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Full Length Research.

New Eurasian Land Bridge: An Evaluation of Efficiency Characteristics

Ksenia K A Novikova[1]and Otieno Robert Kennedy[2]

[1]Transportation Management College,Dalian Maritime University,Dalian, Liaoning, 116026, China,
and
[1]Maritime State University,Vladivostok, Russia.
E-mail: shenia3253@163.com ,Phone: +86 130 1942 9939 or +86 134 7876 2710

[2]AP Service, Logistics Section,Ministry of Internal Security,Harambee House, Nairobi, Kenya,
E-mail: robertko78@gmail.com; rkotieno2000@yahoo.co.uk, Phone: +254 705 664 676

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Economic growth of any country or region is dependent on nature of the transport system within it and between it and other countries or regions. Increase in trade volumes between Europe and Asia coupled with high transport costs, long transit time and extended threats in marine and air transportation as crashes, pirate attacks, terror acts and the like, has resulted in development of the New Eurasian Land Bridge and its greater use. High speed overland haulage through the New Eurasian Land Bridge can greatly increase trade, boost globalization and regional integration. Therefore, there is need for the infrastructure to be utilized efficiently. This research used expert interview to identify efficiency characteristics and central tendency statistics to analyze survey data and determine the significance of the efficiency factors. Structural Equation Modeling, SEM, applying SPSS AMOS® software was used to build a model of the efficiency characteristics. Results of this research point out areas that need to be improved like data accuracy, reliability of trains and rail-road, speed and energy factors.

Key Words: New Eurasian Land Bridge, railway transport, modeling, efficiency, Delphi survey.

1. Introduction

Lyndon LaRouche developed the concept of the Eurasian Infrastructure Corridor in his historic press conference in 1988 which has become a great topic in international business and relations (Schiller Institute, 2001). The railway network from Europe to Asia is regarded as the foundation for development of the two continents with about four billion people. According to the Euro-Asia transport conference held in St. Petersburg in 2000 (Burdman and Bessonov, 2000), the infrastructure can be divided into five main sections, the Northern Corridor is from Europe through Trans-Siberian Railway to China; the TRACECA corridor is from Europe to Central Asia via Caspian Sea; the Central Corridor passes through Southern Europe, Turkey and Iran to China; the Southern Corridor runs through Iran via India and Pakistan to China; and a new rail and ship corridor from Europe to Russia via southern ports of Iran by ship through Arabian Sea to India.

Plan to extend connections to East Asia especially with Japan, Democratic Republic of Korea and South Korea has been put in place (Park, 2009). The first stage would link Trans-Korean Railway to Trans-Siberian Railway and the second stage would link South Korea by under-sea tunnel to China. This would reduce average delivery time from South Korean Busan Port to Hamburg by approximately eight days and would see a cost reduction of 600 US Dollars per TEU (Tannenbau, 2001). A TEU is Twenty Equivalent Unit and is the basic container measurement used in shipping industry.

This infrastructure has heightened hopes for greater regional development and economic integration. Its effective utilization has potential to open new horizons and better living standards of more than 4 billion people in the region (Schiller Institute, 2001).

Weisbord and Weisbord (1997) considered transport efficiency as “a means of maintaining or improving economic opportunities, quality of life, and, ultimately, incomes for people in a particular region” (p. 6). Rostow

(1960) argued that efficient transport is necessary for development. Tennenbau (2001) focused on infrastructural development of the New Eurasian Land Bridge and discussed in detail its nature and the contributions of countries it passes through to its construction. Whereas his research was profound in infrastructural details, it lacks insight on transit volumes and analysis of impacts to the region. Studies conducted under European Commission by several research institutions analyzed development of international railway transport within European Union countries and between EU countries and its neighbours indicate that the New Eurasian Land Bridge competes with the Trans-Siberian Railway and boosts China's economy even at times of economic downturn (Ilie, 2010). The research reported traffic volumes of between 2006 and 2007 but failed to show analysis of efficiency; though it stated that "the corridor is very efficient but needs improvements". Lan and Lin (2003) used data envelopment method to analyze efficiencies of railways in 76 countries and found that optimum line length for highest efficiency was between 2,000 and 3,000 km. Fielding, Babisky and Brenner (1985) provide three transport performance measures namely: cost-efficiency (ratio of service outputs to service inputs), service effectiveness (ratio of consumption to output of service for example ton-km) and cost effectiveness (measure of service consumption to service output). McGreehan (1993) analyzed performance of Ireland's Railways using passenger-kilometre and ton-kilometre as outputs. Train-kilometres had been used to evaluate railway performance of European railways (Gathon and Perelman, 1992).

There is a need to know the current efficiency level of the New Eurasian Land Bridge because studies showed that efficient railway transport provide economic and social opportunities better access to market and additional investment (Rodrigue, 2012). Researchers agree on the need to a more efficient New Eurasia Land Bridge (, 2010).

This research addresses the need and seeks to fill gaps left by previous research by giving insight into the efficiency characteristics of the New Eurasian Land Bridge, examining aspects of the infrastructure, establishing dimensions of efficiency and inefficiencies, developing instruments to evaluate various aspects of impacts of the infrastructure and applying analysis techniques including structural equation modeling to give insights into relationships between salient aspects of efficiency.

1.1. The New Eurasian Land Bridge

The New Eurasian Land Bridge, also known as the New Eurasian Continental Bridge (NECB) is the rail route linking Europe and Asia-Pacific Countries, basically from Rotterdam to Lianyungang port of China, a distance of 11,870 km. The railway link from Lianyungang to Kazakhstan (Youyi Port) consists of Longhai and Lanxin Railway that is uninterrupted. From Almaty, the railway extends to Samarkand and Tashkent, then to Tejen and Ashgabat in Turkmenistan. The line crosses the border with Iran at Serakhs to the 1,435 mm gauge Iranian rail link. The railway line connects China to ports on the Persian Gulf and has links to Caucasus and Turkey. The link between Bosphorus and Marmaray will be completed in 2012.

The main reason for building the NECB was to revive the Silk Road; and by this logic, we research this route. The infrastructure has continued to develop the western part of China (Li, 2004) and improve the economy of China in general (Gu, 1998). Its efficiency can have far-reaching effects.

