The following publication Yang, D., Jiang, L., & Ng, A. K. Y. (2018). One Belt one Road, but several routes: A case study of new emerging trade corridors connecting the Far East to Europe. Transportation Research Part A: Policy and Practice, 117, 190-204 is available at https://doi.org/10.1016/j.tra.2018.08.001.

One Belt One Road[1], But Several Routes: A Case Study of New Emerging Trade Corridors Connecting the Far East to Europe

Abstract:

Under the Belt and Road (B&R) initiative, two new emerging trade corridors connecting the Far East to Europe have been built. One is the China-Europe Sea-Land Express Line (CESEL) and the other is the New Eurasian Land Bridge (NELB). This paper aims to understand the attitude of relevant stakeholders towards the performance of the Traditional Sea-Land Line (TSLL) alongside the two emerging container routes under the B&R initiative. To achieve this objective, we first of all built a performance evaluation system to understand the relative performance of these trade routes. A questionnaire survey was carried out to reveal the differing views on route performance, and Fuzzy Multi-Criteria Decision Analysis (MCDA) was then used to examine and interpret the survey data. Secondly, by dividing the interviewees into two groups, we examined whether the government's development priorities are at variance with the preferences of industry practitioners. Thirdly, we explored the reasons for the variance by conducting an intensive interview with ten key stakeholders and then explain the findings from the perspective of institutional theories. Finally, we addressed the uncertainty and dynamics of route development under three different scenarios. Several managerial implications are proposed on the basis of our findings.

Keywords: Belt and Road (B&R) initiative; Eurasian trade corridor; Multi-criteria decision analysis; Scenario analysis.

[1] The official English term is now "Belt and Road (B&R) initiative".

1. Introduction

Traditionally, most trade cargoes from East Asia to central Europe are first of all transported by ship to the hub ports in Northwestern Europe, and then transshipped to the end customers in central Europe via either rail or inland waterborne transport.

With the launch of the Belt and Road (B&R) initiative in 2013, China has the ambitious goal of transforming regional political and economic landscapes over the coming decades by building a 'Silk Road Economic Belt' and a '21st Century Maritime Silk Road'. Massive investments into these infrastructure networks have already taken place. For the land-based routes, as of April, 2018 eighteen Chinese cities have successively opened direct railway container services to European cities, and most of these services are enjoying subsidies from the local governments. As for the oceangoing routes, in recent years COSCO Pacific Limited has continued to invest heavily in the Port of Piraeus (Greece), transforming it into an important hub port in Southern Europe. At the same time, China has cooperated with Central and Eastern European (CEE) cities to construct railways linking the capitals of Hungary and Serbia, namely, Budapest and Belgrade. Upon their completion in 2018, the travel time by train between Southern Europe and Central Europe will be significantly reduced. With the development of the above railway networks and the rise of the Port of Piraeus, the competitiveness of the new trading routes between Asia and Central Europe has been dramatically improved. According to the Xinhua News Agency, there were 3,637 trains running to Europe via the Eurasian rail line in 2017, which was an increase of 116% over 2016. At the same time, the port of Piraeus broke its own record for container traffic in 2017, showing a 6.4 percent increase at 3,691 million TEU in 2017 compared to 3,471 TEU in 2016.

The purpose of this paper is threefold. The first objective is to understand the attitude of relevant stakeholders towards the performance of the Traditional Sea-Land Line (TSLL) compared to the two emerging container routes under the B&R initiative, these being the China-Europe Sea-Land Express Line (CESEL) and the New Eurasian Land Bridge (NELB), by building a comprehensive evaluation method and criteria system. The three routes are shown in Figure 1. Compared to the TSLL, the CESEL reduces the shipping distance by 5,558 kilometers. Needing only half the transport time compared to the TSLL, the NELB is becoming attractive for transporting high value-added products, such as electronic devices, from production centers in China to Europe. However, this advantage is offset by its higher shipping cost and lower frequency. Shippers have to pay a much higher rail freight rate in comparison to the cost of transport by shipping, even though the former has already been substantially subsidized. The pros and cons of all three routes in various aspects, as well as their development potential, make the resulting route competition rather interesting and dynamic. Although this is an issue that has strong implications for policymakers and industry practitioners, the development potential and choice among these three routes have only received very limited attention in the extant literature.

Secondly, it is also worth noting that these two emerging routes are heavily government-driven compared to the Traditional Sea-Land Line that is market-driven. Therefore, it is both interesting and useful to explore the route choice preferences from the points of view of both government and industry practitioners, to see if there is consensus or disagreement among them—in other words, to ascertain whether the various governments' development priorities on these emerging container routes under the B&R initiative are at variance with the preferences of industry practitioners.

Thirdly, if such variance exists, then it would be interesting and useful to understand the reason for such variance between government policy-makers and industry practitioners, so as to create effective communication in order to reduce their differences of opinion.

Finally, the level of criteria exerts great influence over route performance results. This is especially so, given that the two emerging routes are still in the initial phase of development, and that the international shipping industry is fraught with great uncertainties. It is therefore highly relevant to incorporate potential changes of criteria in various scenarios, and to make route evaluation accordingly.

Therefore, this paper focuses on addressing the following research questions: How does the current competitiveness of the NELB and the CESEL compare to that of the TSLL? Do policymakers and industry practitioners share the same views with regard to decision priorities and route choice criteria? Which aspects should be strengthened by the policymakers in order to promote the development of the new routes? How will future uncertainties affect the competitiveness of the three trade routes?

Please insert Figure 1 here

Figure 1: The three container trade routes from East Asia to Europe

To address the above questions, this paper creates a framework for using the Multi-Criteria Decision Method (MCDA) to ascertain the performances of these three routes using real data. In addition, a questionnaire survey alongside an intensive interview with several key stakeholders have been carried out, and these reveal the differing views held by both policymakers and industry practitioners as to the priorities of the performance criteria. Finally, changes in performance under various scenarios are investigated, these including oil price volatility, the implementation of a global sulphur cap by 2020, and the possible effects brought about by implementing the B&R strategy.

The contribution made by this paper lies in the following three aspects: First, this is a preliminary attempt to systematically investigate the performance and potential of these alternative routes under the B&R background. Second, this paper combines a quantitative method (MCDA) and qualitative theory (insights from institutional theory) together, so as to understand the disagreement over criterion importance between government policymakers and industry practitioners. A criteria system has been developed that considers not only the determinants of mode choice in the presence of transport literature, but that also focuses on the B&R development background. Third, to account for the uncertain and dynamic development of the new routes, scenario analyses have also been made by taking advantage of multi-criteria comprehensive evaluation under uncertainties. Finally, we draw political and managerial implications, and provide suggestions for the development of these routes.

The paper is organized as follows: Section 2 reviews the literature on freight transport mode choice and the application of multi-criteria decision analysis. In Section 3, the evaluation criteria hierarchy and the MCDA framework are introduced. Section 4 presents the survey and discusses the results. In Section 5, an in-depth discussion is carried out based on the findings from an intensive interview with a few key stakeholders, and Section 6 presents the scenario analysis based on fuzzy comprehensive evaluation. Section 7 contains the final conclusion, as well as a summary of the limitations of this paper.

