport modes. Previous literature suggested various multimodal models regarding the mode choice and the combination of the modes from origin to destination (Beresford et al., 2011). The Time/Cost-Distance approach developed by Beresford and Dubey (1990) is a commonly used model. The model has been adopted globally as a standard methodology for analysing supply chain effectiveness in a range of operational and commercial circumstances (UNESCAP, 2003; 2013; 2022; ADB, 2018). The validity of this model can be found in real cases of the international supply chain movement, including the export of garments from Lao People's Democratic Republic (PDR) to the port of Rotterdam in The Netherlands (Banomyong and Beresford 2001), shipment of iron ore from northwest Australia to northeast China (Beresford et al., 2011), export of laptop from Chongqing in China to Rotterdam (Seo et al., 2017). In particular, ADB (2018) uses the Time/Cost-Distance model for a route between Tianjin port and Zamiin-Uud. The results denote it takes about 9 days in the best case scenario and up to 15 days in the worst case scenario to transport goods from Tianjin port to Zamiin-Uud (dry port). This can be interpreted that the best-case scenario denotes 189 km per 24 hours and 113 km per 24 hours for worst case scenario, which is far below the VPoA (Vienna Programme of Action) target for moving cargo by 300-400 km per 24 hours (UNESCAP, 2022). Identified inefficiencies include congestions, unavailability of dedicated space at Tianjin Port, lack of slot availability on trains in China with destination to Mongolia, break of gauge and border crossing formalities. However, COVID-19 has harshly deteriorated the route (Tianjin to Zamiin-Uud), resulting in a severe delay in the goods movement (mainly due to Tianjin port Congestion) for more than one month and soaring freight costs. This indicates further studies need to be conducted by identifying alternative routes and comparing them in terms of lead-time, cost and distance to mitigate logistics problems for Mongolia.

3. Methodology

3.1. Time/Cost-Distance Model

The Multimodal Transportation-Cost model (called 'Time/Cost-Distance model') is developed by Beresford and Dubey (1990) and improved by Banomyong and Beresford (2001). The method is adopted by the UNESCAP (United Nations Economic and Social Commission for Asia and the Pacific) secretariat as an official method of applying the multimodal domain in 2004. Since then, the model has found wide practical uses in different regions all around the world (UNESCAP , 2013).

The methodology is a graphical representation of the cost and time data associated with the transit process. In other words, the model provides an accessible graphical comparison among routes and finds the best cost-wise and time-wise routes. Namely, this model is capable of analysing the cost and time of transportation by any mode of road, rail, sea and transit cost and time between modes at ports, railway freight terminals, and inland clearance depots at the same time. In addition, the model uses curve steepness to reflect the cost changes of each mode, the slopes indicate transport cost per distance, and vertical surges show the cost steps of multimodal transfer (Bonamyong and Beresford 2001). Hence, the model is self-sufficing and flexible enough to be applied to any operational conditions and a supply chain of any length. This methodology assumes that the unit cost of transportation is various for different modes and is reflected in the cost curves (UNESCAP 2003; ADB 2018; Seo et al., 2017). Hence, the model enables to analyse of the following issues for this research:

a. Compare the alternative transport routes

b. Compare the legs

There are different types of costs in the logistics activity, one of the largest costs is may transportation cost. The combination of the most cost-effective transportation options for multimodal transport and the selection of the appropriate route can reduce transportation costs (Banomyong and Beresford, 2001; Seo et al., 2017). Therefore, using this model, the cost of importing automobiles from Korea to Mongolia will be calculated by comparing the cost and distance of each mode of transport on each of the feasible routes.

3.2. Route Identification and Data Collection

The automobile trade from Korea to Mongolia is generally made in terms of the INCOTERMS of the 'EXW (EX Work) and FOB (Free On Board) which means the buyer's obligations of the most costs and risks. To this end, this work develops potential routes through interviews with freight forwarding companies and importers in Mongolia. According to the interview with practitioners, Tianjin port was the main port to transport containerised automobile cargos from Korea to Mongolia, however, the port was not always available in 2021(the pandemic period) due to port congestion. Thus, Qinhuangdao port can be possibly an alternative port due to its good rail and road connection to the Mongolian border. However, other Chinese ports (i.e. Dandong and Yingkou) are not considered for analysis in this study due to a weak railway connection to the Mongolian border. In addition, automobiles produced in the manufacturers in Ulsan and Asan are currently exported to Mongolia,thus, Busan port which is close to Ulsan is selected as the origin port in Korea. The port also has a good maritime connection to Tianjin Port of China and Vladivostok Port of Russia. On top of that, Vladivostok port is chosen because of the connection to Busan Port and TSR. Namely, TSR is directly connected to the dry port of Sukhbaatar in Mongolia. On the other hand, Pyeongtaek Port is not far away from the manufacturing site of automobiles (i.e. Asan) but also close to the port of Tianjin. Due to these reasons, this study includes Busan port and Pyeongtaek port as origin ports, respectively.