Since we claimed the NECB as an instrument to increase trade volumes between Europe and Asia, we therefore researched its shortest way - through Kazakhstan, Russia and European North Corridor (Figure 1).

1.2 Efficiency of the Land Bridge

Efficiency is defined as competency in performance or the ability to produce desired effects with minimum effort, cost or waste (Dictionary.com). Efficiency is therefore a level of performance that uses the lowest amount of inputs to create greatest amount of outputs (Alejandro and Cesar, 2009). It is further defined as degree to which resources used to produce outputs match the optimal use of resources and can be determined in terms of technical efficiency (Padila and Eguia, 2010). Technical efficiency is defined as the conversion of physical inputs into outputs in relation to best practice. It refers to the ability to get maximum output or range of outputs from a set of input factors.

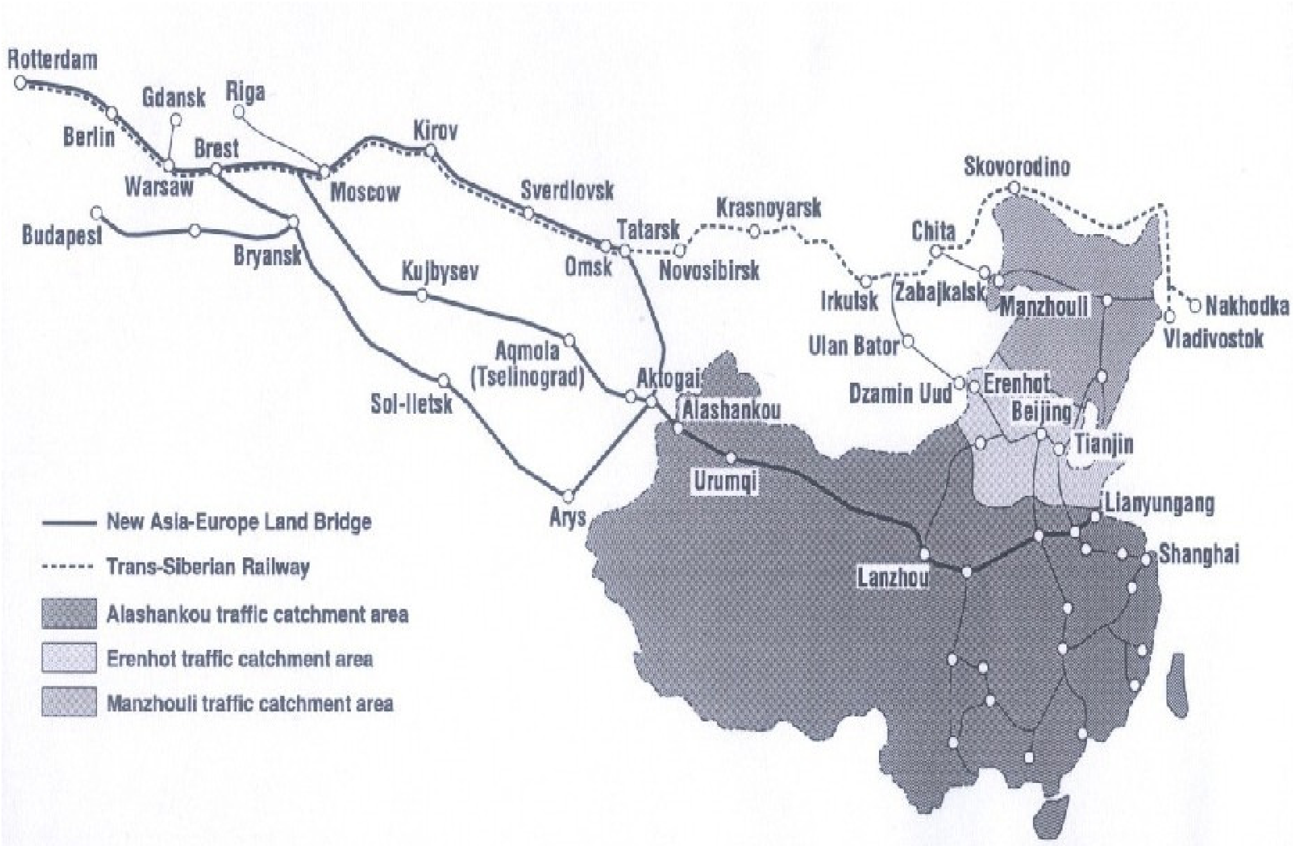

Figure 1 Map showing both Trans-Siberian Railway and the New Eurasian Land Bridge

Technical inefficiency refers to production of same level of outputs with fewer inputs or same level of input with more output. Eliminating technical inefficiencies can lead to reduced costs without change in outputs or increased output without increase in input costs. Though efficiency of transport infrastructure is obviously significant, "consistent and comparable measurement of the efficiencies is a daunting task" (Bloningen and Wesley, 2006). Many factors contribute to transport efficiency, some of which are railway infrastructure characteristics, train and wagon characteristics, labor relations, transit time and time to clear customs. However, there are no consistent data and methods to develop measures and do comparisons of transport infrastructure (US Department of Defense, 2005). Therefore, analyses of transport efficiencies at present do not provide comprehensive efficiency figures across the infrastructure through countries crossed.

Efficiency of railway has been a key area in modern bulk transit research. Zhu (2001) analyzed carrying capacity utilization using computer based simulation and noted that efficiency of railway capacity was vital to research in railway transportation. Algorithmic methods have also been applied to optimize railway transport but have severe difficulties or cannot cope at all with applications which are complex and data-intensive (European Commission, 2006).

To understand efficiency dimensions in railway transportation, it is important to establish key determinants and characteristics of railway efficiency. Previous literature indicated that organizational issues like railway human resource factors and nature of management of railway corporations, information related factors like computer-based intelligent data collection systems, railway logistics process factors for example warehousing are some of the significant efficiency characteristics (Federal Railway Administration Research Board, 2006).