2. Literature Review

The Belt and Road Initiative is increasingly becoming a focal point for socio-economic–political interests because of its likely impact on land and sea transport and maritime logistics. According to Lee et al. (2017), the current knowledge of the B&R route is limited to its likely impact on trade flows and network connectivity. However, owing to the only recent release of B&R documentation and to poor data availability, empirical data is scanty, and the number of quantitative research papers is limited.

With regard to the impact of the Eurasian Land Bridge rail improvement on shipping, Psaraftis and Kontovas (2010) studied the competition between ocean shipping and rail between East Asia and Europe, taking into account environmental factors. They found that the Eurasian rail route has become more competitive than shipping, particularly for the more expensive cargoes. Shipping can maintain its share only if the shipping freight rate decreases, and this is only for cheaper cargoes. Chen et al. (2017) developed a game theoretic model to analyze competition between rail and shipping against the background of the development of intercontinental Sino-Europe container freight transport. They numerically evaluated the model and concluded that this model of railway transport will continue to evolve under the new circumstance of the B&R, provided the frequency is higher, and the waiting time and cost can be significantly reduced. Rodemann and Templar (2014), using data collected from the literature and interviews, intended to identify the factors that enable/inhibit Eurasian rail freight, and to understand how such inhibitors can be overcome. They ascertained that the Eurasian land bridge can take in a minor share of Eurasian (container) transport. Nazarko et al. (2017) investigated the potential of the rail and maritime route linking Europe and Asia under the Chinese Silk Route Initiative, and pointed out that rail transport, in the framework of the B&R, could increase the export opportunities and price competitiveness of EU agricultural products. Shao et al. (2017) proposed a method of selecting the place in most urgent need of transnational high-speed construction in the B&R region. They tested the model with massive experimental data, and the results show that 18 priority road sections urgently need to proceed with the construction of high-speed railways so as to meet the increasing trade volume. Yang, Pan and Wang (2017) reconstructed the shipping network for a shipping carrier, using a bi-level optimization model to consider the competition from rail against the background of the New Eurasian Land Bridge rail service improvement and the Budapest-Piraeus railway. They found that even if the transport capacity is upgraded and the freight rate is reduced, the transport cargo volume through the Eurasian Land Bridge rail system will only achieve a slight increase over the current freight rate. It is found that most researchers share an optimistic attitude towards the development of Eurasian rail under the B&R background, but this is subject to different requirements.

Several factors, including cost (price), time, reliability, and flexibility are broadly used as criterions in mode choice between rail and sea (e.g. Puckett et al., 2011; Brooks et al., 2012; Yang et al., 2017; Panagakos and Psarafitis, 2018). In particular, Yang et al., (2014) explored the potential impact of trade data aggregation on commodity mode choices between ocean shipping and other transport modes. They selected 9 commodity types out of 99 commodities in terms of HS code for which shipping and other transport modes compete. They found that commodity nature, for example value and weight, can be used as a criterion for measuring the mode split at macro level. Psaraftis and Kontovas (2010) and Zis and Psaraftis (2017) formulated generalized freight cost functions by converting all other factors into cost. Haezendonck (2008) pointed out that, with the development of evaluation tools and the involvement of more stakeholders, the performance of a transport project is increasingly evaluated based on a multi-criteria system. He also suggested that not just pure economic effects should be included, but also ecological, spatial and social aspects, which are becoming more and more important. World Bank (2005) provided a multiple evaluation system in a report named “Best Practices in Corridor Management”. The two emerging trade routes in our study, namely NELB and CESEL, are still in the early phases of development, thus leaving great uncertainties, as well as challenges and opportunities. Criteria such as governmental support, infrastructure, and geopolitical stability, play a particularly important role in promoting these new routes at the present stage, but these are also difficult to be generalized and quantified. Together with the poor data availability owing to such recent release of B&R documentation, this study chooses to utilize the MCDA method to quantify the performance of the three alternative routes. MCDA is a procedure that consists of finding the best alternative among a set of feasible alternatives (Sanchez-Lozano et al., 2013). There have been lots of studies in the literature using TOPSIS (Chen, 2000; Chu and Lin, 2002; Dagdeviren et al., 2009; Vaidya and Kumar, 2006; Sipahi and Timor, 2010; Huang et al., 2011) and extended (interval) TOPSIS (Giove 2002; Tsaur, 2011; Yue 2011) for the solution of MCDA problems. TOPSIS has often been applied alongside other methods, such as the AHP (Onut 2008; Sun 2010; Ravi 2011; Samvedi 2013). The applied MCDA framework will be further introduced in the next section.

3. MCDA Methodology

3.1 MCDA framework

The MCDA method applied in this paper is based on the AHP as well as both the traditional TOPSIS and its extended form. More specifically, the AHP is used to analyze the structure of the evaluation criterion system and to determine the weights of the criteria. The traditional TOPSIS method is to rank the three alternative routines given all input data are fixed values. The extended TOPSIS method is used to obtain the performance ranking of the three routes under different scenarios while taking into account various uncertainties. The framework of the MCDA consists of four stages, and these are shown in Figure 2 below.

Please insert Figure 2 here

Figure 2: MCDA Framework applied in this study

The four stages of this framework are specified as follows:

Stage 1: Recognition of the evaluation criterion system

Stage 2: Calculation of weights by AHP

Stage 3: Prioritization of route alternatives using traditional TOPSIS, based on the weights calculated by AHP

Stage 4: Scenario analysis (Oil price volatility, global sulphur cap, effects of B&R initiative), using extended TOPSIS

3.2 Criteria system

The criteria selected for this study are based on extant literature (Haezendonck, 2008; Garcia-Menendez et al., 2004; Brooks and Trifts, 2008; Wong, Yan & Bamford, 2008; Psaraftis and Kontovas, 2010; Bergantino et al., 2013; Yang et al., 2014). We divide our criteria into five categories, these being technology, economics, environment, governance and commodity nature.

Technology and economics are two common criteria adopted by most of the relevant literature. In this study, technology is further divided into two sub-criteria, namely, transport network infrastructure and logistics operation efficiency. Given the relevance of criteria applied in the literature, we selected three indicators for economics, these being freight rate, trip time, and trip frequency.

Environmental indicators are increasingly considered as key criteria in the development of the shipping industry (Garcia-Menendez, 2004 and Psaraftis and Kontovas, 2010). For shipping, the most urgent environmental problem is ship emissions into the air, which in this paper are quantified as CO_2 and SO_x.

The NELB and CESEL routes are initiated by the Chinese government, and both the Chinese government and nations alongside the Belt and Road play an important role in promoting the new routes, so governance is also taken into consideration as a primary criterion. Governance is further divided into two sub-criteria, namely, geopolitical stability and governmental support. It is noted that reliability is one of the most important factors for transportation mode decisions. For our study, since the two emerging routes both pass through multiple countries, the policies, diplomatic relations and even political regime of some of these countries are not stable. Thus, geopolitical stability is recognized as the most important facet affecting the reliability. In addition, whether government support will be sustained, and how it will change in the future, is now also unclear—and this too increases the risks in choosing this route.