Currently, the Mongolian dry ports of Zamiin-Uud (from China) and Sukhbaatar (from Russia) are the only available options for the final legs, which are only available for dry ports connections from China and

Russia due to COVID-19.

Table 1 Transport route options from South Korea to Mongolia

No	Intermodal transportation Routes	Note
1	Origin(Asan)-Road-Incheon port(ICH)-Sea-Tianjin/Xingang(TXG)-Rail-Zamiin Uud(ZUU)-Rail-Destination	Existing route
2	Origin(Asan)-Road-ICH-Qinhuangdao port(QHD)-Rail-ZUU-Rail-Destination	Interviews with freight forwarders and automobile importers in Mongolia.
3	Origin(Ulsan)-Road-Busan port (BSN)-Sea-TXG-Rail-ZUU-Rail-Destination	Interviews with freight forwarders and automobile importers in Mongolia.
4	Origin(Ulsan)-Road-BSN-Sea-Vladivostok port(VVO)-Rail-Naushki(NSK)-Rail-Sukhbaatar(SBT)-Rail-Destination	Interviews with freight forwarders and automobile importers in Mongolia.
5	Origin(Asan)-Road-Pyeongtaek port(PTK)-Sea-TXG-Rail-ZUU-Destination	Interviews with freight forwarders and automobile importers in Mongolia.

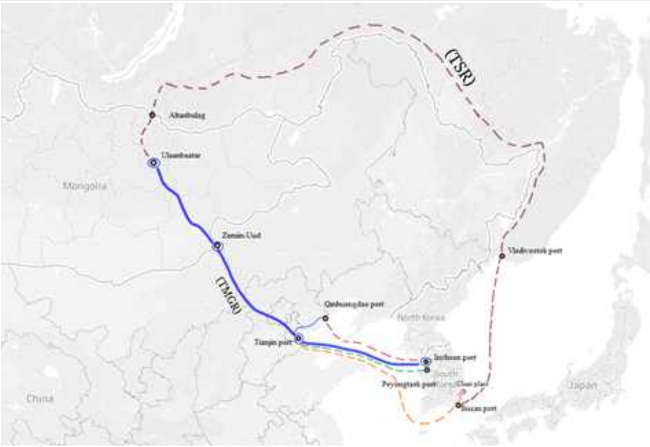


Table 1 shows the selected routes and their legs from origin to destination. The routes will be analysed and compared with each other based on the Time/Cost-Distance model. However, according to interviews with freight forwarders in Mongolia and Korea, lead-time for the five routes in Table 1 is not fixed but very uncertain taking 2~4 months from origin to destination during COVID-19. With regard to the costs, road transportation costs are obtained from the website of Forwarder.kr (https://www.forwarder.kr /tariff/), ocean freight and port charges at origin and destination (documentation, terminal handing and other additional costs) are obtained from the website of TradLinx (https://www.tradlinx.com/container-freight-rate-tariff), and the costs from destination seaport to the final destination are based on real data (i.e. quote rates) obtained from freight forwarders. It also needs to note that the costs used in this study are the average costs of the data sources in the different time frames from October 2021 to June 2022 because the costs of each leg are not fixed price but varied from time to time in a very frequent manner. For example, the quote rates obtained from forwarders include data in October, November, December 2021 and March, and June 2022 for route 1 but only November 2021 and May for route 2. Due to these reasons, this study uses the average costs of each leg based on collected data from different data sources.

4. Results and Discussions

Table 2 shows the information on distance, cost, and lead time in terms of both each leg and the overall supply chain. Each route consists of several different legs of transport modes with the cost of transport and time spent for distance. The same transport modes are commonly used for all routes including road transportation to the origin seaport, ocean transportation to the destination seaport, rail transportation to the dry port and to the final destination. The costs concern the shipment of FEU (forty-foot equivalent unit) on freight for a new car. Regarding lead-time, it is not easy to predict the cargo dwell time at the port (from cargo arrival to cargo departure) for all routes, leading to varied total lead-time of goods to Mongolia. However, the cost of transportation from Korea to Mongolia is suggested in detail based on various sources including websites and quote rates provided by freight forwarders.