2. Research Methodology

To be able to capture aspects of efficiency of the New Eurasian Land Bridge, this research used infrastructure and throughput data, and analyzed survey responses, to give insights into the current efficiency level and the future of this great investment. By both identifying the research tools and strategies that would be employed, and related their application to specified research objectives, the researchers followed acceptable procedure aimed at ensuring validity and reliability in this research (Sekaran, 2003). The objectives of this research were to establish determinants of efficiency, conduct a survey of efficiency attributes by interviewing experts in the field, to evaluate efficiency by weighted factors, and to develop structural equation model of the factors as they relate to overall efficiency.

The hypotheses for this research were formulated as: null hypothesis, H0, The attribute identified was not a significant efficiency characteristic; otherwise, alternative hypothesis, H1, The attribute identified was a significant efficiency characteristic. The research assumed that each identified attribute was not significant to New Eurasian Land Bridge efficiency until there is statistical proof to justify rejection of the null hypothesis. The acceptable threshold for confidence limit was taken as ≥95%. Research questions were:

> Q1: What are significant efficiency characteristics of the New Eurasian Land Bridge?
>
> Q2: How can efficiency of the New Eurasian Land Bridge be improved?

In order to get clear background about the topic of survey, the researchers reviewed an extensive amount of literature concerning the subject matter, efficiency of transport infrastructure, some available work on modeling of transport efficiency and research methods.

A set of priorities were considered in selecting a sample of expert respondents for the panel interview. Selection of the study settings and participants was based upon features and characteristics that enable the researchers to gather deeper information in the areas of research interest (Miles and Huberman, 1994). Since, the sample in this research was qualitative rather than random, due to emphasis in patterns of data from experts in area of study, the sampling used in this research was purposeful and strategic (Crabtree and Miller, 1999), taking into consideration convenience and ease of access to study situations and participants were given only secondary importance.

There has never been a consensus on the optimal number of respondents in panel interviews. The approximate size of Delphi respondents sample is generally under 50, but a bigger number of respondents have been employed (Wiltkin and Alschuld, 1995). Between 10 and 15 respondents could be sufficient if the background of the subject matter is homogeneous. In summary, the size of respondents is variable (Delbec, et al., 1975).

The sample size for this research was determined as N=25 at ≥95% confidence limit, theoretical considerations were taken into account (Pinilla, 2004).

Since "throughout the Delphi literature, definition of Delphi subjects has remained ambiguous" (Kaplan, 1971, p.24), the researchers used respondents' field experience and their related background to guide the selection of Delphi respondents. Since Oh (1974) indicated that selection of respondents was left to discretion of researcher, choice of expert respondents in this study was done from government databases, academia and various authors of Euro-Asian railway efficiency related publications. A set of 66 experts, in the field of railway transportation and logistics in P. R. China, Russia, Iran, Kazakhstan and Europe, representing broad professional demographic formed a group of potential panel members. Of the selected 66 expert respondents, 46 participated throughout all the three rounds of the Delphi survey Chi-square was obtained using the formula: $\chi^2 = \frac{\Sigma(f_e - f_o)^2}{f_e}$. Table 1 shows summary information of expert respondents.

To take into consideration iterative refinement of ideas, time factor and opportunities for controlled feedback expert interviews were conducted in three rounds as a balance between two to four rounds recommended in previous literature (Linstone and Turoff, 1975; Martino, 1983). Questionnaires for the first round was open ended, unstructured, easy to comprehend and with brief questions or statements within acceptable, practical peak limits of 20 to 25 words per statement to increase chances of accuracy of responses (Salancik, et al., 1971). The questionnaire for round 2 contained 28 factors, identified in the first stage and from literature, that were viewed determinants of efficiency of the infrastructure. It was ensured that the questionnaire was free from ambiguous statements or *compound events* as much as possible (Martino, 1983).The question in the questionnaires for the subsequent rounds (i.e. Rounds 2 and 3) was,

> To what extent do you agree that the following factors are *significant* to efficiency of the New Eurasian Land Bridge?

The respondents were required to respond to the question by giving weighted responses for each of the 28 characteristics and also for any added factor. The weights were as per the significance of the factor to efficiency of the infrastructure (1=strongly disagree, 2=moderately disagree, 3=agree, 4=strongly agree, 5= very strongly agree).

Dissemination of survey questionnaires to the respondents was carried out using email because of convenience and time economy. After the deadline of the first round of survey (3 weeks), responses were analyzed and aggregated.

2.1. Data Analysis

2.1.1. Survey Data Analysis

Responses were analyzed by calculating the median and inter-quartile range of data for each of the 28 characteristics in rounds 2 and 3 of the interview process. The median can also be used to arrange the 28 characteristics in order of the average weight or importance. Inter-quartile range showed how experts' responses varied, and was regarded as a measure of consensus. Table 2 summarized determinants of efficiency as obtained both from literature and from experts.

2.1.2. Structural Equation Model Analysis

Analysis for structural equation model of efficiency was done using expert respondent rating results can from each group of characteristics. A total of 28 items with statistical significance based on $p \leq 0.05$ in Round 3 were used in building the model. AMOS® software was used response data for the 28 characteristics were input into the software.

Based on clarifications given in literature (Newsom, 2005), the testing needed for development of a model of supply chain flexibility was done using Bentler-Bonett Normed Fit Index (NFI), Bollen's Incremental Fit index (IFI), Tuckler-Lewis Index (TLI), Standardized Root Mean Residual (SRMR) and Root-Mean-Square Error Approximation (RMSEA). The IFI was selected because it is relatively unaffected by sample size (Our sample size, N= 46, was small) (Hu and Bentler, 1999). If NFI, IFI and TLI >0.9, the model was accepted; the closer the indices were to 1, the more acceptable the model was. SRMR and RMSEA=0 indicated perfect fit (Hunter, et al., 1993). TLI was used to check on the simplicity of the model that is to adjust for parsimony (Mulaik, et al., 1989).