For these reasons, we didn't list reliability as a single sub-criterion in the criteria system.

Commodity nature is often adopted as a criterion in long distance transport studies, as for example in Brooks and Trifts (2008) and Yang et al., (2014). Time sensitivity, cargo value and cargo fragility are selected as sub-criteria under commodity nature.

Criteria can generally be categorized into three groups. Infrastructure, operation efficiency, trip frequency, geopolitical stability, and government support are positively related to the performance of the route, and can thus be regarded as beneficial factors. Freight rate, trip time, and the effect of emissions are negatively correlated with the route performance and thus are cost factors. The third group comprises neutral factors such as time sensitivity, cargo value and cargo fragility that describe the commodity nature, the high values of which do not necessarily indicate a better route performance. Instead, the degree of proximity of the neutral factor, which is the difference between the actual value and a benchmark value of the neutral factor, can be used to judge which route is the more appropriate for transporting the cargo. More specifically, the benchmark value of neutral factor X is the arithmetic mean of its values for the studied routes. The negative degree of proximity indicates that the cargo is more likely transported by the shipping routes; the positive degree of proximity indicates the cargo is more likely transported by the rail route (Yang et al., 2014). Taking cargo time sensitivity for example, the value on the three routes (NELB, CESEL, TSLL) are 3.57, 3.41 and 2.89 respectively obtained from the questionnaire. Its benchmark value for the three routes is then 3.29, by taking the arithmetic mean of its values on three routes. Therefore, the degrees of proximity on the three routes (NELB, CESEL, TSLL) are calculated as the difference of actual value and benchmark value, namely 0.28, 0.12 and -0.4. The result suggests that NELB and CESEL route is more appropriate for transporting time sensitive cargos, while TSLL doesn't favor these cargoes.

In summary, the decision-making problems can be decomposed into a hierarchy, where the first level includes the 5 primary criteria and the second level specifies 12 sub-criteria. The primary criteria and sub-criteria, as well as their detailed descriptions, are shown in Table 1 below.

Please insert Table 1 here

Table 1: Evaluation criteria system used in this study

3.3 MCMA methods description

The AHP is one of the most popular MCDA tools used for decision-making. It was originally introduced by Saaty and since then has been widely applied in operations management (Saaty, 1977). The AHP can help to properly determine the weight of each criterion involved in the final outcome of the resulting layers. The TOPSIS was originally developed by Hwang & Yoon (1981). The TOPSIS is for determining the priority sequence of multiple alternatives by taking into consideration multiple criteria. It is based on the principle that the best alternative is the one that has the shortest geometric distance to the positive-ideal solution and the longest geometric distance from the negative-ideal solution. Different to other MCDA methods, the TOPSIS allows trade-offs between criteria, where a poor result in one criterion can be negated by a good result in another criterion. It provides a more realistic form of modeling which doesn't simply include or exclude alternative solutions based on hard cut-offs (Huang et al., 2011). As for the application of the TOPSIS method on shipping routes, the integrated priorities of the alternative routes can be determined directly without standardization, making it convenient for decision-makers to select the best route among multiple alternatives under China's B&R initiative. In addition, we can utilize its extended form to obtain the performance ranking of the emerging trade routes under various uncertainties.

Under the proposed scenarios, some factors are assumed to be subject to potential improvement. To allow for potential changes to the criteria in various scenarios, extended TOPSIS is employed. Extended TOPSIS considers the mixed-type (with both crisp numbers and interval numbers) decision-making matrix, rather than exact information (the crisp numbers) decision-making matrices. Mixed-type decision-making matrices can first be transformed into interval decision-making matrices by transforming all the crisp numbers into interval numbers, according to Eq.(1) below.

$$\boldsymbol{x}_{ij} = \begin{bmatrix} \boldsymbol{x}_{ij} & \boldsymbol{x}_{ij} \end{bmatrix} \qquad \text{Eq.(1)}$$

Following this process, the interval decision-making matrix can be determined, as presented in Eq.(2) below.

$$\begin{array}{llcccc} & & C_1 & C_2 & \cdots & C_n \\ Routine & 1 & \begin{bmatrix} x_{11}^L & x_{11}^U \end{bmatrix} & \begin{bmatrix} x_{12}^L & x_{12}^U \end{bmatrix} & \cdots & \begin{bmatrix} x_{1n}^L & x_{1n}^U \end{bmatrix} \\ Routine & 2 & \begin{bmatrix} x_{21}^L & x_{21}^U \end{bmatrix} & \begin{bmatrix} x_{22}^L & x_{22}^U \end{bmatrix} & \cdots & \begin{bmatrix} x_{2n}^L & x_{2n}^U \end{bmatrix} \\ \vdots & & \vdots & \vdots & \ddots & \vdots \\ Routine & m & \begin{bmatrix} x_{m1}^L & x_{m1}^U \end{bmatrix} & \begin{bmatrix} x_{m2}^L & x_{m2}^U \end{bmatrix} & \cdots & \begin{bmatrix} x_{mn}^L & x_{mn}^U \end{bmatrix} \end{array} \qquad \text{Eq.(2)}$$

where $\begin{bmatrix} x_{ij}^L & x_{ij}^U \end{bmatrix}$ represent the value of the i-th routine with respect to the j-th criterion, and x_{ij}^L and x_{ij}^U are the lower and upper bounds of the interval number $\begin{bmatrix} x_{ij}^L & x_{ij}^U \end{bmatrix}$.

In order to avoid any interference from differences in units/dimensions of these data, the interval decision-making needs to be normalized according to Eqs.(3)-(5).

For data with respect to beneficial criteria,

$$\begin{bmatrix} y_{ij}^L & y_{ij}^U \end{bmatrix} = \begin{bmatrix} x_{ij}^L / \max\limits_{i=1,2,\ldots,m} \left\{ x_{ij}^U \right\} & x_{ij}^U / \max\limits_{i=1,2,\ldots,m} \left\{ x_{ij}^U \right\} \end{bmatrix} \quad j \in B \qquad \text{Eq.(3)}$$

For data with respect to cost criteria,

$$\begin{bmatrix} y_{ij}^L & y_{ij}^U \end{bmatrix} = \begin{bmatrix} \min\limits_{i=1,2,\ldots,m} \left\{ x_{ij}^L \right\} / x_{ij}^U & \min\limits_{i=1,2,\ldots,m} \left\{ x_{ij}^L \right\} / x_{ij}^L \end{bmatrix} \quad j \in C \qquad \text{Eq.(4)}$$