Route 1(Asan-Incheon port-Tianjin/Xingang-Zamiin Uud-Destination) is the main corridor not only for automobile transportation but also for most of the cargo to Mongolia. This route includes a port-to-port service from Incheon port to Tianjin port by ship and then using rail transportation from Tianjin port to Zamiin-Uud dry port and the final leg ends in Ulaanbaatar by rail. The total distance from the origin (Asan Korea) to the destination (Ulaanbaatar) is 2,720km. The total cost is $7,361 and the leg of Tianjin port to the Mongolian border has the highest cost at $5,300. However, like other routes, this route reaches the maximum inefficiency of port operation during the COVID-19 period, especially due to the port lockdown, leading to the highest port congestion. For this reason, the automobile importer fails to receive their cargo at the estimated time of arrival.

Due to the congestion in Tianjin port, route 2(Asan-Incheon port-Qinhuangdao port-Zamiin Uud

-Destination) is suggested. Qinhuangdao port is located close to Tianjin port, which means the rail distance to ZUU is not much different. The total distance from the origin (Asan Korea) to the destination (Ulaanbaatar) is 2,760km. The total cost is $7,901 and the leg of Qinhuangdao port to the Mongolian border has the highest cost at $5,733. Compared to route 1, route 2 represents that the total distance is a little bit longer, consequently, the total cost is a little bit expensive. However, if there is no port lockdown this port can be an alternative port instead of Tianjin port, especially during the pandemic period.

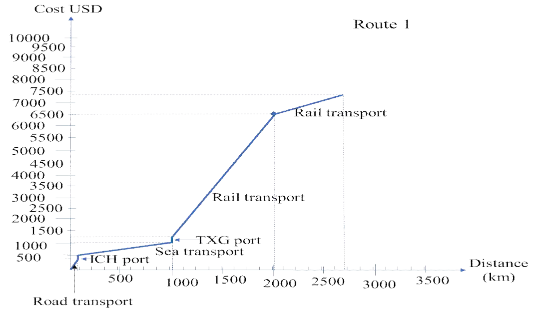
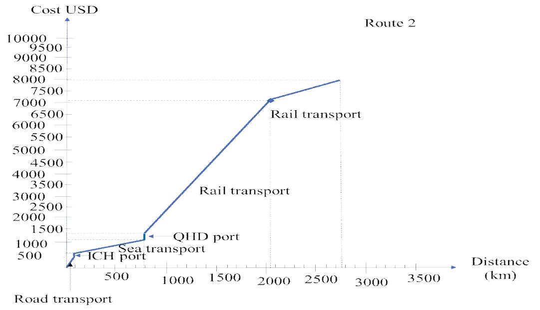
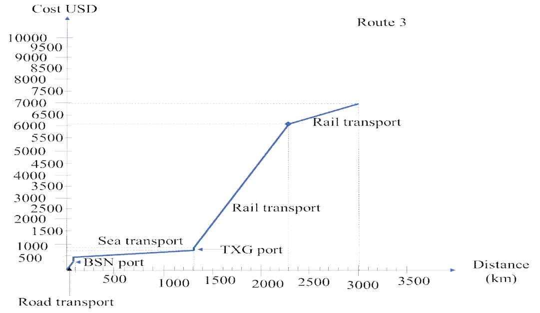
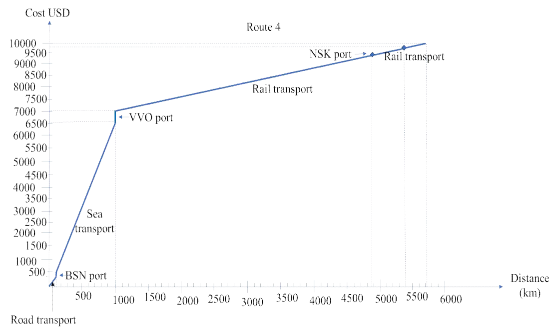
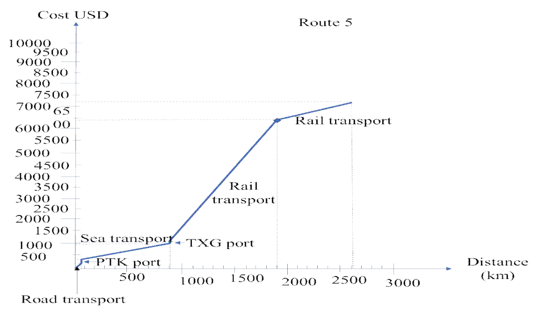
Route 3(Ulsan-Busan port-Tianjin/Xingang port-Zamiin Uud-Destination) is selected because Busan port is close to Ulsan, which represents a cheap cost for road transportation. In addition, the port has good port connectivity to Tianjin port in terms of its service frequency, representing cheap ocean freight and port charges compared to routes 1 and 2. Therefore, even though the route is a long distance of 3,006 km, the total cost($6,964) is cheaper than the other routes. This result indicates that the route can be an alternative route during BAU(business as usual).