Correlation coefficients were used to test the correlation of efficiency characteristics of the New Eurasian Land Bridge represented by models (Oum and Yu, 1994). The test is to show that a change in one attribute can be related to a change in the other attribute. Pearson's correlation coefficient, $\rho_{i,j}$, between two attributes of supply chain flexibility, ***i*** and ***j*** is given by Equation (1).

$$\rho_{i,j} = \frac{cov(X_i, X_j)}{\sigma_i \sigma_j} \quad (1)$$

where, $cov(X_i, X_j)$ is the covariance of the attributes X_i in the first sub-model and X_j in the second sub-model; σ_i the standard deviation of the sample of characteristics within the first sub-model; and σ_j the standard deviation of the of characteristics within the second sub-model. Correlation coefficient is in the range of $-1 \leq \rho_{i,j} \leq +1$. As $\rho_{i,j}$ tends to ±1, there is *strong* correlation.

3. Results

Table 1 Sample of Expert Respondents

Countries Crossed	Population	Respondents expected (f_e)	Respondents who participated (f_o)
China	1.3 billion	15	10
Kazakhstan	15.5 million	8	5
Russia	143 million	15	11
Iran	69 million	8	6
Turkey	74 million	5	3
Europe	823 million	15	11
Total		66	46

Table 2 Efficiency Characteristics

	Attributes of Efficiency		Label[1]
Organization of Railway Corporation	**1.**	Standardized performance measures	RC1
	2.	Safety and security issues along the Land Bridge	RC2
	3.	Efficient utilization of human resource	RC3
	4.	Improved capability of railway workers	RC4
Information Factors	**5.**	Level and nature of data collection	IF1
	6.	Level of development of decision support systems for operations and congestion reduction	IF2
	7.	Enhancing wayside and on-board detection systems	IF3
	8.	Improved visibility of goods in transit	IF4
	9.	Data accuracy and timeliness	IF5
Railway Cross-border Logistics Process	**10.**	Transit speed and gauge characteristics	LP1
	11.	Efficiency of scheduling for trains, crew and car assignment	LP2
	12.	Ability to improve railway hardware management systems	LP3
	13.	Reliability of railway physical infrastructure	LP4
	14.	Energy efficiency and reliability of trains and infrastructure	LP5
	15.	Ability to develop strategies to increase throughput	LP6
	16.	Compliant railway transport planning system	LP7
	17.	Ability to develop computer-based train driving systems	LP8
	18.	Strategies to reduce locomotive idling	LP9
Policies and Legal Issues	**19.**	Flexibility and effectiveness of regulatory revisions	LI1
	20.	Objective evaluation of safety regulations	LI2
	21.	Ability to develop risk-based safety standards	LI3
	22.	Ability to automate track inspections	LI4
	23.	Acceptable tariffs and border crossing procedures	LI5
	24.	Level of compliance with cross-border regulations	LI6
Socio-economic and political Factors	**25.**	Strategies to reduce fuel cost	SF1
	26.	Political and social stability of countries involved	SF2
	27.	Level of regional integration	SF3
	28.	Greater cooperation of countries involved	SF4

[1] The labels were used to refer to the characteristics in model in later sections of this paper

The determinants give basis for examination and evaluation to give insight into efficiency. Container traffic volumes in TEUs (Twenty Equivalent Units) through the Alashankou used as predictor of basic data are presented in the Figure 2.

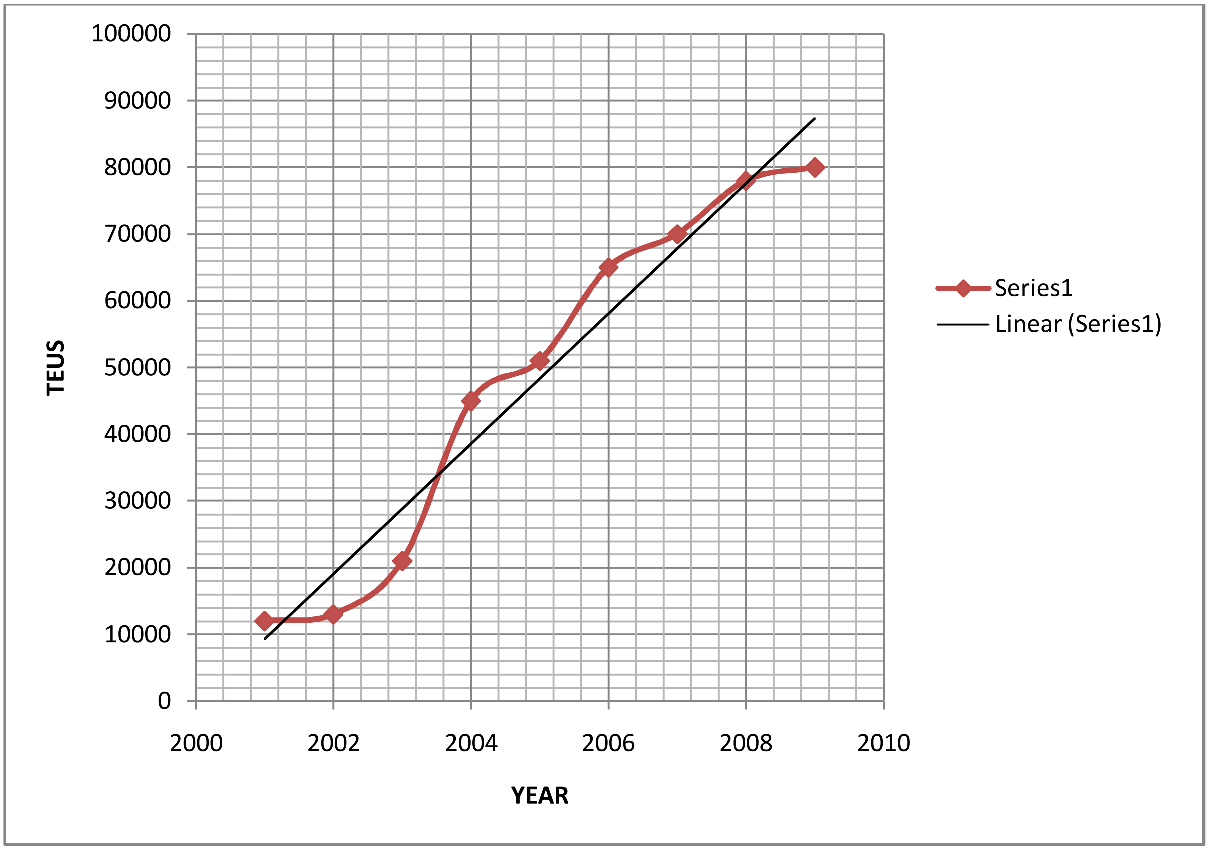

Figure 2 :Throughput of containers at Alashankou at China Border Source: Ksenia (2011)[2]