As for data with respect to neutral criteria, the data applied in this study are crisp numbers, and $x_{ij}^L = x_{ij}^U$ in such a case, so we can normalize the data by

$$\left[y_{ij}^{L} \quad y_{ij}^{U} \right] = \begin{cases} \left(\max\limits_{i=1,2,\ldots,m} \left\{ x_{ij}^{U} \right\} - x_{ij}^{L} \right) / \left(\max\limits_{i=1,2,\ldots,m} \left\{ x_{ij}^{U} \right\} - x_{ij}^{Benchmark} \right) & x_{ij}^{L} = x_{ij}^{U} > x_{ij}^{Benchmark} \\ \left(x_{ij}^{L} - \min\limits_{i=1,2,\ldots,m} \left\{ x_{ij}^{U} \right\} \right) / \left(x_{ij}^{Benchmark} - \min\limits_{i=1,2,\ldots,m} \left\{ x_{ij}^{U} \right\} \right) & x_{ij}^{L} = x_{ij}^{U} < x_{ij}^{Benchmark} \\ 1 \quad x_{ij}^{L} = x_{ij}^{U} = x_{ij}^{Benchmark} & \end{cases}$$

Eq.(5)

where $\left[y_{ij}^{L} \quad y_{ij}^{U} \right]$ represent the normalized value of the *i*-th routine with respect to the *j*-th criterion, and y_{ij}^{L} and y_{ij}^{U} are the lower and upper bounds of the interval number $\left[y_{ij}^{L} \quad y_{ij}^{U} \right]$. The $x_{ij}^{Benchmark}$ is the benchmark value for commodity nature.

4. Data description and results analysis

4.1 Data description

In 2016, an online survey was conducted. The questionnaire was distributed among a broad spectrum of relevant stakeholders. As discussed previously, the NELB and CESEL have been largely driven by the Chinese government, rather than by the market. Thus, it is interesting to explore whether there is consensus or disagreement between government and industry practitioners' attitudes towards the new routes. Therefore, our target audience for the online survey includes not only various industry practitioners but also government officials and their think-tanks. The survey was thus constructed for this audience of people, ones who are experts in this area either because of years of practical experience or of direct or indirect involvement in shaping the B&R strategy.

In total we received 117 responses, among which 39 (33.3%) are researchers from government owned research institutes, 5 (4.3%) are from relevant government bodies, 10 (8.5%) are shippers, 14 (12.0%) are logistics operators, 17 (14.5%) are freight forwarders (The difference between freight forwarders and logistic operators is that the former basically do not have any fixed assets, but only organize shipments for individuals or corporations. In contrast, the logistic operator can have warehouses and trucks, and in some cases they are secondary companies of shippers), 7 (6.0%) are ship owners, 5 (4.3%) are port operators, 2 (1.7%) are shipping brokers, and another 18 (15.4%) are from other disciplines. Among these, 36 (30.8%) respondents work in private companies, 21 (17.9%) are in state-owned companies, and 5 (4.3%) are from joint ventures and foreign companies. 44.4% of our respondents have more than 10 years working experience, and 19.7% of the respondents have 7-10 years working experience. To test for any possible difference between respondents from government and industry, we divided them into two groups, Group 1 having a total number of 44 respondents from government (37.6%) and government-owned research institutes,[2] and Group 2 containing all 55 respondents from within the industry (47.0%).[3] If the respondents did not belong to any of the listed options, we labeled them as 'others'. These 'others' include third party researchers from universities and consultants, and professionals from transport service enterprises such as shipping insurance companies, banks and so on.

The values of the selected criteria are collected or calculated from different resources. The six criteria, namely transport network infrastructure, logistics operation level, geopolitical stability, governmental support, time sensitivity and cargo fragility are descriptive statistics. Therefore, the respondents were asked to rate them on a five-point scale in the questionnaire, and the respective average values were calculated. The criteria average values and data sources can be found in Table 2. For the descriptive value, the standard deviations from the average value are also provided in the table. Group 1 in the table denotes the government group, and Group 2 denotes the industry group.

Please insert Table 2 here

Table 2: Criteria values and data sources

[2] The government institutes include China Waterborne Research Institute (WTI), which is the only waterborne related think tank under the Ministry of Transport, China (MOT), the Institute of Comprehensive Transportation of the National Development and Reform Commission, which focuses on intermodal development plans in China, National Railway Administration.

[3] The industry enterprises include shippers, liner shipping companies, logistics operators, freight forwarders, ship owners, port operators and shipping brokers.

4.2 Calculation of weights using the AHP

By applying the AHP methodology, Table 3 shows the weights of evaluation criteria from all respondents (we name this the aggregated group), the government group (Group 1) and the industry group (Group 2). To ensure the consistency of interviewees' judgements, the Consistency Index (C.I.) and Consistency Rate (C.R.) have also been tested and illustrated in Table 3. Throughout our analysis, C.R.s are less than 0.1, which indicate that the degree of consistency of interviewees' subjective judgements for AHP analysis is acceptable (Saaty, 2002). It is noted that the eigenvector method of AHP has been criticized for having potential problems such as rank reversals. To validate the weights estimated by the eigenvector method, we have also calculated the weights by using the geometric mean method (Barzilai et al. 1987). There is no significant difference in the weights estimated by these two approaches.

For the aggregated group, economics (0.50) shows the highest weight, followed by governance (0.24), commodity nature (0.16), and the environment (0.06), with technology (0.05) being the lowest weight. Compared to the aggregated group, the criterion priorities in Groups 1 and 2 are slightly different—commodity nature and governance swapped their places in both groups. However, the weights of some indicators are remarkably different. For example, the economic criterion has a much higher weight in the government group (0.56) than in the industry group (0.37), whereas commodity nature and governance have a much higher weight in the industry group (0.29 and 0.23) than in the government group (0.16 and 0.16). This difference underscores the absolute importance of the economic criterion considered by the government, while industry thinks that commodity nature and governance have equal importance alongside the economic criterion in evaluating route performance.

Please insert Table 3 here

Table 3: Weight of evaluation criteria in different groups

Table 4 further illustrates the weight of sub-criteria for aggregated group, government group and industry group respectively. The result indicates that multiple factors have significant effects on route performance — in particular, a strong preference for geopolitical stability (0.146), time sensitivity (0.13) and governance support (0.087) over transport cost (0.086) is observed in the industry group. In contrast, these three criteria are weighted much lower (0.097, 0.091 and 0.058) by the government group. This means that industry respondents have a greater willingness to pay for better performance in these factors.

Please insert Table 4 here

Table 4 Evaluation weights of sub-criteria in aggregated group

4.3 Prioritization of route alternatives using TOPSIS

It is noticed in Table 2 that the actual values of sub-criteria are in different magnitudes and units, which makes it difficult for them to be standardized and integrated, but by applying the TOPSIS method, there is no need to standardize the criteria. This also prevents the possibility that the performance values among the alternatives are too close to be distinguished, which has been observed in much of the previous literature (Wang and Elhag, 2006; Wu et al. 2018). Based on the weights listed in Table 3， Table 4 and the actual values summarized in Table 2, the performances of the three trade routes are calculated using the traditional TOPSIS method, following the procedure described in Section 3.3. The results are presented in Table 5 below.