Route 4(Ulsan-Busan port-Vladivostok port-Naushki(Russian dry port)-Sukhbaatar(Mongolian dry port)-Destination) demonstrates not only the longest distance but also the least uncompetitive route in terms of the total cost. However, this route also has great potential because Busan port is close to Ulsan as well as an excellent maritime connection to Vladivostok Port. Through the TSR, the rail connection directly links to the dry port of Sukhbaatar in Mongolia. The rail cost of TSR is generally more competitive than the cost of TCR, despite its long distance. However, the ocean freight surges at the highest level ever due to Covid-19(high demand as an alternative choice of ocean transport to Europe) and the Ukraine-Russia war (carriers' boycott of Russian routes), representing 5~7 times more expensive than the price prior to the catastrophes.

Route 5(Asan-Pyeongtaek port-Tianjin/Xingang port-Zamiin Uud-Destination) is selected because Pyeongtaek port is close to Asan as well as the shortest distance to Tianjin port. Thus, this route has low costs of road and ocean transportation, leading to low total costs next to route 3. This route has more competitive than the routes departing from Incheon port in terms of costs. However, the route does not have enough maritime service frequency with only 2 services per week to Tianjin port.

According to the analysis results in Table 2, each route can be ranked in terms of the total cost while, the lead-time for all options at the present of the COVID-19 period takes 2-4 months, representing no difference among the routes. In general, transport cost is crucial in transportation mode and route choice, but service lead-time, timeliness and reliability are also equally important. In this regard, we conduct semi-structured interviews with 2 automobile importers in Mongolia and 4 freight forwarders in Mongolia and Korea(2 forwarders in Mongolia and Korea, respectively) to ask about the transport quality and convenience of each route using a confidence index (Seo et al., 2017). The confidence index is used to evaluate service reliability including service timeliness(incidence of delay), accuracy on documents and information, the incidence of cargo damage, and responsiveness to special requests) for each route. The evaluation has been made using 5 scales (1) almost no confidence;(2) not very confident; (3) fairly confident; (4) confident; and (5) very confident. The confidence index of all routes is not impressive, indicating routes 1 and 2 are fairly low at 2.17 and 2.33. Other routes show the more serious results with not very confidence. For a better understanding of the results, we ask the participants the reasons why the results of the confidence index are low. The summary of their comments is that practitioners are reluctant to change their business practices, especially in multimodal transportation, the liabilities of partners in China and Russia are crucial and it is not easy to form partnerships with partners with good capabilities.Therefore, the leg of TXG-ZUU can be more attractive than the other legs between China(Russia) and Mongolia. However, Busan port has great potential as an origin port thanks to a short distance from the manufacturing site(Ulsan) and good maritime connectivity to Tianjin port.