Table 3: Rounds 2 and 3 Results of Expert Interview

Attributes of Efficiency		Round 2		Round 3		Round 3 One Sample z-stat
		Median	Inter-quartile Range	Median	Inter-quartile Range	
1.	Standardized performance measures	5.0	1.00	5.0	0	4.102
2.	Safety and security issues along the Land Bridge	5.0	1.00	5.0	0	3.992
3.	Efficient utilization of human resource	5.0	0.75	5.0	0.75	3.123
4.	Improved capability of railway workers	4.0	1.50	4.0	1.00	1.762
5.	Level and nature of data collection	3.5	1.00	4.0	0.75	2.993

[2] Ksenia, K A Novikova (2011) New Eurasian Land Bridge: Factors influencing intermodal container transport, master thesis, Dalian Maritime University.

Table 3 continues

6.	Level of development of decision support systems for operations and congestion reduction	4.5	0.50	5.0	0.10	3.015
7.	Enhancing wayside and on-board detection systems	4.0	0.75	4.0	0.70	2.345
8.	Improved visibility of goods in transit	5.0	0.50	5.0	0.25	2.876
9.	Data accuracy and timeliness	5.0	0.25	5.0	0	3.991
10.	Transit speed	5.0	0	5.0	0	3.971
11.	Efficiency of scheduling for trains, crew and car assignment	5.0	0	5.0	0	3.567
12.	Ability to improve railway hardware management systems	5.0	0.25	5.0	0.25	2.889
13.	Reliability of railway physical infrastructure	5.0	0.25	5.0	0	4.012
14.	Energy efficiency and reliability of trains and infrastructure	4.0	0.50	5.0	0.20	3.214
15.	Ability to develop strategies to increase throughput	3.0	1.00	4.0	0.75	1.544
16.	Compliant railway transport planning system	4.0	0.50	5.0	0.75	1.750
17.	Ability to develop computer-based train driving systems	4.0	0.50	4.0	0.50	2.872
18.	Strategies to reduce locomotive idling	5.0	0.25	5.0	0.10	3.561
19.	Flexibility and effectiveness of regulatory revisions	4.0	1.00	4.0	0.60	3.110
20.	Objective evaluation of safety regulations	3.0	0.75	3.0	0.80	2.625
21.	Ability to develop risk-based safety standards	4.0	0.80	4.0	0.50	2.750
22.	Ability to automate track inspections	4.0	1.00	3.0	1.00	1.961
23.	Acceptable tariffs and border crossing procedures	5.0	0.40	5.0	0.30	1.977
24.	Level of compliance with cross-border regulations	3.0	0.20	3.0	0.30	1.812
25.	Strategies to reduce fuel cost	4.0	0.50	4.0	0.25	1.625
26.	Political and social stability of countries involved	4.0	1.00	4.0	0.25	1.735
27.	Level of regional integration	4.0	0.70	4.0	0.50	2.671
28.	Greater cooperation of countries involved	4.0	0.40	4.0	0.20	1.345

3.1. Model Results

Correlation between Railway Corporation efficiency factors and that of information factors is given by model diagram in Figure 3. Variance σ_i^2 for Railway Corporation factors was 0.35 and that for Information factors, σ_j^2 was 0.42. Covariance was 0.32(see AMOS® graphic diagram in Figure 3). Pearson's correlation coefficient, $\rho_{i,j}$, was 0.8346. Model fit indices NFI=0.898; IFI= 0.989; TLI= 1.000; RMSEA= 0.000, SRMR= 0.0627 and χ^2{N=46, df=13, p= 0.04} = 23.14. Acceptable results were found for correlation of the remaining pairs of characteristics.

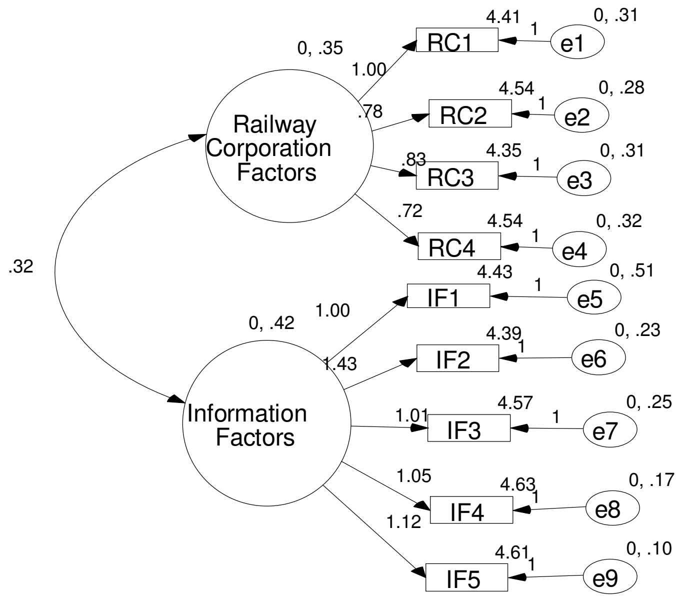

Figure 3 Correlation model of Railway Corporation and Information Factors

The final model of efficiency is as shown in Figure 4. Fit indices for overall efficiency model are: NFI=0.901; IFI= 0.911; TLI= 0.905; RMSEA= 0.048, SRMR= 0.0523 and χ^2{N=46, *df*=352, *p*= 0.04}= 399.8.