Please insert Table 5 here

Table 5: Calculated performance of the three trade routes

The three groups (namely All Group, Group 1 and Group 2) reach the consensus that the TSLL has the best performance, followed by the CESEL, with the NELB being in last place. The difference in performance among the three routes is significant. It is worth noting that the government group and the industry group have different attitudes towards the performance of the NELB. The NELB receives an approximately 10% higher performance score from the government group (0.260) than from the industry group (0.238). This implies that the current development of the NELB, and its future prospects, may not receive the same degree of recognition from both groups. In contrast, the major part of the CESEL is already part of the traditional shipping trunk line, and has well-developed bases, such as the port of Piraeus. In addition, countries along the rail route are all in Europe and have a similar culture, and are thus viewed as having fewer uncertainties by industry practitioners.

5. Discussion

The model has identified the different preferences between policymakers and industry practitioners as to route choice. It is interesting for us to understand the reason for this variance. In addition, the model result may be affected by certain other factors, such as the selection of route choice criteria and interviewees, and the heterogeneity of the shipment. We therefore further conducted an intensive interview with several key stakeholders, hoping to understand the answers to the following three questions:

1) The current competitiveness of the rail service compared to shipping transport;
2) The reasons why government policymakers and industry practitioners weight differently on route choice criteria;
3) The way that government policymakers and industry practitioners can have effective communication in order to harmonize their opinions.

In total, ten anonymous people were interviewed, including five policymakers involved in formulating the new Eurasian corridors, and five industry practitioners who are currently working on the marketing and operation of the Eurasian train service. Table 6 below presents details about the interviewees:

Please insert Table 6 here

Table 6: List of interviewees

From these interviews, we first found that the heterogeneity of sea and rail transport has an impact on their own competitiveness. The NELB has shorter transport time. As a result, shippers are more interested to use the NELB when transporting “high value or time sensitive" cargos, such as "electronic devices" and "e-commerce commodities", whereas traditional sea transport (CESEL and TSLL) is more superior as to freight rate and transport volume. Given its limited transport volume, shippers do not yet consider the NELB as a competitive mode for large quantities of goods. For such goods, the NELB at the present stage is more like a supplementary mode of transport. However, as mentioned in introduction, there have already been 3,637 trains in service on the Eurasian corridor during 2017, which was more than the total number during the whole previous five years. This dramatic development may imply its great potential for increased competitiveness in the future. The industry interviewees also explained that the shippers who prefer the NELB are mostly small in size. These shippers are more sensitive to freight rate change, but more importantly, are more flexible as to the shift in operation mode. In contrast, large shippers place more emphasis on the stability and reliability of the transport corridor, which is where the NELB currently lags far behind that of sea transport. Thus, large shippers have so far tended to take a 'wait and see' attitude, which explains why industry practitioners highly weight commodity nature.

Second, there are three key actors involved in China's B&R railway implementation, namely, the central government, the local authorities (for example, the Chongqing Municipal Government), and industry practitioners at all levels. In considering the criteria for route choice (Table 1), the central government has played a decisive role in planning the NELB and affecting the route performance. For example, the NELB has been strategically planned to transit through cities having strong electronics manufacturing industries that support the growth in rail transport. As a result, the commodity nature of the route has been indirectly defined. Also, China is committed to dozens of large-scale investments to improve the transport infrastructure and logistics operation efficiency. The government can also strengthen the geopolitical stability of the route by making long-term bilateral or multilateral agreements with countries through which the railway passes. However, despite its decisive role, the central government has not issued any concrete development prospects for the NELB in its mid-term (5-10 years) future, and thus there are still great uncertainties over its primary criteria trends, which could affect its overall performance. For instance, whether the infrastructure will continue to be promoted in the future as planned, for how much longer the freight subsidy can be sustained, what the relevant countries' attitudes are towards this initiative, and so on.

In China, the central government has maintained a top-down approach in decision-making and has used administrative relationships to manage central-local relations. Local governments have little power to define national policy or to make a central-local bargain. In addition, central government not only controls critical resources (e.g. policy resources and finance) but has also decisively impacted on the appointment and promotion of local officials. Therefore, once the central government signals a clear policy on policy direction, local authorities tend to make active and symbolic responses (Marquis, and Qian 2014, Yin and Zhang 2012). However, local authorities lack the means to promote the NELB, being mostly confined to the establishment of local companies or to financial means such as subsidies. Moreover, the power of the central government is reinforced by the lack of horizontal coordination among local governments, with most of them defending their own political interests. For example, some local authorities are described by the interviewees as “speculators” and “followers”, who do not fully understand, or lack the means to match, the needs of local industry. This has amplified the differences among cities in terms of profitability and efficiency of the NELB. For example, Chongqing, which is located in the west of China and has a large amount of exported electronic commodities, is profitable, whereas Wuhan, in the middle of China, is losing money.

Indeed, the current multiple-level institutional system impedes effective communication between industry practitioners and actual government policy-makers, leading to disagreement between the policymakers and industry practitioners. From the bottom to the top, local industry practitioners put forward their wishes for change as to local authority over the NELB. However, the central government has only defined the fundamentals of the development plan, so what the local authority can do is limited to the economic subsidy. The industry’s real needs on factors affecting their choice of the NELB has not been correctly conveyed to the central government, nor addressed with a systematic overview.

The above disparity can be further explained by applying the notion of “trajectory activities” presented by Child, Lu and Tsai (2007). They applied the notion of “trajectory activities” to explain the difference between a developed country and China when forming a system. They indicated that in most developed countries, it follows the bottom to top trajectory, which begins with a cognitive system, goes through a normative system and results in a regulative system. However, in China the formation of one system was characterized by a ‘made order’, in which the regulative system came first, with the state and its agencies dominating the process as the principal institutional entrepreneurs, resulting in the strategies of the central government having different effects at a local level. As a result, the efficiency of new policies is low.

Facing this situation, Child, Rodrigues and Tse (2012) offered new theoretical and empirical insights to facilitate the co-evolutionary development between government and industry in China. One is to provide a specific proposal for change in both the firm and its environment, and the second is to build a concrete relational framework between the actors. Based on our own understanding and these theories, we can note some policy and managerial implications for the new routes.

For central government, firstly, it urgently needs a national implementation plan with concrete details, rather than just a national policy. This will reduce all the speculation around launching the NELB and will clear away any doubts and uncertainties about it. Secondly, it is important to build a concrete relational framework, and to apply appropriate policy instruments to monitor and integrate the existing NELB. For example, to aggregate the services into a few key cities, which have appropriate trading commodity structure and good location for the NELB, and to increase train frequency and transport capacity. Thirdly, it is necessary to improve the geopolitical stability and infrastructure on the NELB, as this is of great concern to the industry practitioners so that more large shippers are attracted to using this route. For local authorities, it is very important to rationally judge if the local industry structure is suitable for developing the NELB, not just to provide a subsidy that is not sustainable in the long term.

It is noted that the current intermodal connection between the port of Piraeus and the hinterland of Middle and East Europe is erratic. Due to poor facilities, the speed and capacity of the rail system is limited. There is also no efficient rail operator providing a regular train service, causing the frequency and efficiency of the CESEL to be very low. Current improvement of the CESEL should focus more on infrastructure construction, inter-governmental coordination and management. As with the CESEL, one primary constraint is the poor geopolitical stability of countries along the routes.