Table 2 Time/Cost-Distance Analysis

Rroute	Leg	Mode	Distance (km)	Cost (USD)	Transit time	confidence index	Cost and distance figure
Route 1	Origin-ICH	Road	90	360	2 hours	2.17	
	Port			179	1~3 days		
	ICH-TXG	Sea	930	554			
	Port			158	2~4 months		
	TXG-ZUU	Rail	990	5,300			
	Dry port						
	ZUU-Des	Rail	710	810	2 days		
	Total		2,720	7,361	2~4 months		
Route 2	Origin-ICH	Road	90	360	2 hours	1.67	
	Port			179	1~3 days		
	ICH-QHD	Sea	690	640			
	Port			178	2~4 months		
	QHD-ZUU	Road	1,270	5,733			
	Dry port						
	ZUU-Des	Rail	710	810	2 days		
	Total		2,760	7,901	2~4 months		
Route 3	Origin-BSN	Road	66	291	2 hours	2.33	
	Port			155	1~3 days		
	BSN-TXG	Sea	1,240	255			
	Port			153	2~4 months		
	TXG-ZUU	Rail	990	5,300			
	Dry port						
	ZUU-Des	Rail	710	810	2 days		
	Total		3,006	6,964	2~4 months		
Route 4	Origin-BSN	Road	66	291	2 hours	1.5	
	Port			153	1~3 days		
	BSN-VVO	Sea	940	6,200			
	Port			378	2~4 months		
	VVO-NSK	Rail	3,890	2,700			
	NSK-SBT		500				
	SBT-Des	Rail	325	310	2 days		
	Total		5,721	10,032	2~4 months		
route 5	Origin-PTK	Road	19	170	1 hour	1.83	
	Port		16	156	1~3 days		
	PTK-TXG	Sea	880	610			
	Port		990	160	2~4 months		
	TXG-ZUU	Rail		5,300			
	Dry port		14				
	ZUU-Des	Rail	710	810	2 days		
	Total		2,629	7,206	2~4 months		

5. Conclusion

This study aims to identify new routes for transporting automobiles from South Korea to Mongolia by comparing them with the existing route. Through consecutive discussions with automobile importers and freight forwarders in Mongolia, the potential routes were selected and evaluated using the Time/Cost-Distance method (Beresford and Dubey, 1990) to provide various options for automobile logistics from South Korea to Mongolia. Table 2 demonstrates the analysis of Time/Cost-Distance of the 5 routes from South Korea to Mongolia, in which route 1 is mainly used by practitioners while the other four routes are newly selected for automobile transportation in this study.

The results identified in each route and its associated legs are as follows.

Route 3 (BSN-TXG-ZUU) shows the cheapest option with relatively short distance, representing cheaper than the original route(Route 1). In addtion, all routes have a low confidence index, but the route is the highest among them. However, the lead-time for all options at the present of the COVID-19 period takes 2-4 months, representing highly uncertain due to political risk (i.e. Chinese Policy regarding COVID-19). This directs that consigners and consignees in both Mongolia and South Korea pay more attention to the Chinese policy that is variable depending COVID situation in China.

Legs between the seaport of China/or Russia and the border of Mongolia share the longest distance and highest cost. Based on analyses of the Time/Cost-Distance and confidence index, it can be denoted the leg of TXG-ZUU is the most potential linkage. For this reason, most of the cargo to Mongolia has been transported through the TXG (Tianjin). However, during COVID-19, a large number of containers are being stuck at the port, leading to delay cargo to Mongolia. This situation lets importers and freight forwarders choose alternative transit sites, which may be helpful when the alternatives are available for streamlined services.

From the results of the legs between Korean Ports and Chinese/Russian ports, this work suggests diversified options of the origin ports in South Korea including Busan and Pyeongtaek, which has great potential when concerning costs. In particular, cargo handling charges and maritime freight are advantageous compared to those costs in Incheon origin routes. In addition, transportation through the Russian port of Vladivostok is the longest distance and most expensive option but takes a similar lead-time. However, longer lead-time in this route is mainly generated by TSR booking difficulty bouncing to Central Asia regions including Mongolia because logistics service providers pay more attention to the increased cargo to Europe due to high maritime freight rates. In this situation, making long-term relationships with logistics service providers may be helpful to tackle the problems.

Regarding the final leg from the border of Mongolia to the final destination, there are not many options except the two dry ports of ZUU and SBT, which is the only available dry ports from/to the seaport of China/or Russia during COVID-19. The other dry ports of Gashuunsukhait and Altanbulag are being closed due to the pandemic. The dry ports are not significant in trade volume and service frequency than ZUU and SBT, indicating longer train or truck waiting time to load full of freights. On the other hand, Mongolia should urgently complete the planned infrastructure projects of the geographically advantageous dry ports such as Bichigt, Gashuunsukhait, Altanbulag. The improved infrastructure would increase the capacity for alternative rail and road choices.

This study cannot make a conclusion about which route is superior to others because, according to Ganbat and Kim (2015), time and cost-related factors are equally crucial to other factors when forwarders choose a route of multimodal transportation between South Korea and Mongolia. However, this work provides the (real information of) critical parameters of distance, cost and lead-time in terms of selected transportation routes from South Korea to Mongolia so that importers and exporters can make a comparison among the routes in terms of their priority on each parameter. This can be fruitful to find an optimal solution for practitioners and policymakers in the manner of the second-best but not the best situation.

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