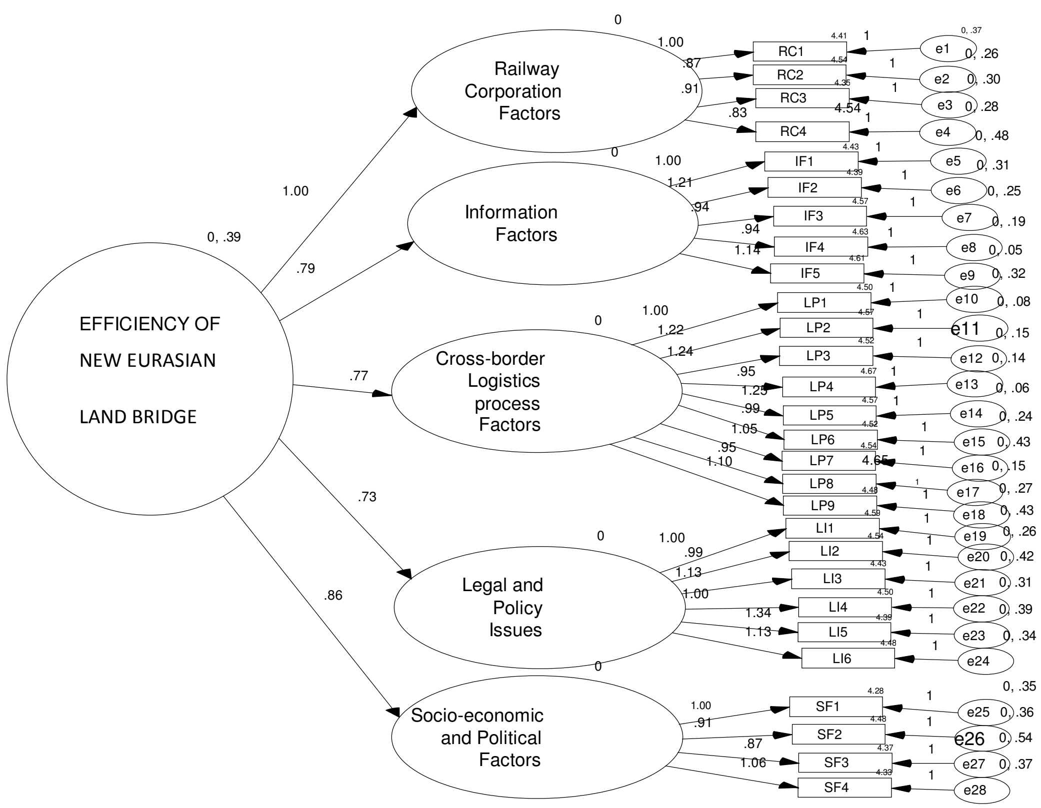

Figure 4 Overall Model of Efficiency of New Eurasian Land Bridge

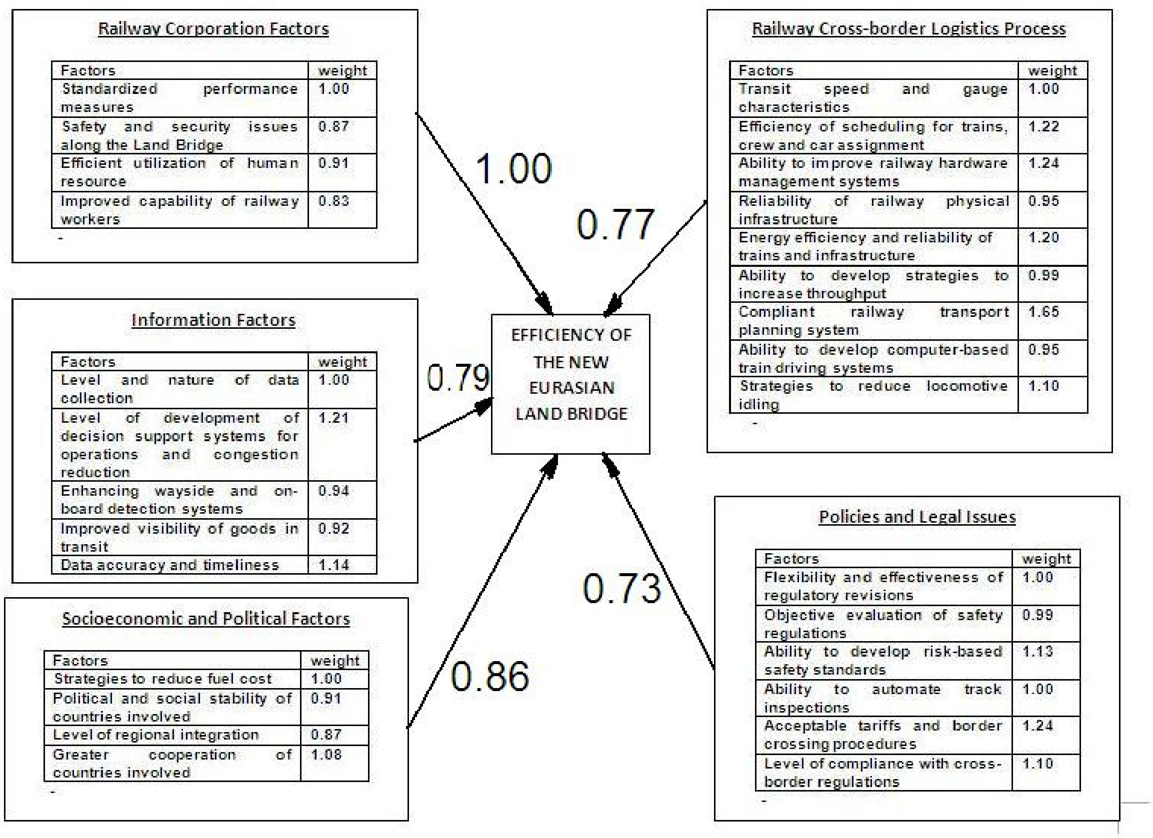

Figure 5 Simplified model diagram showing factors and regression weights

4. Discussion

Chi-square test was done for the sample of respondents and found to be within acceptable limit (Chi-square, χ^2=1.1212, degrees of freedom, *df* =5, significance level, *p*= 0.0478).