However, this challenge in turn implies that there is great potential for improvement.

6. Scenario analysis

It is noted that the international shipping industry is fraught with great uncertainties, factors such as fluctuation of the oil price and the issuance of new regulations making the market very unpredictable. On the other hand, the development of the two new routes is still in the initial phase and is thus also subject to many changes. Therefore, it is highly relevant to incorporate potential changes of criterion into the various scenarios and to make route evaluations accordingly. In this section, three scenarios are introduced below to estimate the potential changes of primary criteria and their combined impacts on route comparison.

6.1 Scenario of oil price changes

Bunker cost is the most important cost element for ship operation, and is heavily influenced by the fluctuation of oil prices. Given its importance, a variety of oil prices is assumed under this scenario. As a result, the shipping freight rate, sailing speed, and thus seaborne transport time will be adjusted accordingly to accommodate bunker cost changes. At the same time, the amount of fuel consumed will also be affected, which will lead to a change in carbon dioxide (CO_2) and sulphur oxide (SO_x) emissions from ship exhausts.

The variation range of crude oil prices is based on historical Brent Oil prices obtained from the U.S. Energy Information Administration. The effect of raising crude oil prices on maritime transport costs has been investigated by Martino et al. (2009), who found that doubling the crude oil price results in a 50% increase in maritime transport costs. In the case of a plunge in oil prices, the shipping freight rate is assumed to remain the same, because price undercutting by liner operators with respect to a low bunker price has not been very effective. It is assumed that land transport segments for the three routes are operated by electric train only, and therefore the rail freight rate is assumed to be unaffected by any oil price fluctuation and thus remains unchanged. The optimal sailing speeds at sea for the three scenarios are obtained from Wang and Meng (2012). It is worth noting that the time for rail transport, as well as that for maneuvering, cargo handling and berthing in ports, remains constant throughout all three scenarios.

Any change in sailing speed will directly affect the amount of a ship's air exhausts. In order to estimate the effect on ships' emissions, the details of an Emma Maersk vessel have been adopted[4] as an example. Also, the sulphur Emission Control Areas (ECA) Regulation has been taken into consideration, namely, that a ship will switch from Heavy Fuel Oil (HFO) to Marine Gas Oil (MGO) with 0.1% sulphur content when entering any ECA. On this basis, ship emission factors and emission amounts are obtained from the ship emission model developed by Kristensen (2012), which considers main ship particulars, engine types, and operating conditions (Jiang et al., 2014). This study concentrates on two types of ship emission, namely CO_2 and SO_x. The values of changed indicators can be found in Table 7.

Insert Table 7 about here

Table 7: Input values for oil price change scenarios

6.2 Scenario of the 2020 global sulphur cap

With the tightening of regulations on ship emissions and their impacts on air quality and climate change, the International Maritime Organization (IMO) has set a global limit for sulphur in fuel oil used on board ships of 0.5% m/m (mass by mass) from 1 January 2020.[5] This will significantly reduce the amount of sulphur oxide from ships and will promote health and environmental benefits throughout the world. To comply with this regulation, ship operators will need to adopt cleaner but considerably more expensive marine gas oil (MGO), or the use of LNG as a fuel for shipping, or invest in abatement technologies such as scrubbers. All these measures come with compliance costs, which can generally be passed on to shippers, as for example by raising the freight rates. In this scenario, it is assumed that the MGO solution will be adopted for Emma Maersk. Price forecasts for MGO from the Danish Maritime

[4] Ship specifics for Emma Maersk can be found at http://www.emma-maersk.com. This is the first E-class container ship owned by the A.P. Moller-Maersk Group and is still extensively used for the round trip between Europe and Asia.

[5] http://www.imo.org/en/MediaCentre/HotTopics/GHG/Documents/FAQ_2020_English.pdf

Authority (DMA) have been used (DMA, 2015) to study various price scenarios.[6]

As in the oil price change scenario, MGO price changes are assumed to lead to higher container freight rates. Nevertheless, lower emissions of SO_X can be achieved by using cleaner MGO. The values of changed indicators can be found in Table 8.

Insert Table 8 about here

Table 8: Input values for 2020 global sulphur cap scenarios

6.3 Scenario of B&R effects on emerging routes

Among the three routes, the TSLL has been well developed over many years, thus presenting the best performance on criteria such as freight rate, trip frequency, infrastructure, operational efficiency and geopolitical stability. The performance of the CESEL on these criteria is no better than the TSLL, and there is also still room for improvement of its port and rail infrastructure. As the most recently developed route, the NELB has relatively weak performance with regard to economics, technology and geopolitical stability. However, its advantages show up in trip time and governmental support.

Under the B&R initiative, significant resources have been invested into improving the performance of these two emerging transport routes. In this scenario, the two emerging routes are assumed to have experienced improvement in various respects over their current development.

For the CESEL route, one milestone development is that COSCO has already obtained the approval of a concession agreement from the Piraeus Port Authority, which clears the way for the acquisition of a 67 percent stake in the port by COSCO.[7] It is expected that the investment by COSCO in the port will continue. Therefore, the

[6] Since the sulphur regulation was introduced in 2015, an increased demand for low sulphur MGO is expected and thus there is no low price scenario.

[7] http://www.joc.com/port-news/european-ports/port-piraeus/piraeus-port-authority-approves-cosco-concession_20160613.html

capacity and operational efficiency of the Piraeus Port will be further improved. Furthermore, the new railway linking Hungary and Serbia, sponsored by China, will complete construction in 2018, and naturally this new rail service will also be promoted. Therefore, in this scenario, it is assumed that the freight rate, trip frequency, infrastructure and operational efficiency of the CESEL will gradually increase to the levels of TSLL in the future.

For the NELB route, with the announcement by the Chinese Government in March 2016[8] of the 'Vision and Actions on Jointly Building Silk Road Economic Belt and 21st Century Maritime Silk Road', certain projects, for example the China-Kazakhstan Logistics Terminal and the China-Kazakhstan Horgos International Border Cooperation Center, have been listed in the schedule. A series of cooperative agreements have also been signed between China and countries along the Belt and Road, for example Tajikistan, Kyrgyzstan and Uzbekistan. At the same time, Asian Infrastructure Investment Bank and Silk Road Funding has allocated funding for improving the infrastructure along the rail corridor. Against this background, in this scenario we also assume that the infrastructure, operational efficiency and geopolitical stability of the NELB will gradually increase to the same level as the CESEL (but will still not be as good as the TSLL). The hypotheses are shown in Table 9.

Insert Table 9 about here

Table 9: Input values for B&R effect scenarios

6.4 Scenario result analysis

To catch potential effects from the changes in certain of these evaluation criteria, the extended TOPSIS (Interval TOPSIS), which can handle the interval numbers and address the uncertainties, was applied to the above three scenarios. In addition, considering that industry practitioners are the decision makers for route choice in the future, we take into account only the weight of industry practitioners in the scenario analysis. Table 10 shows the calculated route performance for the above three

[8] http://en.ndrc.gov.cn/newsrelease/201503/t20150330_669367.html

scenarios.

Insert Table 10 about here

Table 10: Calculated performance of proposed scenarios

It is observed that the routes' performance ranking in all three scenarios are the same as the baseline. This implies that the TSLL would still have a comparative advantage over the two alternatives for some period of time. However, the degree of this comparative advantage varies across the three scenarios.

In the scenario of an oil price increase, a higher freight rate is expected to cover the extra cost of oil and the longer transit time, because the carriers will adopt a slow steaming strategy to cover the increase in oil price. In addition, the emissions of CO_2 and SO_x will decline accordingly, because ships operating at lower speeds have a reduced amount of emissions. Therefore, the significant influence of increases in freight rate on route performance is partially offset by the decrease in emission effect. The oil price change exerts a relatively greater negative influence on the CESEL, because the freight rate of the CESEL is higher than the TSLL, and the NELB is electric driven rather than oil. However, this influence is minor.

The implementation of a global sulphur cap has only a minor effect on the competitiveness of sea transport compared to rail transport. This is because the freight rates of the TSLL and CESEL only increase slightly when MGO is used, whereas their emissions show a significant decline, which offsets the negative effect of the freight increase.

In the B&R effect scenario, the performance of the CESEL has been largely improved and it comes close to the performance of the TSLL. This indicates that if the infrastructure, operational efficiency, freight rate and frequency of the CESEL is improved to the same level as the TSLL, the CESEL will pose considerable competition for the TSLL. The advantages of the TSLL come from its geopolitical stability, which is weighted heavily and has a higher performance score than the CESEL. As for the NELB, we found that if the infrastructure, operational efficiency and geopolitical stability of the NELB can be improved to the same level as the

CESEL, the performance of the NEBL will also achieve an improvement, but only to a limited extent. This is because the freight rate of the NELB, which has a high weighting among all the indices, cannot be reduced further. This implies that the NELB should target valuable shipping cargo, which is not very sensitive to the freight rate.

7. Conclusion

With the launch of the One Belt One Road initiative, the two new emerging trade routes have attracted great attention from both the transport industry and countries along the Road and Belt. This paper aims to evaluate the performance of the Traditional Sea-Land Line (TSLL), the China-Europe Sea-Land Express Line (CESEL) and the New Eurasian Land Bridge (NELB), and ascertain their relative performance rankings using real data. This is done by conducting a broad survey covering both government bodies and industry practitioners, and then performing Multi-Criteria Decision Analysis (MCDA). The differing preferences towards certain evaluation criteria between policymakers and industry practitioners, as well as the reasons for the differences are also explored using insights from institutional theories based on information collected through an intensive interview with a few key stakeholders. To consider the potential changes of certain primary criteria and their combined impacts on route performance, three scenarios are proposed, including oil price change, a global sulphur cap and the B&R effects.

The weight calculation results indicate a strong preference from all respondents that criteria regarding economic factors, such as trip frequency, freight rate and trip time, take precedence over other factors. Geopolitical stability is also heavily weighted, which indicates the concern of relevant stakeholders towards the political stability of the nations along the transport route. By dividing the respondents into groups, we found that government policymakers and industry practitioners each apply remarkably different weightings to certain criteria. For example, the economic indicators present much higher weights in the government group than in the industry group, whereas commodity nature and geopolitical stability have higher weights in the industry group. This may be attributed to the different concerns and expectations between government policymakers and industry practitioners on the development of the new routes. This distinct variance is generated due to unique “trajectory activity” in the multiple-level institutional system of China. In China, the formation of one system follows a ‘made order’, in which the regulative system came first, with the central government dominating the process as the principal institutional entrepreneurs, resulting in the strategies of the central government having differing effects at a local level. Based on institutional theories certain policy and managerial implications are suggested to solve this problem. There is no doubt that the TSLL performs better than the CESEL and NELB for all respondents. The CESEL takes precedence over the NELB, as the NELB is at present only playing a supplementary role to the shipping route.

The effect of the global sulphur cap on route performance will be limited, because CO_2 and SO_x emission reductions are offset by an increase in freight rate. However, it is noted that oil price volatility will have a unique effect on the performance of the CESEL, although this effect will not alter the performance ranking of the three routes. If the B&R strategy helps in raising the infrastructure, operational efficiency, freight rate and frequency of the CESEL to the same level as the TSLL, the CESEL will become more competitive to the TSLL and will hold only a slightly inferior position. On the other hand, if the infrastructure, operational efficiency and geopolitical stability of the NELB can be improved to the same level as the CESEL, the NELB will still perform far behind the shipping route, because its freight rate is still too high in comparison to the shipping freight rate.

There are certain limitations in the current paper that could be improved on in a future study: (1) In the questionnaire data collection, all respondents are from Asia. This is partly because the route is a headhaul one from Asia to Europe, and thus Asian shipping practitioners have more influence on the route choice. Another reason is due to our limited sources of information on western practitioners such as shippers. However, this imbalance in trade may change in the future, given the current highly debated issues in many European economies about the reshoring of manufacturing from China back to Europe, so it would be highly relevant to also include respondents from the European side. A systematic stakeholder analysis could also be made in a future study to classify the people who have influence over route selection. (2) The presented hierarchy of criteria and classification of the indicators inevitably exert an influence on the weights of indicators and the route rankings. Thus, further work should test the robustness of the results, taking into account different hierarchy and classifications. (3) The heterogeneity of commodities for different transport modes needs to be further considered. (4) With more data accessibility, a transport behavioral model can be applied in a future study.

Reference

Barzilai, J., Cook, W.D. and Golany, B., 1987. Consistent weights for judgements matrices of the relative importance of alternatives. *Operations research letters*, *6*(3), pp.131-134.

Bergantino, A.S., Bierlaire, M., Catalano, M., Migliore, M. and Amoroso, S., 2013. Taste heterogeneity and latent preferences in the choice behaviour of freight transport operators. Transport Policy, 30, pp.77-91.

Brooks, M.R. and Trifts, V., 2008. Short sea shipping in North America: understanding the requirements of Atlantic Canadian shippers. Maritime Policy & Management, 35(2), pp.145-158.

Brooks, M.R., Puckett, S.M., Hensher, D.A. and Sammons, A., 2012. Understanding mode choice decisions: A study of Australian freight shippers. Maritime Economics & Logistics, 14(3), pp.274-299.

Chen, C.T., 2000. Extensions of the TOPSIS for group decision-making under fuzzy environment. Fuzzy sets and systems, 114(1), pp.1-9.

Chen, X., Zhu, X., Zhou, Q. and Wong, Y.D., 2017. Game-Theoretic Comparison Approach for Intercontinental Container Transport: A Case between China and Europe with the B&R Initiative. Journal of Advanced Transport, Volume 2017.

Child, J., Lu, Y. and Tsai, T., 2007. Institutional entrepreneurship in building an environmental protection system for the People's Republic of China. Organization studies, 28(7), pp.1013-1034.