Table 3 shows summary results of the survey data. Median and inter-quartile ranges were preferred because Likert Scale rating was used. Experts were in agreement (inter-quartile range of zero) that six of the 28 factors were significant to efficiency and were rated 5 (very strongly agree). Twenty four factors had a median response of 4 or higher, meaning that the expert respondents were in strong agreement that they were significant to efficiency of NECB. Further analysis of one sample z-statistics of round 3 allowed the researchers to indicate with ≥95% confidence that 70% of the factors (21 factors) were significant efficiency characteristics of NECB.

The analysis showed that standardized performance measures, reliability of railway physical infrastructure, safety and security issues, data accuracy and timeliness and transit speed are top priority factors of efficiency. The results point out the importance of information in efficiency and show that all the information related factors had z-statistics values above 1.960 and median of 4 and above. Stakeholders should therefore ensure that information systems are put in place to ensure efficiency and timeliness. Generally, all the factors rated were significant to efficiency and should be considered in order to boost efficiency of utilizing the infrastructure.

In the structural model, correlations between pairs of all factors gave acceptable fit indices and correlation coefficients that show strong to very strong positive correlation. This indicated that an improvement of core characteristics like railway infrastructure and information factors could be associated with the improvement of logistics process factors, for example. Therefore, stakeholders of the New Eurasian Land Bridge need to know the core factors identified in this research, especially the highly rated ones, so that they can focus on these factors to boost efficiency.

Model fit indices NFI, IFI, TLI, RMSEA, SRMR and χ^2 indicate good model for efficiency of the New Eurasian Land Bridge. The model in Figure 4 shows an overall variance of efficiency characteristics as 0.01. Regression weights are 1.00, 0.79, 0.77, 0.73 and 0.86 for railway corporation factors, information factors, railway cross-border logistics process, policies and legal issues, and socioeconomic and political factors respectively in order of their increasing significance to efficiency of utilization of NECB. Figure 5 simplified the information in the structural equation model in Figure 4.

4.1. Implications of Research Findings

The findings of this research have implications to business practitioners, governments and further research. Improving efficiency of the New Eurasian Land Bridge can help firms and governments respond to ever-increasing uncertainties and dynamism in global business environment, especially Euro-Asian business, through addressing the characteristics presented in this paper (Tables 2 and 3). Stakeholders should improve information systems and railway corporation organizational stature (has highest regression weight in the final model) to ensure efficiency. Moreover, performance should be standardized and it should be ensured that railway infrastructure is reliable. It is noted that all the factors examined are of great significance to efficiency of the infrastructure.

Issues of security and safety are rated highly by the expert respondents. Model results also confirm the importance of this aspect with a regression weight of 0.73. Improving safety and security along the bridge is strongly positively correlated with efficiency. Countries and other stakeholders should ensure flexible and appropriate policy and legal factors that ensure *timely* delivery. With the improvement of efficiency, countries can improve their economies and firms can increase profitability and reliability of their service. The key efficiency factors identified by respondents like acceptable tariffs and border crossing procedures (regression weight 1.24 in Figure 4) and improved visibility of goods in transit (regression weight 0.92 in Figure 4) examined by this research also have impacts of firm profitability and service . The research corroborated work by Gael (2008) that showed example of how visibility affects profitability and service quality. He argued that visibility "delivers near-real-time information on assets … used e.g. for short-term performance forecasts, identifying bottlenecks, benchmarking, proof of delivery, proof of compliance, invoicing, or allocating shipments in transit to customer orders" (Gael, 2008, p. 14). Therefore achieving efficiency of the New Eurasian Land Bridge by putting in place information systems that boost visibility would lead to the benefits identified by Gael (2008).

Efficiency characteristics related to cross-border logistics processes like efficient scheduling for trains, crew and car assignment (regression weight 1.22 in Figure 5), and strategies to reduce locomotive idling (regression weight 1.10 in Figure 5) coupled with improvement of railway information systems could help in processes like "rerouting shipments, expediting delayed shipments and coordinating intermodal transport" (Gael, 2008, p. 15)

The results showed that socioeconomic and political factors (regression weight 0.86 in structural model) was found to be of priority, second after railway corporation factors (regression weight 1.00). Factors like strategies to reduce fuel costs, political and social stability and greater cooperation of countries involved is key to investor confidence (European Union, 2011). Greater cooperation between the European Union and Central Asia was identified as. For more efficient New Eurasian Land Bridge and greater investor confidence, stakeholders should seek for political stability in countries crossed by the infrastructure. The strategy stated: "Security questions and regional economic development require close cooperation of the EU with each Central Asian state ... in particular with respect to Afghanistan, Pakistan and Iran ..." (European Union, 2011).

Experts in railway transportation, the business communities in the countries crossed, governments and Euro-Asian regional economic unions can develop policies and strategies using factors identified in this research to improve efficiency of the New Eurasian Land Bridge.

4.2. Limitations and Further Research

Precautions were taken to avoid obvious limitations, but it was impossible to avoid all concerns. In this study, the assumption was that the experts in the field of railway transport and supply chain have knowledge of variables studied in this research. A repeat of the same study with actual data analysis like ton-kilometre, staff number, train-kilometre as indicators of efficiency could be a point of interest. Further research should evaluate efficiency measures developed in this research and also test structural model results to provide further evidence on validity and reliability of the instruments used in this research. Data collection in this study was based on 46 expert respondents which, though supported by literature on Delphi technique, could result into less reliable results. Another limitation was that the research did not consider implications of cost figures and energy efficiency on overall infrastructure efficiency. Future research could shed more light in this area and provide further confirmation of results in this paper.

5. Summary and Conclusions

The paper examined efficiency characteristics of the New Eurasian Land Bridge and its attributes namely: railway corporation factors, information, cross-border logistics process factors, legal and policy issues and socio-economic and political factors. A research model that related the attributes to each other and to various characteristics was developed. The study constructed a network of efficiency constructs and conducted analysis of responses from experts in a number of countries crossed by the bridge. The study is one of the first investigations into railway efficiency using structural equation modeling. Sub-dimensions of efficiency were measured using carefully designed, valid and reliable instruments. Great care was taken during item generation and evaluation to capture the content domain of the constructs; moreover, factor structure was simple and had good loading above 0.7. The research instruments proposed in this study mark a good progress towards establishing standard transport infrastructure efficiency measures and can be applied in evaluating the efficiency of transport network or in comparing efficiency across a number of transport networks between countries or regions.

References

Alejandro, G. C. and César R. T.(2009) Mexico: total productivity changes at the principal container ports CEPAL Review*,* 99:173 – 185.

Blonigen, Bruce A., and Wesley W. Wilson (2006) New Measures of port efficiency using international trade data, NBER working paper, 12052,

Burdman, Mary and Bessonov, Roman (2000) A new financial order is essential for the Eurasian Land Bridge EIR Vol 27, 38:1 – 6 available at http://www.larouchepub.com/eiw/public/2000/eirv27n38-20000929/index.html

Crabtree, B. and Miller,W. Doing qualitative research, (1999) Sage Publications, London.

Delbecq, A. L. , Van de Ven A. H. and Gustafson, D. H. (1975) Group techniques for program planning, Scott, Foresman, and Co., Glenview, IL,.

Dictionary.com Efficiency definition available at http://m.dictionary.com/d/?=efficiency&o=0&l=dir

European Commission, (2006) Algorithms for robust and online railway optimization: Improving the validity and reliability of large-scale systems Available online: http://arrival.cti.gr/

European Union (2011) The EU and Central Asia: Strategy for a new partnership, Eurodialoge, available at http://eurodialogue.org/eu-central-asia-strategy/10

Federal Railroad Administration Research Board (2006) Research to enhance rail network performance *A Workshop* April 5 – 6 , Washington DC.

Fielding, G. J., Babitsky, T. T. and Brenner, M. E. (1985) Performance evaluation for bus transit,Transportation Research, Vol. 19A, 1: 73 – 82.

Gael, Asvil (2008) In-Transit Visibility, available at http://www.telematique.eu/publications/Go08_ITV.pdf

Gathon, H. J. and Perelman, S. (1992) Measuring technical efficiency in European railways: A panel data approach, The Journal of Productivity Analysis, 3:135 – 151.

Gu Longgao, *Economic strategy of the new Eurasian Continental Bridge*, South East University Press, 1998.

Hu, L. and Bentler, P. M. (1999) Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives, Structural Equation Modeling, 6: 1 – 55.

Hunter, L., McGregor, A., MacInnes, J. and Sproull, A. (1993) The flexible firm: Strategy and segmentation, BRIT J IND RELAT*,* 39: 383 – 407.

Ilie, Elena (2010) New Eurasia Land Bridge provides connection between China and Europe, Railway Pro, available at http://www.railwaypro.com/wp/?p=2153

Kaplan, L. M. (1971) Use of Delphi methods in higher education, Technological Forecasting and Social Change, 4:2:173-186.

Lan, L. W. and Lin, E. T. J. (2003) Technical efficiency and service effectiveness for railways industry: DEA Approaches, Journal of East Asia Society for Transportation Studies 5:2932 – 2947.

Li Kaiyi (2004) New Eurasian Land Bridge strategy for economic development (China Section) Changan University Press,

Linstone, Harold A., Turoff, Murray (1975) The Delphi method techniques and applications Addison-Wesley: Reading, MA.

Martino, J. P. (1983) Technological forecasting for decision-making, Elsevier, New York.

McGreehan, H., (1993) Railway costs and productivity growth, Journal of Transport Economics and Policy, 27:19 – 32.

Miles M. B. and Huberman M. (1994) Qualitative data analysis: A source book of new methods, Sage Publications. London.

Mulaik S. A., James, L. R. Van Alstine . Bennett J., N., Lind S. and Stilwell C. D. (1989) Evaluation of Goodness- of-Fit Indices for structural equation models", PSYCHOL BULL*,* 105: 430 – 445

Newsom, (2005) Some clarifications and recommendations on fit indices, USP 655 SEM Winter.

Oh, K. H. (1974). Forecasting through hierarchical Delphi, Unpublished doctoral dissertation, The Ohio State University, Columbus

Oum, Tae Hoon and Yu, Chunyan (1994) Economic efficiency of railways and implications for public policy: A comparative study of OECD Country's railways, Journal of Transport Economics and Policy, 28:2:121 – 138.

Padilla, M. J. and Eguia, R. E. (2010) Relative efficiency of seaports in Mindanao, 11th National Convention of Statistics (NCS), Davao City, October, 4-5, 1 – 16.
Park, Ki-Im (2009) Towards a productive Korea-Japan relationship, Korea International Trade Association, August 17, 2009.
Pinilla, C. (2004) International entrepreneurship in local SMEs supplier networks, J ECON ISSUES, available at http://e-archivo.uc3m.es/bitstream/10016/7321/2/international_IJEI_2004.pdf
Rodrigue, J. Paul (2012) Geography of Transport System, Chapter 7 available at http://people.hofstra.edu/geotrans/eng/ch7en/conc7en/ch7c1en.html
Rostow, W. W., 1960 The Stages of Economic Growth, Cambridge, Cambridge University Press.
Salancik, J R., Wenger. W. and Helfer, E. (1971) The construction of Delphi event statements, TECHNOL FORECAS SOC, 3:65 – 73.
Schiller Institute (2001) Chronology: From Productive Triangle to Eurasian Land Bridge available at www.schillerinstitute.org/russia/ruseal_chronology.html
Sekaran, U. (2003) Research methods for business – A skill - building approach, John Wiley & Sons, Inc., New York
Tennenbau, J. (2001) The New Eurasian Land Bridge infrastructure takes shape Schiller Institute.
US Department of Defense Dictionary of Military and Associated Terms.
Weisbord, Glen and Weisbord, Burton (1997) Assessing the economic impacts of transportation projects, 477:1 – 34, available online at http://onlinepubs.trb.org/onlinepubs/circulars/circular477.pdf
Witkin B. R. and J Altschuld,. W. (1995) Planning and conducting needs assessment: A practical guide, Sage Publications, Inc., Thousand Oaks, CA.
Zhu Xiaoning (2001) Computer-based simulation analysis of railway carrying capacity utilization, Info-tech and Info-net. Proceedings. ICII 2001 - Beijing. 2001 International Conferences, 29th October to 1st November, 2001, 4:107 – 112,