Child, J., Rodrigues, S.B. and Tse, K.K.T., 2012. The Dynamics of Influence in Corporate Co-Evolution. Journal of Management Studies, 49(7), pp.1246-1273.

Chu, T.C., 2002. Facility location selection using fuzzy TOPSIS under group decisions. International journal of uncertainty, fuzziness and knowledge-based systems, 10(06), pp.687-701.

Chu, T.C. and Lin, Y.C., 2002. Improved extensions of the TOPSIS for group decisionmaking under fuzzy environment. Journal of Information and Optimization Sciences, 23(2), pp.273-286.

Dagdeviren, M., Yavuz, S. and Kılınç, N., 2009. Weapon selection using the AHP and

TOPSIS methods under fuzzy environment. Expert Systems with Applications, 36(4), pp.8143-8151.

Giove, S., 2002. Interval TOPSIS for multicriteria decision making. Lecture notes in computer science, pp.56-63.

Haezendonck, E., 2008. Transport Project Evaluation: Extending the Social Cost Benefit Approach.

Hwang, C.L., Yoon, K., 1981. Multiple Attribute Decision Making: Methods and Applications. New York: Springer-Verlag.

Huang, I.B., Keisler, J. and Linkov, I., 2011. Multi-criteria decision analysis in environmental sciences: ten years of applications and trends. Science of the total environment, 409(19), pp.3578-3594.

Jiang, L., Kronbak, J. and Christensen, L.P., 2014. The costs and benefits of sulphur reduction measures: Sulphur scrubbers versus marine gas oil. Transport Research Part D: Transport and Environment, 28, pp.19-27.

Kristensen, H.O., 2012. Energy demand and exhaust gas emissions of ships. Work Package 2 of Project Emissionsbeslutningsstøttesystem. Copenhagen: Technical University of Denmark.

Lee, P.T.W., Hu, Z.H., Lee, S.J., Choi, K.S. and Shin, S.H., 2018. Research trends and agenda on the Belt and Road (B&R) initiative with a focus on maritime transport. Maritime Policy & Management, 45(3), pp.282-300.

Marquis, C. and Qian, C., 2013. Corporate social responsibility reporting in China: Symbol or substance? Organization Science, 25(1), pp.127-148.

Martino, A., Casamassima, G., and Fiorello, D., 2009. The impact of oil price fluctuations on transport and its related sectors. European Parliament, Brussels.

Nazarko, J., Czerewacz-Filipowicz, K. and Kuźmicz, K.A., 2017. Comparative analysis of the Eastern European countries as participants of the new silk road. Journal of Business Economics and Management, 18(6), pp.1212-1227.

Panagakos, G. and Psaraftis, H.N., 2018. A Taxonomy of Carbon Emission Reduction Measures in Waterborne Freight Transport (No. 18-00608).

Psaraftis, H.N. and Kontovas, C.A., 2010. Balancing the economic and environmental performance of maritime transport. Transport Research Part D: Transport and Environment, 15(8), pp.458-462.

Puckett, S.M., Hensher, D.A., Brooks, M.R. and Trifts, V., 2011. Preferences for alternative short sea shipping opportunities. Transport Research Part E: Logistics and Transport Review, 47(2), pp.182-189.

Ravi, V., 2011. Selection of third-party reverse logistics providers for End-of-Life computers using TOPSIS-AHP based approach. International Journal of Logistics Systems and Management, 11(1), pp.24-37

Rodemann, H. and Templar, S., 2014. The enablers and inhibitors of intermodal rail freight between Asia and Europe. Journal of Rail Transport Planning & Management, 4(3), pp.70-86.

Saaty, T.L. and Vargas, L.G., 2012. Models, methods, concepts & applications of the analytic hierarchy process (Vol. 175). Springer Science & Business Media.

Saaty, T.L., 1977. Scenarios and priorities in transport planning: Application to the Sudan. Transport Research, 11(5), pp.343-350, Pergamon Press.

Samvedi, A., Jain, V. and Chan, F.T., 2013. Quantifying risks in a supply chain through integration of fuzzy AHP and fuzzy TOPSIS. International Journal of Production Research, 51(8), pp.2433-2442.

Sánchez-Lozano, J.M., Teruel-Solano, J., Soto-Elvira, P.L. and García-Cascales, M.S., 2013. Geographical Information Systems (GIS) and Multi-Criteria Decision Making (MCDM) methods for the evaluation of solar farms locations: Case study in south-eastern Spain. Renewable and Sustainable Energy Reviews, 24, pp.544-556.

Shao, Z.Z., Ma, Z.J., Sheu, J.B. and Gao, H.O., 2017. Evaluation of large-scale transnational high-speed railway construction priority in the belt and road region. Transport Research Part E: Logistics and Transport Review.

Sipahi, S. and Timor, M., 2010. The analytic hierarchy process and analytic network process: an overview of applications. Management Decision, 48(5), pp.775-808.

Sun, C.C., 2010. A performance evaluation model by integrating fuzzy AHP and fuzzy TOPSIS methods. Expert systems with applications, 37(12), pp.7745-7754.

Tsaur, R.C., 2011. Decision risk analysis for an interval TOPSIS method. Applied Mathematics and Computation, 218(8), pp.4295-4304.

Vaidya, O.S. and Kumar, S., 2006. Analytic hierarchy process: An overview of applications. European Journal of operational research, 169(1), pp.1-29.

Wang, Y.M. and Elhag, T.M., 2006. Fuzzy TOPSIS method based on alpha level sets with an application to bridge risk assessment. Expert systems with applications, 31(2), pp.309-319.

Wang, S. and Meng, Q., 2012. Sailing speed optimization for container ships in a liner shipping network. Transport Research Part E: Logistics and Transport Review, 48(3), pp.701-714.

Wong, P.C., Yan, H. and Bamford, C., 2008. Evaluation of factors for carrier selection in the China Pearl River delta. Maritime Policy & Management, 35(1), pp.27-52.

Wu, B., Zong, L., Yan, X. and Soares, C.G., 2018. Incorporating evidential reasoning and TOPSIS into group decision-making under uncertainty for handling ship without command. Ocean Engineering, 164, pp.590-603.

Yang, D., Ong, G.P. and Chin, A.T.H., 2014. An exploratory study on the effect of trade data aggregation on international freight mode choice. Maritime Policy & Management, 41(3), pp.212-223.

Yang, D., Pan, K. and Wang, S., 2017. On service network improvement for shipping liners shipping lines under the one belt one road initiative of China. Transport Research Part E: Logistics and Transport Review. In press

Yin, J. and Zhang, Y., 2012. Institutional dynamics and corporate social responsibility (CSR) in an emerging country context: Evidence from China. Journal of business ethics, 111(2), pp.301-316.

Yue, Z., 2011. An extended TOPSIS for determining weights of decision makers with interval numbers. Knowledge-Based Systems, 24(1), pp.146-153.

Zis, T. and Psaraftis, H.N., 2017. The implications of the new sulphur limits on the European Ro-Ro sector. Transport Research Part D: Transport and Environment, 52, pp.185-201.